A FRAMEWORK FOR ANALYSING THE INFLUENCE OF TEAMWORK PROCESSES OF ONSITE CONSTRUCTION TRADE CREWS ON PRODUCTIVITY

A THESIS

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APRIL 2023

Dedicated to my Family, my Teachers & the Oneness

Dedicated to Construction Workers

<u>CERTIFICATE OF ORGINAL AUTHORSHIP</u>

I, **Santhosh Loganathan**, declare that this thesis, is submitted in fulfilment of the requirements for the award of **Doctor of Philosophy**, in the School of Built Environment, Faculty of Design, Architecture and Building at the **University of Technology Sydney**.

This thesis is wholly my own work unless otherwise referenced or acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

I certify that the work in this thesis has not previously been submitted for a degree nor has it been submitted as part of the requirements for a degree except as fully acknowledged within the text.

This thesis is the result of a research candidature jointly delivered with **Indian Institute of Technology Madras** as part of a Collaborative Doctoral Research Degree.

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Date: 19 April 2023

THESIS CERTIFICATE

This is to certify that the thesis titled **A Framework for Analysing the Influence of Teamwork Processes of Onsite Construction Trade Crews on Productivity** submitted by me to the Indian Institute of Technology (IIT), Madras and the University of Technology Sydney (UTS) Australia for the award of the degree of **DOCTOR OF PHILOSOPHY,** is a bona fide record of research work carried out by him under the supervision of Prof. K N Satyanarayana (IIT Madras), Prof. Koshy Varghese (IIT Madras), Prof. Shankar Sankaran (UTS Australia) and Prof. Perry Forsythe (UTS Australia). The contents of this thesis, in full or in parts, have not been submitted to any other Institute or University for the award of any degree or diploma.

The research work has been carried out at IIT Madras and UTS Australia.

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ABSTRACT

The subject of construction productivity and its relationship to project success has long been investigated and reported in academic journals and industry reports. That said, while the productivity growth of the manufacturing sector is said to have increased by 100% in the past 30 years, the construction industry's productivity growth has remained sluggish or flat (Sezer and Bröchner 2014; McKinsey Global Institute 2017). Hence improving construction labour productivity (CLP) is a key ongoing area of interest.

Construction management research related to CLP is primarily conceptualised and operationalised at three levels - *industry, project, and activity levels* (Yi and Chan 2014). The debate on construction productivity has primarily been focused on three main topics – *measurement of productivity; modelling of productivity and production processes; factors that influence and explain productivity growth* (Sezer and Bröchner, 2014). Although considerable research attention is given to all three levels, the present research focuses specifically on *activity-level productivity* as this best epitomises the context of onsite construction trade crews besides offering the main basis required in meeting the research aims.

Dominated by a quantitative approach, research on CLP has tended to focus on measuring individual worker output (e.g. m2/man-hour), and while this provides a useful measure of performance in broad benchmarking terms, it is relatively uninformative in terms of how and where to improve performance. For instance, it does not delve into the complexities of how to get the best out of the holistic crew as an interactive unit, which is how most work actually occurs onsite. It can also be argued

that the existing approaches to study CLP excludes the context of crew-based work practices (*where crews work as teams*) and can be instrumental in effecting productivity. Therefore, there is a fundamental need to better understand the nature and operations of work crews and their influence on work outcomes. In an attempt to address this gap in knowledge, the present study aims to investigate what work practices trade crews follow while executing their work, and why and how do those practices emerge.

The research follows the qualitative paradigm as the phenomenon of interest that the study aims to address is in the early stages of theoretical advancement in the construction context. Within the gamut of the qualitative approach, case study methodology is chosen as an appropriate research methodology as it provides an in-depth understanding of the phenomenon under study in real-time settings. The study uses a multiple case study approach and a mixed-method approach to data collection and analysis strategy was adopted. The scope of the present study is limited to building construction activities. The present study is conducted in two stages.

In Stage 1, the study aims to identify the trade crew work practices. To explore the proposition that crew work practices considerably influence onsite construction productivity, a case study methodology was adopted. The case study compared a high-performing with an average-performing crew, in unveiling the influence of crew work practices on productivity. Stage 1 identified five broad themes of crew work practices that influence productivity. These include work preparation and execution strategy; group formation and stability; avoiding duplication of non-value adding tasks; crew social cohesion and internal and external leadership.

In Stage 2, the study aims to verify and validate these identified work practices. The aim of Stage 2 is to examine the team-based skills and behaviours influencing the productivity of onsite construction trade crews. In this regard, the mainstream organisational and management literature provided an alternative line of inquiry where trade crews can be conceptualised as teams. Using a structured literature review methodology, a conceptual framework is developed in stages by merging the concepts of teamwork and CLP. The developed conceptual framework is grounded in empirical data collected from the multiple case studies conducted in the Australian and Indian construction contexts. The theoretical rationale for choosing Australia and India is because of the distinct nature of the respective construction industries in these countries and their associated construction practices. For instance, the Australian construction industry is more formally organised compared to the Indian construction industry, which is largely informal.

Three longitudinal case studies both in the Australian and Indian contexts were conducted. The trade crew carrying out a cyclic construction activity in each case project was chosen for the study. The episodic data collection included collecting data from multiple sources, such as the use of psychometric survey, direct field observations and interactions, participant observations, and semi-structured interviews in all six cases at specific intervals, from the start to completion of their trade activity. The collected field data were transcribed and coded using thematic analysis. The developed themes were then compared to the a priori codes presented in the developed framework. The analysis process was primarily aimed at grounding the empirical data using the variables presented in the framework, thereby customising and contextualising the framework to suit the context of the study.

The grounded framework identified task-focused and relationship-focused teamwork processes that impact team effectiveness in the context of onsite construction trade crews. The identified task-focused teamwork processes include crew leadership, crew orientation, and adaptability. The identified relationship-focused teamwork processes include communication, mutual performance monitoring and backup behaviour, and mutual respect and trust.

The findings discussed how the various teamwork processes and their dimensions positively and negatively influenced team effectiveness in the context of Australian and Indian cases. The Australian crews were found to have exhibited better team-based work processes and practices compared to the Indian crews. While the specific causes for the difference in teamwork processes and their impact on team effectiveness were elaborated, the wider contextual differences between these contexts also caused the differences.

The grounded framework views teamwork in the context of onsite trade crews as against viewing teamwork as a professional or managerially focused phenomenon. Using the theoretical underpinning in the mainstream organisational and management literature, the present study aimed at extending and refining theory in the construction context. By doing so, the study provided an alternate insight for analysing onsite construction activities by suggesting modifications to established conceptualisations of construction trade crews. By conceptualising crews as teams, the heterogeneity of team-based skills and behaviours of crew members and their impact on productivity performance can be more readily understood. The framework offers a practical one-stop means of implementing productivity improvement in a way that is inclusive of a closer real world

understanding of construction trade crew management onsite. An in-depth understanding of team-based work processes and practices will enable the training of foremen and onsite trade crews in such processes and practices to systematically develop high-performing crews.

Keywords: Construction crews, teamwork, productivity, work practices, construction workers, construction labour productivity.

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CHAPTER 1.

INTRODUCTION

1.1 BACKGROUND AND NEED FOR THE STUDY

Construction activity is an integral part of a country's infrastructure and industrial development. As a major contributor to the economy of most nations, the construction industry employs over 180 million worldwide. The construction industry accounts for an average of nearly 7% of the world's workforce and contributes approximately 13% to the gross domestic product (GDP) of most countries (McKinsey Global Institute 2017). The industry facilitates the construction of buildings and infrastructure that is essential to the operation of all other industries, besides adding to the wealth and capital stock of any nation. The demand for construction activities is driven by a number of factors such as population growth, industrial activities, income growth, technology changes, commodity cycles, consumer sentiments, interest rates, inflation etc. The availability, price, location of resources, including skilled labour, building materials, and equipment are some other key determinants of the pace at which the industry grows. The supply chain for construction is highly complex and strongly interrelated, encompassing manufacturing (materials, equipment components), services (design, engineering, consulting, project management) and traditional construction trades.

Construction projects are often turbulent, largely because of the number of variables involved, particularly the labour-intensive work, the unique character, and the occurrence of unpredictable events (Eriksson and Szentes 2017). These factors are, at the same time, some of the major causes of stagnation in the industry in terms of low profitability and productivity. While the productivity growth of the manufacturing sector is said to have increased by 100% in the past 30 years, the productivity growth of the construction industry have not been up to the mark (McKinsey Global Institute 2017; Sezer and Bröchner, 2014). Productivity is a crucial component in ensuring the profitability of most construction projects, and hence one of the most frequently discussed topics in the construction industry (Yi and Chan 2014). It is also one of the most frequently used performance indicators to assess the success of a construction project (Yi and Chan 2014). Further, in a study analysing trends in construction management research, productivity was identified as the second top research area next only to scheduling. Labour and personnel issues, in particular, gained increasing research attention over the last 10 years (Jin et al. 2019; Abudayyeh et al. 2004).

There are a number of factors accounting for construction productivity, but it can be argued that for a majority of projects, labour is the primary resource used, despite being the most complex and volatile to manage (Dolage and Chan 2013; Yi and Chan 2014). Site labour can account for 30-50% of project costs, thereby demonstrating the impact of construction labour productivity (CLP) on the industry (Harmon and Cole 2006; Hong et al. 2018). Hence, for the contract work to be financially viable, it is imperative that CLP is well understood and improved, so that labour costs and by extension total project costs can be controlled and reduced (Harmon and Cole 2006; Yi and Chan 2014).

The success of a construction project is often measured by its performance in the parameters of time, cost, quality, and safety. Flyvbjerg et al. (2003) studied 258 mega infrastructure projects from 20 developed and developing countries and derived that globally, 90% of the large infrastructure projects suffer from time and cost overruns. For instance, in the Indian context, a study by Narayanan et al. (2019) on time and cost overrun in 30 Indian mega projects indicates that the time overrun ranges from 10% to 265% with an average of 127%. Studies also indicate that rework can account for 20% of the construction costs while accidents can account for 8% of the total project cost (Akcay et al. 2018; Love et al. 2018; John and Itodo

2013). This is particularly important because many construction operations have remained craft-based over the years as labour-intensive operations are largely considered the cheapest option, at least in the short term, in many economies around the world (Chiang 2009; Ng and Tang 2010). For instance, in developing economies such as Brazil, China, India, South Africa, where demand for housing and commercial construction is high, onsite construction activities remain labour-intensive. In fact, local construction in developed economies is also reliant on labour-intensive, in-situ construction methods (Ng and Tang 2010). Despite forming the core bulk of the construction activity, studies indicate that labour is often used to only 40-60% of its potential efficiency, and up to 50% of labour cost goes to labour waste due to poor workforce and crew management practices (Harmon and Cole 2006; Tulacz and Armistead 2007; Hajikazemi et al. 2017). This rightly explains why improving CLP gets significant research and industry attention as many construction professionals believe that construction costs and schedule can be reduced by up to 15% by improving CLP. Besides, studies have found that 1% rise in productivity is capable of generating several million dollars in savings thereby indicating that opportunity for understanding and improving CLP clearly exists (McKinsey Global Institute, 2017; Yi and Chan 2014; Goodrum et al. 2011; Enshassi et al. 2007).

1.2 CONSTRUCTION LABOUR PRODUCTIVITY (CLP): INTRODUCTION AND FOCUS OF THE PRESENT STUDY

Since the 1960s, researchers have studied and rationalized short-term as well as long-term explanations for low productivity growth in the construction industry (Abdel-wahab and Vogl 2011; Sezer and Bröchner 2014; Sveikauskas et al. 2016). The earliest use of the word ‘productivity’ can be traced back to 1766 when it was first pointed out in an article by Quesnay (Vaggi 1987). Several definitions of productivity are encountered in construction literature, depending on the measurement objectives and data availability. However, in its simplest terms, productivity is the output produced by a unit of study as a proportion of the inputs required to produce it (Schreyer 2001). Outputs are measured by the value or quantity of goods or services produced to comply with certain quality standards – for construction, this is often expressed in terms of common units of building measure such as m^2 or m^3 of completed work. Inputs, on the other hand, include resources such as labour (manual and managerial), materials, plant, equipment, technologies, and energy – which are often expressed in terms of resource usage time such as hours required to complete the work. As stated previously, labour continues to be by far the strongest resource of interest in construction research and practice (Yi and Chan 2014; Naoum 2016; Jin et al. 2019) thereby establishing the necessity and relevance of understanding and improving construction labour productivity (CLP).

Construction management research related to CLP is primarily conceptualised and operationalised at three levels - *industry, project, and activity levels* (Yi and Chan 2014). The debate on construction productivity has primarily been focused on three main topics - *the measurement of productivity; modelling of productivity and production processes; along with the factors that influence and explain productivity growth* (Sezer and Bröchner, 2014). Although considerable research attention is given to all three levels, the present research focuses specifically on *activity-level productivity* as this best epitomises the context of onsite construction trade crews besides offering the main basis required in meeting the research aims. Figure 1.1 shows the classification of CLP research. It can be argued that the problem with the existing approaches to measurement and modelling of productivity at activity-level (*i.e., CLP, construction labour productivity*) is that it manifests purely in terms of output per worker, where this excludes the context of crew-based work practices (*where crews work as teams*) and can be instrumental in effecting productivity.

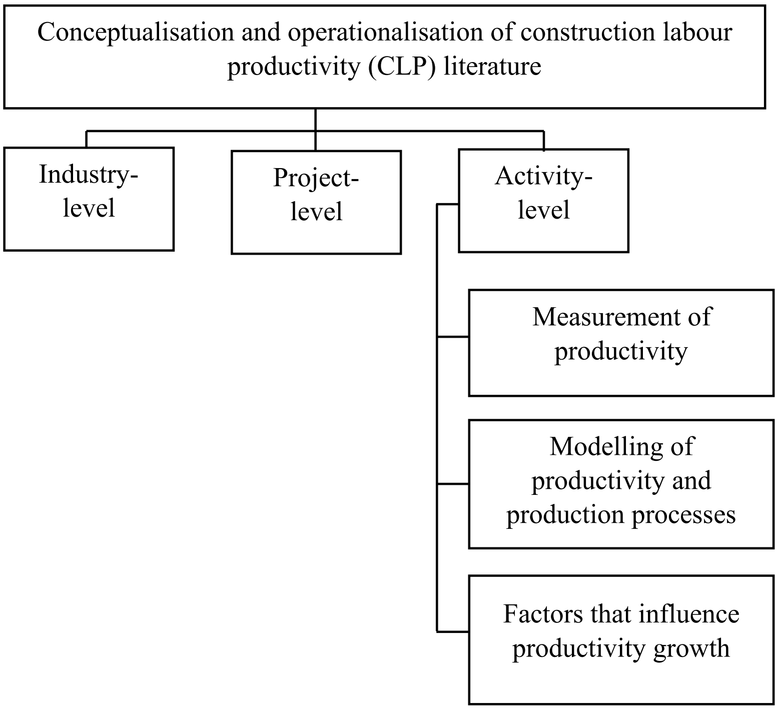

Figure 1.1 Classification of CLP literature

1.3 RESEARCH PROBLEM

The subject of construction productivity and its integral relationship to project success has long been investigated and reported in academic journals and industry reports. Dominated by a positivist approach, research on CLP largely tended to focus on measuring individual worker output (e.g., m^2/man-hour). While this provides a useful measure of performance in broad benchmarking terms, it is relatively uninformative in terms of indicating how and where to improve performance. For instance, it does not delve into the complexities of how to get the best out of the holistic crew as an interactive unit, which is how most labour actually occurs onsite. It is important to note that this takes into account the adage that the total effectiveness of a group, where and when there is ongoing interaction among the participants, is greater than the scenario where and when participants act in isolation from one another. However, this is not well understood, particularly in the context of onsite construction activities (Dolage and Chan 2013; Yi and Chan 2014; Raoufi and Fayek 2018). Therefore, there is a fundamental need to better understand the nature and operations of work crews as distinct from the practice of purely keeping them busy.

Apart from complex operations, work crews usually follow their own practices in terms of how they plan, organise and coordinate work (Mitropolous and Cupido 2009). Quite often, managers on construction projects fail to follow either historically successful or innovative practices that lead to enhanced crew productivity (Gurmu and Aibinu 2017; Caldas et al. 2015). Also, there is little research on the nature of crew work practices. That said, in contrast to the wealth of research on the influence of broader construction management practices on productivity (Gurmu and Aibinu 2017; Bernold and AbouRizk 2010) there is a noticeable paucity of attention given to the aspect of trade crew work practices (Mitropolous and Cupido 2009). Also, as discussed before the need to understand and improve CLP clearly exists in research and practice, thereby adding to the importance of studying the issues at the crew level, particularly looking at their work practices.

1.4 RESEARCH CONTEXTS AND SETTINGS

The present study revolves around two research contexts – Indian and Australian. The theoretical rationale for choosing India and Australia is because of the distinct nature of the respective construction industries in these countries and their associated construction practices. For instance, the Australian construction industry is more formally organised compared to the Indian construction industry, which is largely informal. In the following sections, a brief overview of the Indian and Australian construction industry and their respective workforce is presented.

1.4.1 Indian construction industry - Overview

The last two decades have seen the Indian economy grow significantly. India's GDP crossed the USD 2.5 trillion mark in 2018. It is estimated that about 9% of India's GDP hinges on construction activity (Invest India 2022). The Indian construction industry employs over 51 million people across infrastructure, industrial and real estate sectors. It is the country's second-largest employer after agriculture and is valued at over USD 126 Billion (Make in India 2022; Invest India 2022). The sector accounts for the second-highest inflow of FDI after the services sector. It forms a vanguard activity of several other key sectors of the economy whose performance is dependent on the satisfactory performance of this industry.

Despite its large size, the industry belongs to the informal sector of the economy primarily because of its structure. At a broad level of categorisation, the industry comprises over 200 firms which may be called the corporate sector of the industry. These firms are large by Indian standards. Secondly, there are about 90,000 firms which are classified as class 'A' contractors and are registered with various government construction client bodies such as the Central Public Works Department (CPWD), various State Public Works Departments (PWDs), Municipal Corporations etc. These firms may be of medium or large size in terms of their business turnover. There are about 0.6 million small contractors/sub-contractors who compete for small sized jobs as subcontractors of main contractors (Make in India 2022). The prevalence of such a high number of small firms and the informal nature of the industry are often considered as primary factors impeding the performance of the industry. Nonetheless, the industry continues to remain optimistic in its presence due to the continuously rising demand from real estate and infrastructure projects. As the share of urban population in India is expected to be 50% of the total population by 2050 (Ministry of Housing and Urban Affairs 2019), the real estate sector is expected to reach a market size of USD180 Billion by 2020 and

USD 1 Trillion by 2030 (Ministry of Housing and Urban Affairs 2019). The industry is therefore predicted to grow at an annual average of 7.1% by 2025 (Invest India 2022).

1.4.2 Indian construction workforce

The current pool of the construction workforce in India comprises mainly of semi-skilled and unskilled workers as reported in the Twelfth Five Year Plan (2012-2017) Economic Sectors by the Planning Commission, Government of India (Planning Commission 2013). Table 1.1 shows the employment in the Indian construction sector by the education and skill level of employees and workers. The Commission has projected that the construction sector will require 47 million workers over the next decade.

Table 1.1 Employment in the Indian construction sector by the education and skill level of employees and workers

Category	Percentage of employment	Total Employment
Semi and Unskilled workers	83.3%	34.2 million
Skilled workers	9.1%	3.73 million
Engineers	2.5%	1.05 million
Technicians and Foremen	2.7%	1.12 million
Clerical	2.2%	0.93 million

Construction labour in India consists of three segments: the Naka/Mandi segment, the Institutional segment, and the Intermediaries segment (Ministry of Labour 2002). The Naka/Mandi segment refers to the market that caters to small builders and petty contractors who need to employ casual labour for day-to-day work. They are paid on a daily basis. The Institutional segment refers to workers who are direct employees of large construction companies. The companies give formal training to this segment of workers, retain them as core workers and transfer them from one site to another upon completion of projects. The Naka and Institutional segment of workers are relatively small in size.

The Intermediaries segment is referred to as labour sub-contractors. Labour subcontractors are mostly individuals, non-registered entities, who bridge the gap between semi and unskilled labour seeking work and contractors who can offer work. They are variously known as maistries, mukkadams, sardars or jamadars in different parts of the country. They recruit workers directly from towns and villages. These workers are generally semi-skilled and unskilled, stay with the labour sub-contractor over a period of time and informally acquire on the job skills with the help of the skilled workers on the site (Loganathan and Kalidindi 2016). Some of them return to their villages during sowing and harvesting season and also during festival seasons such as Holi (which usually falls in the month of March), and Durga Pooja (in the month of October) to spend time with their families (Loganathan and Kalidindi 2016). The problem of absenteeism and turnover is highly prevalent among these workers due to issues such as lack of basic facilities, delay in payments, illness, and on-duty injuries (Loganathan and Kalidindi 2016).

A demographic survey of around 1200 construction workers in India shows that the average age of construction workers in India was 28 years, with 81% under 35 years of age (Loganathan and Kalidindi 2016). While the average age of the Indian construction workforce is 28 years, it ranges from 38 to 45 years in other countries. For instance, it is 38 years in Australia, South Africa and People's Republic of China, 41 years in Brazil and Canada, and 42 years in United Kingdom and United States of America, and 45 years in Germany (Loganathan et al. 2021). This indicates the high turnover of young workers from the industry which can be rationalized through the aforementioned causes. Workers quit the industry after a few years and move to other industries. Also, as indicated before, for most of the migrant workers, construction is largely seen as part-time work as some of them return to their hometowns seasonally to work on farmlands.

1.4.3 Australian construction industry - Overview

The construction industry is a major driver of economic activity in Australia. It is Australia's third-largest industry, and contributes 8% to the GDP of the nation, in value-added terms (Australian Bureau of Statistics 2022). The industry employs 1.05 million people, which is around 9% of the country's total workforce (AI Group Economic Research 2015). The Australian construction industry is considered to be one of the most highly productive construction industries in the world (McKinsey Global Institute 2017). In addition to its direct contribution to GDP, the industry also supports a large upstream and downstream supply chain. For example, the production of building materials, building components and accessories are supplied from the manufacturing sector, the sale and management of property is a part of the real estate services, and the financing of property mortgages forms a part of the financial services sector (AI Group Economic Research 2015). These upstream and downstream industries are large and significant in their own right. Collectively, they extend the reach of construction-related activities in terms of contribution towards GDP to around 20% of total Australia's economy, in value-added terms (AI Group Economic Research 2015).

Like any other major industry, the construction industry in Australia operates in both the private and public sectors and across three broad areas. It includes engineering construction (major infrastructure, mining and heavy industrial resource-based projects); non-residential building construction (hospitals, shops, hotels, offices, industrial premises, entertainment facilities) and residential building construction (houses, apartment buildings, townhouses). Engineering construction is the largest activity, followed by residential and non-residential building activities (AI Group Economic Research 2015). For instance, in 2018, 48.3% of the total activity was contributed by the engineering construction, followed by 35.7% by residential and 15.6% by non-residential activities (AI Group Economic Research 2015).

As per the Australian Bureau of Statistics (ABS) business register 2015, the construction industry comprises over 338,000 businesses nationwide. These include project-based businesses (major builders and contractors, designers, engineers, project managers); property sector businesses (organisations that develop, commission, own, manage and lease buildings and other infrastructure) and the traditional construction trades (concreting, bricklaying, structural steel, carpentry services etc.). As represented in Table 1.2, the industry is overwhelmingly composed of small businesses with fewer than 20 employees (98.6% of construction businesses). Infact, 60% of the construction businesses are sole operators with no employees (AI Group Economic Research 2015).

Table 1.2 Distribution of businesses by employment size in the Australian construction

Employee range	No. of businesses	Share of businesses (in %)
Non-employing	201,785	60.0
1-19	131,546	38.6
20-199	4,698	1.3
200+	197	0.1
Total	**338,226**	**100.0**

The majority (98.6%) of these small businesses operate in the trade services sector of the building industry that includes steel fixers, carpenters, masons, plumbers, electricians, plasterers and a variety of other specialist building trades (AI Group Economic Research 2015). Medium-sized businesses (employing between 20 and 199 employees) made up 1.3% of the total number of businesses while medium to large businesses (employing 200 or more persons) accounted for just 0.1% of the total.

1.4.4 Australian construction workforce

As stated before, the industry directly employs 1.05 million people (Australian Bureau of Statistics 2022) and is the third-largest employer, next only to health care and retail trade (Australian Bureau of Statistics 2022). According to the Department of Education, Skills and Employment, Government of Australia (2022), employment in the construction industry is mostly concentrated in New South Wales, Victoria, and Queensland states. These three states together account for 75% of the entire construction employment.

Some of the notable employment and employee characteristics in this industry include far higher shares of full-time, male, self-employed, certificate-qualified workers in comparison to most other industries (Department of Education, Skills and Employment, Government of Australia 2022). As of February 2015, about 89% of construction workers are male, significantly higher than the average figure of 54% across all industries (AI Group Economic Research 2015). With regards to share of employment, sub-contract labour share 58.7% of the total employment while onsite and off-site employees share 33.9% and 7.4% respectively (AI Group Economic Research 2015). Within the Australian context, the industry has a relatively young workforce, with 43% of workers aged between15 to 34 years (which is 39% across all industries), and the median age of workers is 38 years (which is 40 years across all industries) (Department of Education, Skills and Employment, Government of Australia 2022). The number of trained and skilled workers in the construction industry is also higher compared to other industries. About 45% of the industry workers have completed a certificate III or IV qualification which is well above the share of all industries, which stands at 20% (Department of Education, Skills and Employment, Government of Australia 2022).

The above discussions provided an overview about the Indian and Australian construction industry with specific reference to the workforce in these countries. As mentioned before, the theoretical rationale for choosing India and Australia is because of the distinct nature of the respective construction industries in these countries and their associated construction practices. As noted in the previous discussions, the construction industry in Australia is more formally organised compared to the Indian construction industry, which is largely informal. For instance, the Indian construction workforce significantly consists of semi-skilled and unskilled workforce. A significant percentage of construction workers are migrants, who largely recognise construction as a part-time work as they are seasonally employed in agriculture and associated sectors. On the other hand, Australian construction workforce consists of formally trained and skilled workforce. Given the nature of organisation of construction workforce in India and Australia, it influences the way in which work is organised in project sites, the work practices that the trade crews follow and ultimately its impact on CLP.

1.5 RESEARCH OBJECTIVES

The present research study was carried out to achieve the following objectives:

1. To identify and understand the work practices of onsite construction crews and their influence on productivity.
2. To develop a framework for team-based skills and behaviours for onsite construction trade crews by synthesising (a) construction labour productivity literature, (b) teamwork literature from the mainstream organisational and management literature and (c) the identified work practices.
3. To examine the team-based skills and behaviours influencing the productivity performance of onsite construction trade crews based on the developed framework.

The scope of the present study is limited to building construction activities. Given the labour-intensive nature of building construction activities, it provides a reasonably broad scope to study the crew-based work practices and to observe and examine the team-based skills and behaviours of onsite construction crews. As already mentioned, and elaborated, the study revolves around the Indian and Australian context.

1.6 METHODOLOGY OVERVIEW

The present study follows the qualitative paradigm as the phenomenon of interest that the study aims to address is in the early stages of theoretical advancement in the construction sector. Using the theoretical underpinning in the mainstream organisational and management literature, the present study aims to extend and refine theory in the construction context. Within the gamut of qualitative approach, case study methodology is chosen as an appropriate research methodology as it provides an in-depth understanding of the nature and complexity of the phenomenon under study in real-time settings. The present study uses a multiple case study approach. Within the multiple case study approach, a mixed-method approach to data collection and analysis strategy was adopted. The case studies were conducted in large building construction projects in major Indian and Australian cities.

The choice of using case study approach is additionally influenced by other benefits. For instance, case studies allow the collection of data through multiple methods such as field observations, interviews, documents and reports collection etc. The use of multiple data collection methods enables different interpretations and meaning to be included in data analysis and strengthens the credibility of outcomes (Yin 2009). In case studies, the emphasis is placed on qualifying relationships that are too complex to be controlled by experimental research strategies (Eisenhardt 1989). In addition, case studies are good at providing a detailed longitudinal view of social phenomena (Yin 2009; Eisenhardt 1989). All these features were considered relevant in the selection of case study methodology for the present research.

An important contribution of the present study is to provide an alternate insight for analysing onsite construction activities by suggesting modifications to established conceptualisations of construction trade crews. By conceptualising construction crews as teams, their team-based work processes and practices were analysed. The aim is therefore to develop a framework for conceptualising the way that teams dynamically work together, in achieving productivity outcomes. The developed framework is grounded in empirical data collected from the multiple case studies conducted in the Indian and Australian construction contexts.

1.7 ORGANISATION OF THE THESIS

The thesis is organised into seven chapters. The present chapter introduced the area of the study, defined the focus of the present study, discussed the research problem, outlined the research contexts and settings, and established the objectives of the study.

Chapter 2 critically reviews the existing construction labour productivity (CLP) literature under the themes of measurement of productivity, modelling the productivity and production processes, and discerning the factors affecting CLP. Empirical analysis of the literature theme on factors affecting CLP has been conducted to introspect and accentuate the significance of *crew work practices* on productivity. The synthesis of the key findings from these bodies of knowledge helps to identify theoretical gaps that need further exploration.

Chapter 3 first outlines the philosophical position of the present research and the overall research approach adopted. It elaborates the stage-wise progression of the research and shows how the outcomes of the first stage lead as input to the second stage of the study. While an overarching case study methodology was adopted for both stages of the study, a mixed-methods approach to data collection and analysis strategy was adopted. The chapter provides an overview of the data collection and data analysis methods used in the various stages of the study.

Chapter 4 addresses the ***first objective of the research***. It explores how the work practices of onsite construction crews influence their productivity. It identifies five broad themes of work practices of onsite construction crews which influence their productivity. It argues that it makes both conceptual and practical sense to focus on crew-based work practices, instead of a long list of isolated and disaggregated factors to study the impact on productivity. The chapter highlights the inadequacy of the existing literature on the aspect of dimensioning CLP in terms of work crews and concludes by collectively conceptualising the identified work practices through the lens of 'teamwork', i.e., crews as 'teams'. This is further developed as a framework in the following chapter.

Chapter 5 addresses the ***second objective of the research***. It develops a framework for team-based skills and behaviours for onsite construction crews. It utilises literature support from the mainstream organisational and management literature, which also provides an alternative line of inquiry where trade crews can be conceptualised as teams. A framework is developed in stages by synthesising (a) CLP literature, (b) teamwork literature from the mainstream organisational and management literature and (c) the identified work practices (i.e., outcomes of Chapter 4, research objective 1).

Chapter 6 addresses the ***third objective of the research***. It examines the team-based skills and behaviours influencing the productivity performance of onsite construction trade crews with empirical data collected from the field in the Australian and Indian context, based on the framework developed in the previous chapters.

Finally, **Chapter 7** summarises the research work. It presents the key findings of the study and establishes the theoretical, methodological, and practical contributions of the present work. The chapter concludes by discussing some key limitations of the present work and while also recommending how the study can be extended further by related researchers in the domain.

Appendices of the thesis include Appendix A - Psychometric survey instruments used, Appendix B - Consent form and participant information sheet used, and Appendix C – Human ethics approval and related forms. **References** are included towards the end of the thesis.

CHAPTER 2.[1]

CONSTRUCTION LABOUR PRODUCTIVITY: LITERATURE REVIEW AND 'THE MISSING PERSPECTIVE'

Chapter One of this thesis introduced the study topic, discussed the significance of construction labour productivity (CLP) in determining the success of a construction project and defined the need for studying crew-based work practices and its influence on productivity. The present chapter aims to critically review and analyze the existing CLP literature and highlight the *missing perspective* in it.

2.1 MEASUREMENT OF PRODUCTIVITY

Productivity in the construction industry has always been difficult to measure and control due to the wide range of mediating factors involved in it (Sezer and Bröchner 2014; Yi and Chan 2014). One of the main challenges is the absence of common understanding and agreement on how to specifically define and quantitively measure productivity. Researchers professed that they struggled to obtain measurement data largely because of project complexity and the unique characteristics of construction projects (Crawford and Vogl 2006; Forsythe 2018). Companies often use their own internal systems for this purpose, but these systems are non-standardized,

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[1] Some sections of the Chapter are published in the Journal articles co-authored with Prof. Satyanarayana N Kalidindi and Prof. Perry Forsythe. The citation is as follows:

Loganathan, S., P. Forsythe, and S. N. Kalidindi. 2018. "Work practices of onsite construction crews and their influence on productivity." *Construction Economics and Building*, 18 (3): 18-39.

Loganathan, S., and P. Forsythe. 2020. "Unravelling the influence of teamwork on trade crew productivity: a review and a proposed framework." *Construction Management and Economics*. 38 (11): 1040-1060.

thus diminishing the chances of soliciting external benchmarking. The difficulty to develop standard productivity definitions and measures is compounded by the non-repetitive operations carried out on construction projects (Crawford and Vogl 2006; Forsythe 2018; Dolage and Chan 2013) highlight the measurement problem further, where 36 per cent of the 139 papers they reviewed on productivity, specifically raised concerns about *measurement* of construction productivity. This extent of inquiry tends to hint more at a lack of consensus than at an agreed understanding. That being said, measuring productivity in a valid and reliable way still remains as a major challenge in the research in this domain (Abdel-wahab and Vogl, 2011; Forsythe 2018).

In this view, there are two established measures of construction productivity. This includes total factor productivity and single factor productivity. Total factor productivity (TFP), also known as multi-factor productivity, includes multiple factors such as labour, equipment, materials, and capital as inputs. TFP is usually employed in a larger scale in economic studies than in technically orientated construction process studies. For instance, Wang et al. (2013) developed a TFP measure for the Chinese construction industry and conducted spatial differences analysis to improve China's construction industry TFP. In contrast, single-factor productivity is more common in construction process studies, and in this context, CLP is by far the most commonly used single-factor productivity measure in the construction industry. CLP is usually measured as output (i.e., total quantity of work produced) per input hour by workers. It is often expressed in simple unitised measures such as m^2/hour (as achieved by a notionally individual worker). For instance, in an attempt to study the influence of buildability factors on rebar fixing activity, Jarkas (2010) used single-factor productivity measure, i.e., kg/man-hour to examine CLP. Much the same can be said of performance ratios which is obtained by dividing actual productivity over expected productivity. Enshassi et al. (2007) for example, used performance ratio to compare masonry labour productivity across different projects. Despite its use in several studies, such measures are not absolute and ultimately provide a unit-less measure of variation in productivity (Yi and Chan 2014).

With regards to productivity measurement techniques, some of the commonly used data collection techniques include time studies, time-lapse visual techniques, delay surveys, activity sampling etc. The problem that was noted with these conventional productivity measurement techniques is the reductionistic approach in analysing work time (Drewin 1982). Much of the analysis of productivity data has been concerned with the binary relationship between productive (or value-adding) time and time loss. However, researchers in the past challenged these assumptions and indicated that they are unsupportable for most construction operations (Thomas et al. 1990). Most of the studies also focused on largest construction activities such as concrete, masonry, structural steel, and electrical works. It was also argued that concentrating on the predominant or largest activity results in a reductionistic approach, which fails to consider the entire construction process (Chan and Kaka 2004).

A series of studies by Thomas and his colleagues from the late 1990s (Thomas et al. 1990; Thomas et al. 2004) also attempted to develop reliable productivity measurement systems. Despite the depth of inquiry into the detailed activity processes, these studies continue to provide limited explanatory feedback about what went wrong or right, particularly in the context of the involvement of trade labour. A recent systematic review of productivity studies by Chan and Ejohwomu (2018) also indicates the trend that while more studies have focused on measuring productivity, significantly less attention is paid to managing productivity.

The aforementioned facts lead us to conclude that while many studies focus on analysing individual worker productivity at activity-level, they fail to provide adequate understanding about the impact of crews and their work practices on productivity *in particular*. There is, however, a need to understand the interdependencies between crew members since multiple members are often required to complete a task or activity. It is also important to take into account the heterogeneity of labour skills and behaviours required to execute a given trade activity (Schreyer 2001; Thomas et al. 2004). It is pertinent to note that existing studies have paid less attention to examine the contribution of project management to productivity, which also signifies the aspects of interdependencies and teamwork at trade crew level (Chan and Ejohwomu 2018).

2.2 MODELLING OF PRODUCTIVITY AND PRODUCTION PROCESSES

Effective planning of the production process is critical to the success of any construction project – it addresses strategies for site and crew set-up along with construction methods and procedures (Gidado 1996). While project management focuses on macro level strategic issues, production (or operation) management focuses on the micro level. Project management is the process takes into account a company's way of doing business, allowing for the possibility of a significant payoff with fewer risks (Callahan and Brooks 2004) whereas production management take into the actions incorporated to meet a project's target by adjusting time, cost and resources (Lee et al. 2006). Production management therefore investigates the productivity aspects of resources that are utilised to complete a project.

Since the early 1970s, researchers and practitioners have developed various construction models to deal with both project and production issues in construction. Kartam et al. (1997), suggested that the existing models could be divided into two types, system models and process models, on the basis of whether the models emphasise the whole system or only the onsite construction process. The following sub-sections attempts to analyse the various productivity models developed in the literature within the context of the present research.

2.2.1 Entity Interdependence Model

Thompson (1967) developed the entity interdependence model. In this model, as shown in Figure 2.1 (adapted from Thompson (1967)), the interdependencies existing between the various entities were explicitly explained. Thompson based his classifications on the flow of work or how the work is to be divided among individual members of the workgroup. Thompson identified three types of interdependencies - 1) pooled (no coordination), 2) sequential (simple coordination), and 3) reciprocal (complex coordination). Thompson (1967) emphasized the importance of a thorough knowledge of how these interdependencies work to enable a smooth and effective coordination among the work units (and crews) working on the different construction operations. Entity interdependence model indicates that the study of interdependence helps understand how the performance of a work unit/crew depend on the performance of others who work in the same environment.

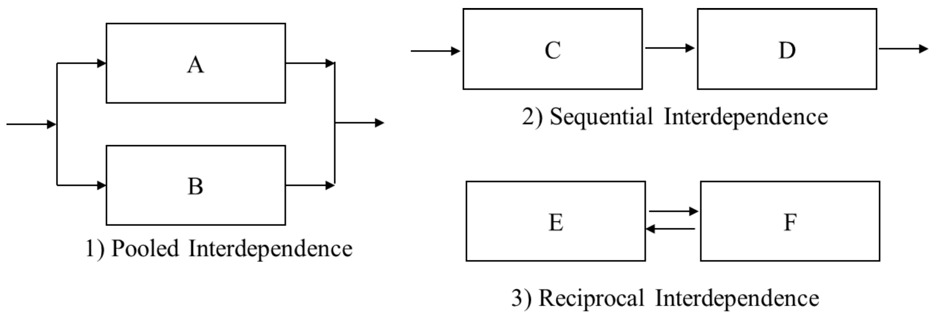

Figure 2.1 Entity Interdependence Model (Thompson 1967)

2.2.2 Conversion Models

Alexander (1974), in his conversion model, showed that the inputs are converted into output by undergoing a process which is regulated by a controller, which goes on to establish the operating characteristics of the process. In the conversion model, as shown in Figure 2.2

(adapted from Alexander (1974)), it was assumed that the cost of any process could be minimised by minimising the cost associated with the respective sub-processes.

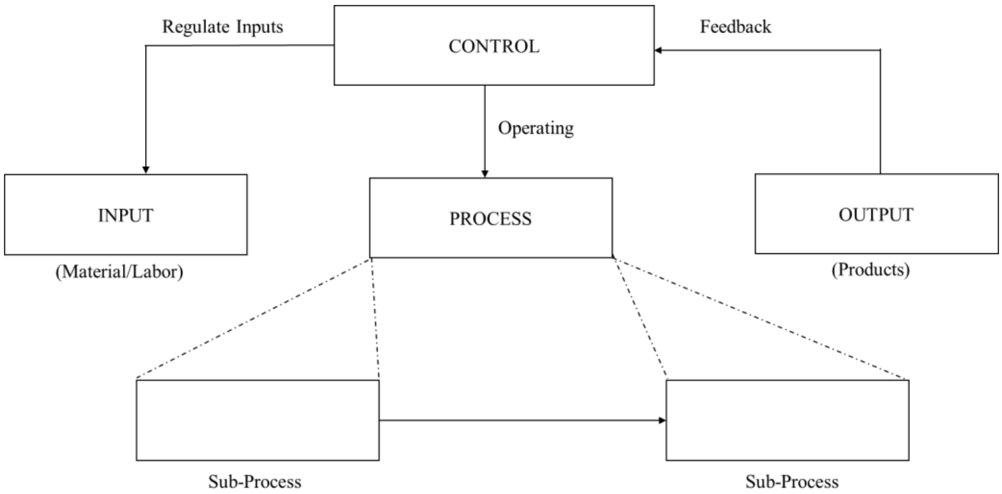

Figure 2.2 Conversion Model (Alexander 1974)

Walker (1985) extended the above conversion model (as shown in Figure 2.3 – adapted from Walker (1985)) provided by Alexander (1974) and applied it to the construction process. He divided the transformation process into two groups, namely the construction process and client process; where each process while converting inputs to outputs, is affected by various environmental factors. The model was sufficient and seemed acceptable to show the construction process but only in terms of the transformation of processes. It overlooked the flow of material and information and value generation components associated with a construction process, which Koskela advocated in his work (Koskela 1992). Further, it did not make an attempt to explain how the construction processes are interdependent with considerable performance variation.

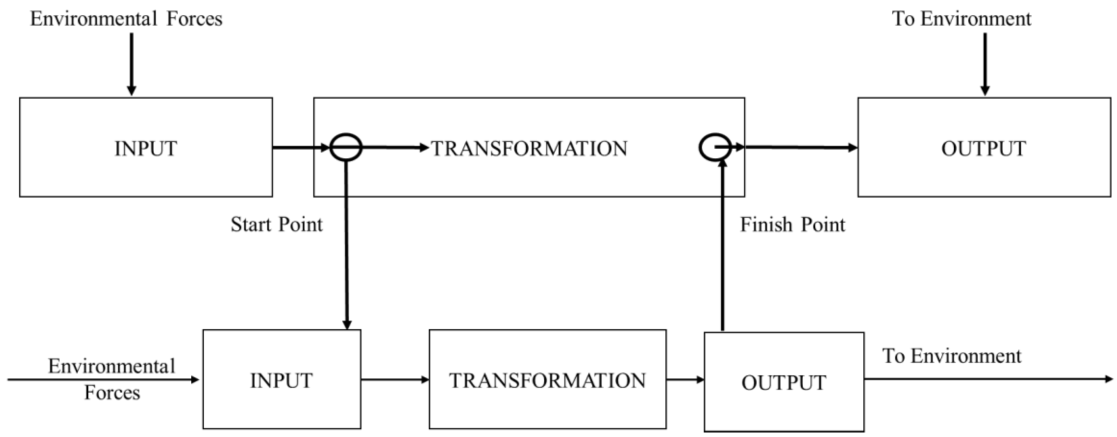

Figure 2.3 Conversion Model (Walker 1985)

2.2.3 Method Productivity Delay Model

Adrian and Boyer (1976) developed the method productivity delay model (MPDM). This model was developed for application by small to mid-size construction firms that cannot afford professional services. The MPDM measures, predicts and helps to improve the productivity of the construction operations in four stages, namely data collection, data processing, model structuring, and model implementation. In this model of construction delays were classified into five major types: environmental, equipment, labour, material, and management. By collecting data on these delay types occurring in the construction operation, the model measures the efficiency of construction operations and identifies the problematic areas lowering productivity. MPDM does not consider the other interactions and interdependencies occurring among crews on the site, which may lead to optimising individual processes but not the whole system.

2.2.4 Control Model

Sanvido (1984) suggested a control model that addresses the dynamic construction environment and identifies eight major activities that constitute onsite construction. This model presented in Figure 2.4 (adapted from Figure 2.4) elucidated the various important functions of the construction process and how to regulate or control them (Figure 2.4). The main focus of this model was to take corrective actions once mistakes or inefficiencies are encountered rather than taking preventive actions before their occurrences (Kartam et al. 1997). This model was significant as it established a hierarchical way to address and control the construction process by highlighting the broad-level interdependence among the important onsite construction activities and allowing the management to better manage the dynamic construction process. However, the model fell short of providing details on crew-level dynamics and interactions.

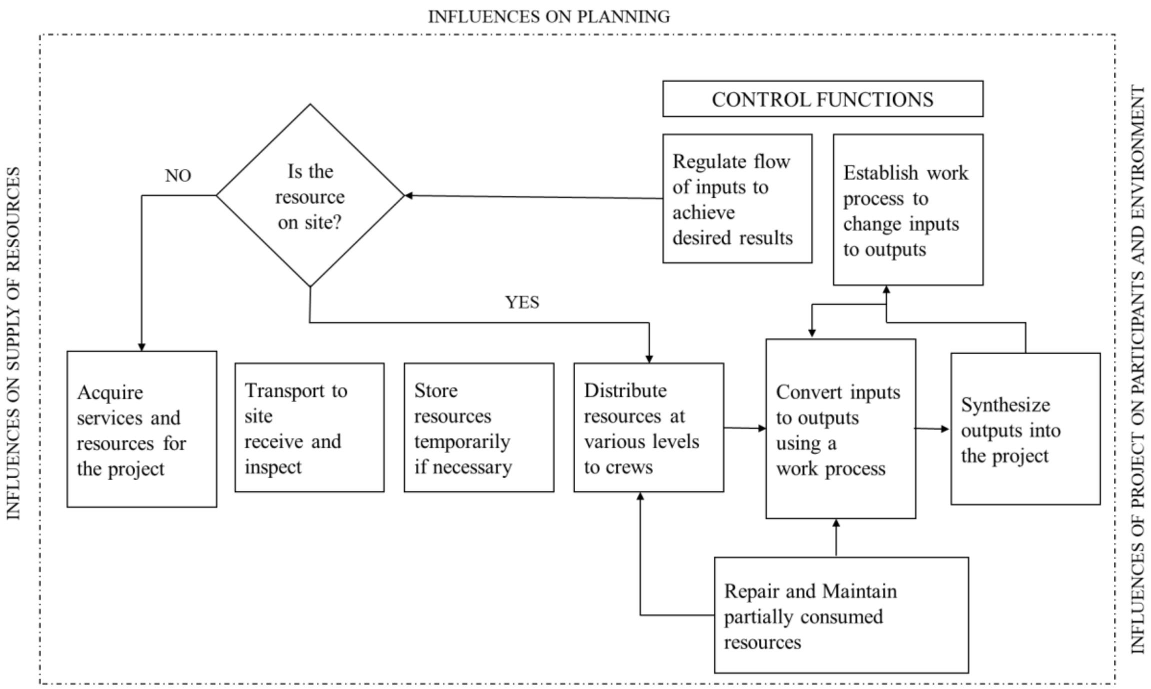

Figure 2.4 Control model (Sanvido 1984)

2.2.5 Factor Model

The factor model which was proposed by Thomas et al. (1990) (as represented in Figure 2.5 – adapted from Thomas et al. (1990)) is different from previous models in that it focuses on productivity at the activity-level and mathematically calculates the actual productivity by considering the most common factors affecting productivity at the activity-level. It is similar to the method productivity delay model in that both attempts to account for the factors which affect productivity and then predicts the actual productivity.

Both models attempt to enhance the performance of workers and crews by focusing on the activity-level productivity. However, neither took into consideration the soft factors such as interdependency and coordination issues that exist among crews or the variation in the flow of work within the crew which also directly affect the productivity of crews (Nerwal 2012).

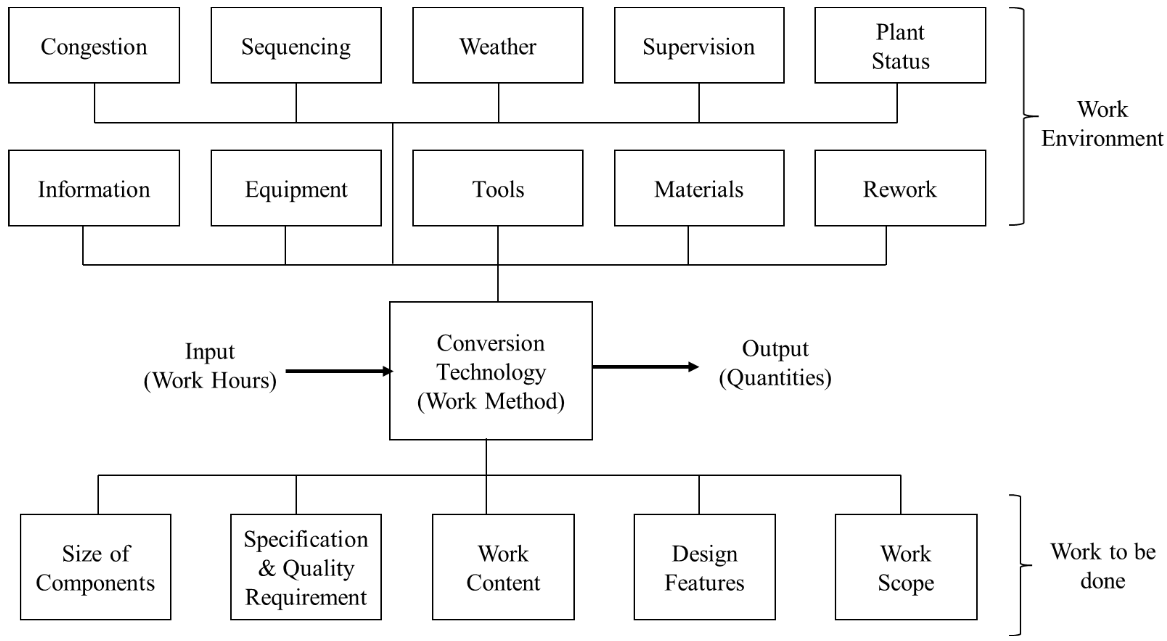

Figure 2.5 Factor model (Thomas et al. 1990)

2.2.6 Flow process model

The processing activities of construction operations fall under the transformation/conversion aspect of production, and this has been accounted for and discussed by the previous models. However, inspecting, moving, and waiting comes under the flow aspect of production. In the flow process model, as proposed by (Koskela 1992) (represented in Figure 2.6 – adapted from Koskela (1992)), any activities other than processing, such as moving, waiting, inspection, etc. are considered as waste without any value addition to the process/project.

While the flow process model provides a good representation of the production process, it does not take into account the system concept and neglects the feedback and interdependencies existing in the production process (Nerwal 2012). Also, the model focuses largely on the flow of resources such as material and/or information being processed whereas the reasons for the variation in the performance of the crews and the reasons for the inherent waste in the crews executing these activities are not elaborated (Thomas et al. 2002; Thomas et al. 2003; Nerwal, 2012). Researchers are also doubtful if the workflow in the model sufficiently considered the labour component. (Thomas et al. 2002; Thomas et al. 2003).

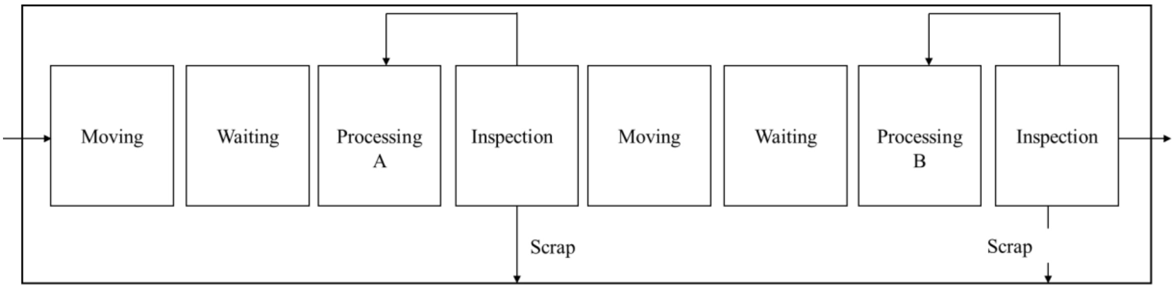

Figure 2.6 Flow model (Koskela 1992)

2.2.7 The Last Planner System

The Last Planner System was introduced by (Ballard and Howell 1997) with an objective to overcome the limitations that the conversion process models and traditional project management practices have in coordinating and controlling the field production process. This system was implemented with an attempt to stabilise the production work environment by reducing the upstream variation and thereby diminishing management uncertainty. It was estimated that there was almost a 50% gap between the number of planned activities that 'SHOULD' be done and which are actually 'DONE' (Ballard and Howell 1997) postulated that the traditional project management practice of planning and controlling work should be modified from 'Should-Did' to 'Should-Can-Will'. They argued that differentiating between what 'SHOULD' be done and what 'CAN' be done is important to augment the reliability of plans. It is an established and preferred system which enables coordinating and control of the field production process by stabilising the workflow. However, LPS too, like other productivity models, omits the discussion on how the crews are designed and the performance variation factor which could exist due to interactions existing within and between the interdependent crews. It also lacks the consideration of crews as teams thereby not being sensitive to the soft factors affecting productivity.

While the aforementioned discussions provide an overview of the model developments in CLP literature, *there is still very limited reference made to the role of trade crews and their work practices in terms of their impact on construction productivity*. The models also lack attention to the dynamics of how the crew internally operates and self-manages including member interdependencies, coordination and variation in workflow issues, which directly affect crew productivity (Thomas et al. 2004; Watkins et al. 2009; Nerwal 2012). The models also lack the consideration of practices which crews and supervisors follow to improve their performance, which can be argued as critical aspects of managing work crews.

2.3 A CRITICAL ANALYSIS OF FACTORS AFFECTING CONSTRUCTION LABOUR PRODUCTIVITY

While trade crew work practices are not specifically discussed and developed into a knowledge area within the extant CLP literature, the importance of this area is apparent in the literature sub-streams that analyse factors affecting CLP. Scholars have widely written about factors affecting CLP, hence there is a necessity to efficiently distill the issues involved. To achieve this, this research focused on formulating a two-staged cascade type content analysis approach to critically analyse existing literature that dealt with factors affecting CLP. Cascade type content analysis is where the outputs of first stage of the content analysis leads as input to the second stage for advanced analysis. Cascade type analysis can be seen in the work by Forsythe (2018). The content analysis was carried out using NVivo software. The method of creating coding broadly followed the method prescribed by (Jackson and Bazeley 2019), and similar work carried within the construction management discipline such as those by (Poirier et al. 2015).

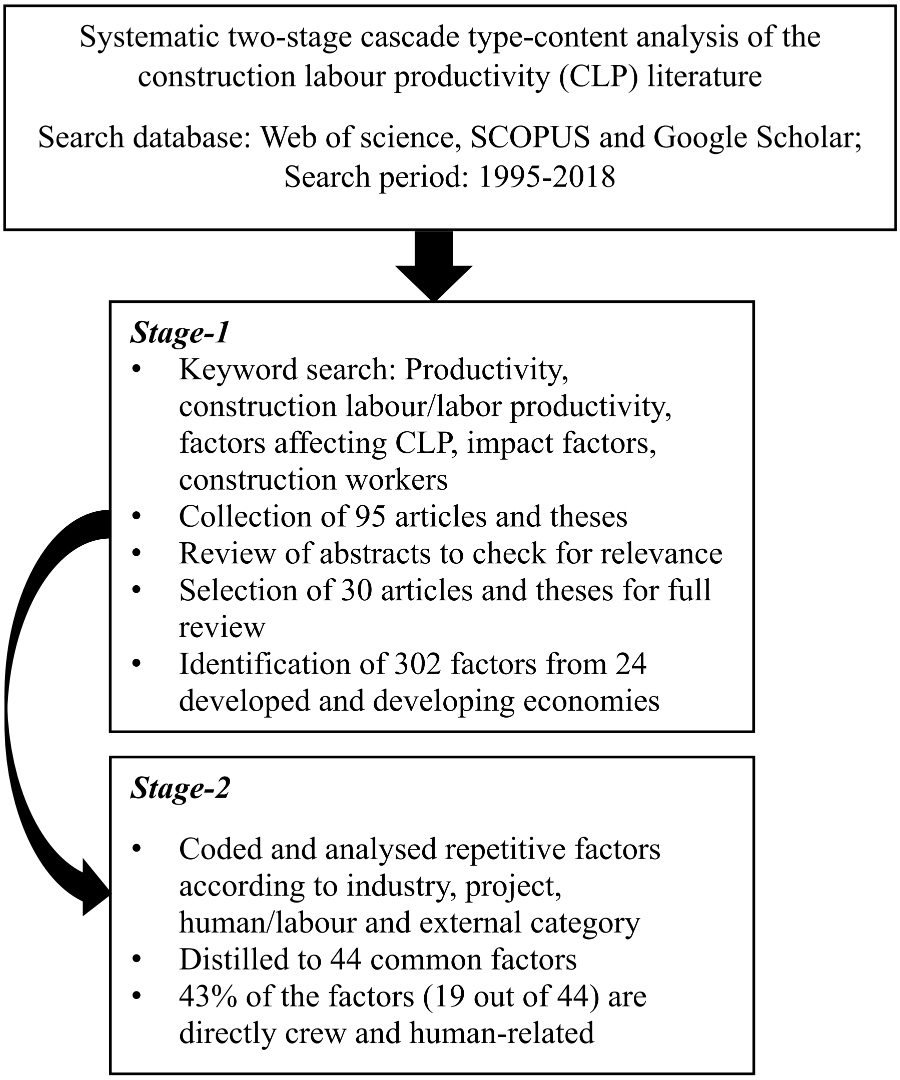

Figure 2.7 Cascade-type content analysis of the CLP literature

As can be seen in Figure 2.7, stage-1 focused on marshalling productivity articles using a keyword-based comprehensive desktop search. The search databases included *Web of Science*, *Science Direct*, *SCOPUS* and *Google Scholar* with a combination of keywords including productivity, construction labour/labor productivity (CLP), factors affecting CLP, impact factors, and construction workers. To acquire an initial focus, the desktop search was further refined by referring to the six top-ranked academic Journals in construction management, as ranked by (Wing 1997). These include *Journal of Construction Engineering and Management*; *Construction Management and Economics; International Journal of Project Management*; *Engineering, Construction and Architectural Management*; *Journal of Management in Engineering*; and *Automation in Construction*. Articles published in *Journal of Civil Engineering and Management*; *International Journal of Construction Management*; *Construction Economics and Building*; *International Journal of Productivity and Performance Management*; *Construction Innovation*; *Building and Environment*; ASCE's Construction Research Congress conference and ARCOM annual conference proceedings were also included in the review. These Journals and conferences are also known to have frequently published articles on CLP. The search focused on the period between 1995 and 2022. About 95 publications were identified through the desktop search. Next, the identified literature was carefully reviewed to sort the publications on the basis of how they considered similar/identical factors affecting CLP as its primary focus. This resulted in the synthesis of 30 publications which were to be taken up for an in-depth critical analysis in the next two stages. The selected 30 publications covered content from 23 Journal articles, four articles from conference proceedings and two PhD theses. The outcome of this stage revealed a total of 302 factors causing a positive/negative impact on CLP from 23 developed and developing economies.

In stage-2, critical content analysis was carried upon the 302 issues identified in stage 1, as a means to categorise core content. In practice, this employed existing analysis frameworks proposed by authors including (Jarkas and Bitar 2012; Yi and Chan 2014) for analysing CLP research at the industry, project as well as activity level. The content analysis was undertaken using NVivo software to code and analyse repetitive issues according to the industry, project, and activity typology. This enabled the distillation of 44 common factors affecting CLP from the abovementioned 302 issues. For example, a factor was created on *'communication difficulties between supervisors and workers'* which represented the issues of poor communication; clarity of instructions and information exchange; communication system which occurred across the different studies analysed. Table 2.1 presents the outputs of the empirical analysis with indicative references in the literature for each factor. It can be seen in Table 2.1 that 43% of the factors (19 out of 44) are directly crew and human-related, while 32% are project-related, 20% industry-related and 5% external-related. This supports the significance of studying and determining the impact of crew and human-related factors in CLP.

Table 2.1 Critical analysis of factors affecting CLP

Factor No.	**Factor category**	**Indicative examples**
	A. Industry-related factors (20% of all factors)	
A-1	Advancement in construction technology	*(El-Gohary and Aziz 2014), (Hamza et al. 2022)*
A-2	Constructability of the design	*(Naoum 2016), (Jarkas and Bitar 2012)*
A-3	Leadership and competency of construction management	*(Naoum, 2016), (Jarkas and Bitar 2012), (Hasan et al. 2018)*
A-4	Management of migrant work force (internal migrant and immigrant work force)	*(Naoum, 2016), (Lim and Alum 1995)*
A-5	Difficulty in recruitment of supervisors and foreman	*(El-Gohary and Aziz 2014), (Hasan et al. 2018)*
A-6	High labour turnover	*(El-Gohary and Aziz 2014), (Lim and Alum 1995)*
A-7	Compatible contract documents and statutory compliance	*(Jarkas and Bitar 2012), (Dai et al. 2009)*
A-8	Mechanization of activities and tasks	*(El-Gohary and Aziz 2014), (Hamza et al. 2022)*
A-9	Shortage of skilled labour	*(El-Gohary and Aziz 2014), (Jarkas and Bitar 2012)*
	B. Project-related factors (32% of all factors)	

Continued in the next page

B-1	Site layout	(*Jarkas and Bitar 2012*), (*Hughes and Thorpe 2014*)
B-2	Clarity of technical specifications	*(Jarkas and Bitar 2012), (Dai et al. 2009)*
B-3	Methods of working	*(Jarkas and Bitar 2012), (Dai et al. 2009)*
B-4	Availability of drawings onsite	*(El-Gohary and Aziz 2014), (Hughes and Thorpe 2014)*
B-5	Availability of tools and equipment	*(El-Gohary and Aziz 2014), (Hughes and Thorpe 2014)*
B-6	Availability of materials	*Naoum (2016), (Jarkas and Bitar 2012)*
B-7	Equipment breakdown	*(El-Gohary and Aziz 2014), (Hughes and Thorpe 2014)*
B-8	Inspection delay	*(Hughes and Thorpe 2014), (Jarkas and Bitar 2012)*
B-9	Unbalanced distribution of resources	*(El-Gohary and Aziz 2014), (Jarkas and Bitar 2012)*
B-10	Over time work	*(El-Gohary and Aziz 2014), (Jarkas and Bitar 2012)*
B-11	Poor planning and scheduling of activities and tasks	*(El-Gohary and Aziz 2014), Naoum (2016)*
B-12	Payment issues to workers	*(El-Gohary and Aziz 2014), (Dai et al. 2009), (Hamza et al. 2022)*
B-13	Lack of incentive scheme for workers	*(El-Gohary and Aziz 2014), (Dai et al. 2009)*
B-14	Distance between project site and labour's place	*(El-Gohary and Aziz 2014), (Jarkas and Bitar 2012)*
	C. Crew and Human-related factors (43% of all factors)	
C-1	Education, skill and experience of labour	*(El-Gohary and Aziz 2014), (Jarkas and Bitar 2012)*
C-2	Crew size and composition	*(El-Gohary and Aziz 2014), (Jarkas and Bitar 2012)*
C-3	Competency of supervisors and foreman	*(Hughes and Thorpe 2014), (Dai et al. 2009), (Hasan et al. 2018)*

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C-4	Physical fatigue, injuries and accidents of human	*(Hughes and Thorpe 2014), (Jarkas and Bitar 2012)*
C-5	Absenteeism and turnover of labour	*(Hughes and Thorpe 2014), (Lim and Alum 1995)*
C-6	Communication difficulties between supervisor/foreman and worker	*(Hughes and Thorpe 2014), (Hamza et al. 2022)*
C-7	Pulling people off a task before it is done	*(El-Gohary and Aziz 2014), (Dai et al. 2009)*
C-8	Teamwork among workers and crews	*Naoum (2016); (El-Gohary and Aziz 2014)*
C-9	Motivation of labour	*(Jarkas and Bitar 2012), (Dai et al. 2009)*
C-10	Working culture	*Naoum (2016), (Jarkas and Bitar 2012)*
C-11	Skill of equipment operatives	*(Jarkas and Bitar 2012), (Dai et al. 2009)*
C-12	Availability of proper work front	*(El-Gohary and Aziz 2014), (Jarkas and Bitar 2012)*
C-13	Linguistic differences between workers, crews and supervisors	*(El-Gohary and Aziz 2014), (Lim and Alum 1995)*
C-14	Basic facilities for workers	*(El-Gohary and Aziz 2014), (Jarkas and Bitar 2012)*
C-15	Respect for workers and crews	*(Dai et al. 2009)*
C-16	Stress and work-life balance of human	*(El-Gohary and Aziz 2014), (Jarkas and Bitar 2012)*
C-17	Improper coordination & cooperation among workers and crews	*Naoum (2016), (Hasan et al. 2018)*
C-18	Respect and recognition for craft worker suggestions/ideas	*(Jarkas and Bitar 2012), (Dai et al. 2009)*
C-19	Job satisfaction	*(Naoum 2016), (Dai et al. 2009)*
	D. External factors (5% of all factors)	
D-1	Inclement weather	*(Jarkas and Bitar 2012), (Lim and Alum 1995)*
D-2	Unforeseen events	*(El-Gohary and Aziz 2014), (Dai et al. 2009)*

Looking closely at the crew and human-related factors, it can be inferred that several of them are of particular relevance to this research. For instance, communication difficulties between supervisors/foreman and workers; improper coordination and cooperation among workers/crews; teamwork among workers/crews; pulling people off a task before it is done; working culture are strongly influenced by practices that crews follow when executing activities and tasks onsite. Hence, the significance of understanding the nature of crew work practices is ubiquitous in the literature, although crews *per se*, are not directly acknowledged as a specific phenomena of research interest.

On the other hand, the importance of work practices from the perspective of work teams/crews can be found in several other related disciplines. Studies in other comparable disciplines such as aviation, military, healthcare and manufacturing indicate that practices of work teams within the project and organisation context significantly influence overall safety, quality and performance (Kozlowski and Bell 2003; Salas et al. 2008). Furthermore, research into high-reliability work teams/high-reliability organisations investigated characteristics, operating principles and practices of organizations which perform complex operations in extreme conditions but manage to restrict serious incidents to surprisingly low rates. Such organizations include nuclear power plants, aircraft carriers and firefighting crews (Roberts 1993; Bigley and Roberts 2001). They perform operations that have an overwhelming potential for error and disaster but have managed to develop practices that enable them to manage the unexpected with better expertise than most kinds of organizations (Weick and Sutcliffe 2001). These proven benefits in comparable disciplines, further reinforce the need to make advancements in studying the nature and influence of crew work practices in order to facilitate optimum onsite construction productivity.

2.4 LEAN CONSTRUCTION AND BROADER CONSTRUCTION MANAGEMENT PRACTICES FOR IMPROVING PRODUCTIVITY

Lean construction practices have developed over the last few decades in many countries, bringing in continuous improvement, inclusive culture and improved levels of certainty in project delivery. Koskela (2000) presented the 'TFV' theory of production where production was conceptualised in three complementary ways – Transformation (T) of inputs into outputs; Flow (F) of materials and information; and Value (V) generation for the customers. Koskela (2000) noted that to augment productivity and optimise production, it is important to consider all aspects of production, i.e., transformation, flow and value. Within lean construction, a significant amount of research has been conducted to understand how to stabilise and improve workflow and to study the effects of flow variation in the production process (Howell and Ballard 1994; Thomas et al. 2002; Liu and Ballard 2009). One of the essential features of these studies was to identify a manner by which a reliable workflow can be ensured, as ill-planned work assignments are a major source of workflow variability in construction (Howell and Ballard 1994; Liu and Ballard 2009). As noted earlier, Ballard & Howell (1997) introduced the Last Planner System (LPS), which helps to stabilise workflow. LPS aims to improve the formation and assignment of tasks to crews by ensuring that all resources are mobilised and ready for the task. With LPS, the percentage of planned tasks completed (PPC) is measured to show changes in planning reliability. While LPS as a planning tool provides an introduction to the issue of onsite crew dynamics, it fails to delve deep into the makeup and execution of productive crews onsite. This is more evident in the context of studying the dynamic behaviour and practices of the crews impact on productivity in its totality as distinct from measuring performance and productivity of individual workers.

Broader management practices have also focused on improving productivity in the wider construction productivity literature. In 1983, the USA Construction Industry Institute's

(CII) Business Roundtable identified CLP improvement primarily as a management issue (Business Roundtable Report 1983). Following that, Sanvido (1988) categorised four ways to improve labour productivity through management practices which include planning, resource supply and control, information flow and feedback, and selection of the right people to control certain factors. Later, a study by Adrian and Adrian (1995) emphasised the importance of other key management practices to the same effect, including estimating and cost control, subcontractor management, and use of new technology. Subsequent studies by Bernold and AbouRizk (2010) and Gurmu and Aibinu (2017) provided enlightening insights into the importance of management practices in construction. They considered categories of materials, preconstruction-phase, construction methods, construction equipment and tools management practices, human resources management practices, and safety and health practices.

The key point here is that construction, despite largely being a labour-centric management proposition, often employs broadly spanning management structures which fails to adequately cover the main construct under which labour operates onsite, namely activity level crews and the practices they follow while executing tasks.

2.5 RESEARCH GAPS AND POINT OF DEPARTURE

Based on the critical analysis of the literature on construction labour productivity (CLP), the following research gaps are identified:

1. Research on CLP largely tended to focus on measuring individual worker output (e.g., m^2/man-hour). While this provides a useful measure of performance in broad benchmarking terms, it is relatively uninformative in terms of indicating how and where to improve performance.

2. While many studies focus on analysing individual worker productivity at activity-level, they fail to provide adequate understanding about the impact of crews and their work practices on productivity.
3. Production models developed so far also lack attention to the dynamics of how the crew internally operates and self-manages including member interdependencies, coordination, and variation in workflow issues, which directly affect crew productivity.
4. While a significant percentage of factors affecting CLP are crew and human-related, crews *per se*, are not directly acknowledged as a specific phenomenon of research interest.

Summing up, the above discussions indicate that the existing literature has inadequately addressed the 'crew' aspect of CLP. The measurement and productivity models developed so far has lacked explanatory power at a detailed level, in knowing how and where to improve labour usage. The literature also has paid scant attention to the complexity of social construction, interactions, and interdependencies at this level, in explaining productivity – instead it attempts to explain productivity through simplified and linear cause-and-effect relationships (Dolage and Chan 2013). This constrains the scope of new conceptualisations needed to improve CLP. At present, the lack of conceptual development of such issues highlights *the missing perspective* in the extant productivity literature. Having thus recognised and argued the need to study the influence of crew work practices on productivity, the *first stage* of the present research aims to study the following research questions:

1. What work practices do trade crews follow while executing their work?
2. Why and how do those practices emerge?

2.6 CONCLUSION

The present chapter critically reviewed the existing literature on CLP under the themes of measurement of productivity, modelling the productivity and production processes, and discerning the factors affecting CLP. Empirical analysis of the literature theme on factors affecting CLP has been conducted to introspect and accentuate the significance of crew work practices on productivity. The synthesis of the key findings from these bodies of knowledge helped identify the research gaps that need further exploration. Accordingly, specific research questions are developed to address the research gaps.

The next chapter (Chapter-3) discusses the research methodology and approach adopted by the present research.

CHAPTER 3.

RESEARCH METHODOLOGY

3.1 OVERALL RESEARCH DESIGN

Research methodology or research designs comprise the plans and procedures made to approach and conduct research and span the decisions from broad assumptions to detailed methods of data collection and analysis (Creswell and Creswell 2017). Research design hence involves the *intersection of philosophy*, *strategies of inquiry* and *specific methods of data collection and analysis* (Creswell and Creswell 2017). The present Chapter thus deals with elucidating the philosophical position of the research, the research approach adopted, specific data collection and analysis methods used, and the overall research methodology employed. Before elaborating on this, it is pertinent to present the specific research objectives that the current research aims to investigate:

1. To identify the work practices of onsite construction crews and their influence on productivity.
2. To develop a framework for team-based skills and behaviours of onsite construction crews by synthesising (a) construction labour productivity literature, (b) teamwork literature from relevant mainstream organisational and management literature and (c) the identified work practices.
3. To examine the team-based skills and behaviours influencing the productivity performance of onsite construction crews based on the framework developed.

The above research objectives are primarily emerged from the research questions presented at the end of literature review, in the previous chapter. The two research questions highlight – what work practices trade crews follow while executing their work, and why and how do those practices emerge. Research objective-1 therefore aims to identify the work practices of onsite construction crews and their influence on productivity. While the research objective-1 essentially addresses the two research questions that were identified from the literature, research objective-2 develops on research objective-1 to further synthesise a framework for team-based skills and behaviours for onsite construction trade crews. The idea is to synthesise the identified work practices through the lens of teamwork. It utilises literature support from the mainstream organisational and management literature, which provides an alternative line of inquiry where trade crews can be conceptualised as teams. A framework is developed in stages by synthesising (a) CLP literature, (b) teamwork literature from the mainstream organisational and management literature and (c) the identified work practices (i.e., outcomes of research objective-1). Research objective-3 examines the team-based skills and behaviours influencing the productivity performance of onsite construction trade crews with empirical data collected from the field, based on the developed framework.

Figure 3.1 shows the overall research design adopted for the present study. As can be seen in Figure 3.1, the present research is conducted in different stages. First, a critical review of the literature and exploratory studies in the field is conducted to define the research questions and objectives (which was presented in the previous Chapters). Stage-1 of the present research is conducted to investigate the research objective-1. Development of the conceptual framework based on the outcomes of the research objective-1 and a critical review of the literature on teamwork forms the first part of the Stage-2 of the research, addressing research objective-2. Subsequently, empirical studies conducted to ground the developed conceptual framework marks the completion of Stage-2 of the present research, addressing research objective-3.

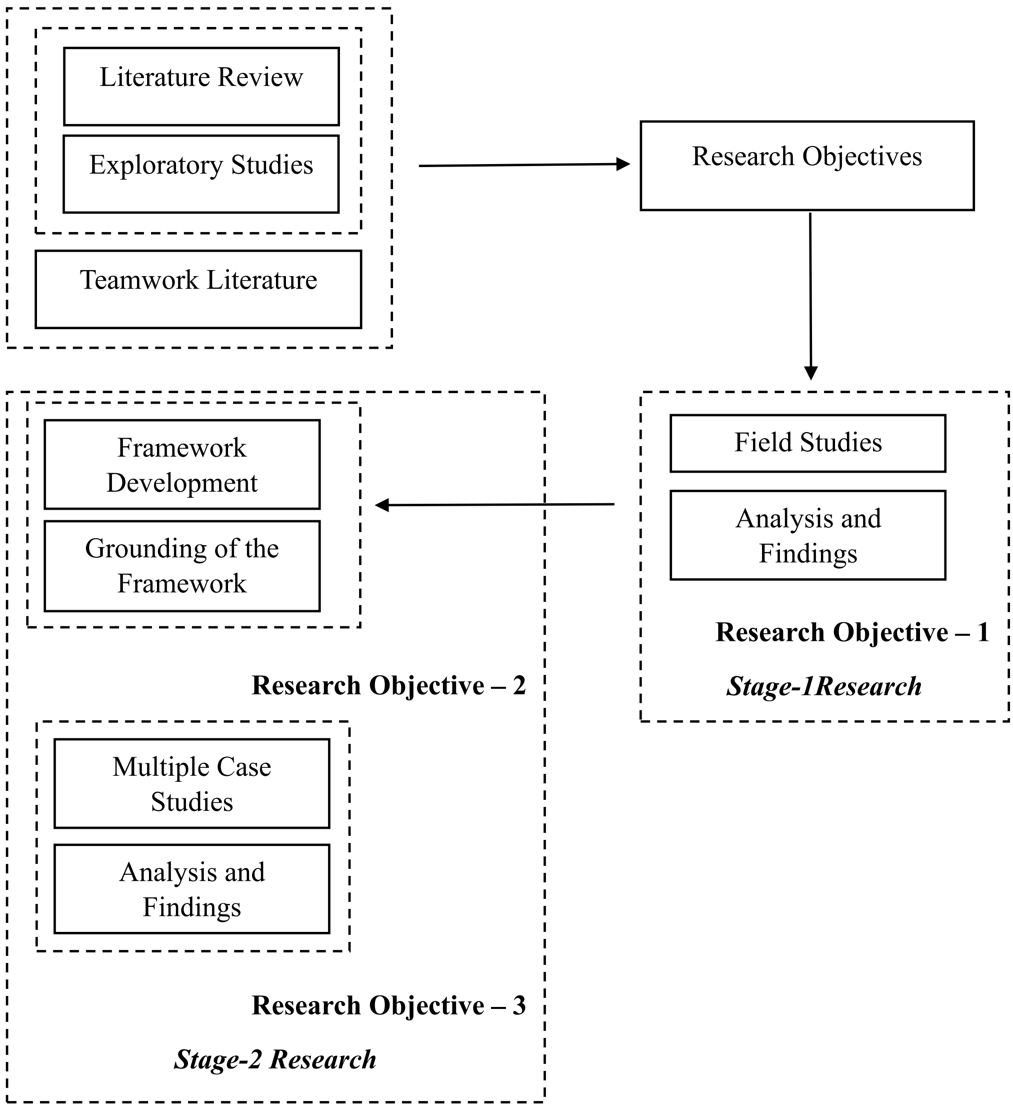

Figure 3.1 Overall research design

3.2 PHILOSOPHICAL POSITION OF THE STUDY

Creswell and Creswell (2017) point out that the fact that despite philosophical ideas remaining largely hidden, they still inform and influence the practice of research. Philosophical viewpoints are also called *paradigms* (Lincoln et al. 2011; Mertens 2010); *ontologies* and *epistemologies* (Crotty 1998); or *broadly conceived research methodologies* (Neuman 2009). The philosophical standpoint explains why researchers choose qualitative, quantitative, or mixed method approaches for their research (Creswell and Creswell 2017). Hence, researchers are encouraged to state their standpoints with regard to the nature of the scientific enquiry they embark upon.

Ontology and epistemology concern the researcher's fundamental standpoint. Ontology refers to the *conceptions of being and existence*, and the basic question that the researcher seeks to understand is 'what exists', or 'what is reality' (Crotty 1998). Epistemology concerns the *nature of knowledge*, and here the basic question the researcher attempts to grasp is 'what can be known', or 'how we can know' (Crotty 1998). The answers to these questions have a fundamental impact on the choice of a particular research methodology. To define, arrive and subsequently adopt a philosophical standpoint, it is important to understand a certain distinction between two main schools of thought – the positivist/realist approach and the interpretivist/constructivist approach (Creswell and Creswell 2017).

The positivist/realist approach assumes that reality exists objectively, i.e., independent of the knowledge of the observer, and that research objects are concrete and measurable (Creswell and Creswell 2017). The interpretivist approach views the external world as socially constructed and subjective, believing that human beings actively create their own realities (Creswell and Creswell 2017).

Positivists view knowledge as conjectural and believes that research is the process of making claims and warrants refining some of them for other claims (Creswell and Creswell 2017). Positivist researchers begin with a theory, with an assumption that the theory can be tested rationally and commonly approach research through the use of controlled experiments which involve the manipulation of dependent and independent variables to determine cause and effect relationships (Creswell and Creswell 2017; Hammersley and Atkinson 1995). However, positivism has been criticised in social science research for a variety of reasons such as its lack of holistic approach, lack of insider's point of view, lack of consideration of real-time conditions, its inability to better understand the behaviour of subjects in their context, limited applicability to build and develop theory and also the flexibility to extend and expand theory when applied in a different knowledge domain (Creswell and Creswell 2017; Runeson and Skitmore 1999; Miles and Huberman 1994; Strauss and Corbin 1990).

Interpretivism *overcomes* the above limitations of positivism particularly in contexts when the research deals with understanding the behaviour of human subjects in real-world conditions. Interpretivists believe that meanings are subjectively hence varyingly constructed by human beings as they engage with the world they are interpreting (Creswell and Creswell 2017). Interpretivism hence aims to understand the processes of interaction among individuals and systems (Creswell and Creswell 2017). The meanings derived through interpretivist approach are hence varied and multiple, leading the researcher to look for a complexity of views rather than narrowing and confining meanings into a few set categories or ideas (Creswell and Creswell 2017).

The present study pursues the interpretivist approach. As the present research aims to investigate the work practices of onsite construction crews – which invloves studying the real-time behaviour of subjects in their immediate context, the interpretivist approach is considered as a preferred approach. Also, the adaption of theoretical approaches from the mainstream organisational and management literature with an aim to extend its applicability to the construction context suit the consideration of interpretivist approach as a much valid approach.

3.3 STRATEGIES OF INQUIRY

As mentioned previously, research design involves the intersection of philosophy, strategies of inquiry and specific data collection, and analysis methods (Creswell and Creswell 2017). The previous section concluded *interpretivist approach* as a preferred philosophical approach to guide the progress of the present research. This section deals with the strategies of inquiry that the present research adopts.

Strategies of inquiry are types of qualitative, quantitative, and mixed method approaches that provide specific directions and procedures in a research design (Creswell and Creswell 2017). Quantitative strategies of inquiry are invoked by positivist researchers to generally test theories. These include true experiments, quasi-experiments, correlational studies (Campbell and Stanley 2015) and specific single-subject experiments (Neuman and McCormick 1995). Quantitative strategies include methodologies such as survey research, experimental research, correlational research, causal-comparative research etc. (Creswell and Creswell 2017) which are generally used for theory testing. As the phenomenon of interest that the present research aims to address is in the early stages of theoretical advancement, quantitative approaches that are premised on theory testing appear to be less suitable. Instead, the present study follows the *qualitative approach*.

Qualitative strategies of inquiry are invoked by interpretivist researchers. It is an approach to explore and understand the meaning that individuals or groups ascribe to a social or human problem (Creswell and Creswell 2017). As mentioned earlier, this approach is widely adopted when a concept or phenomenon is at a comparatively early stage of research attention and needs to be understood in depth. It predominantly focuses on building theories, as well as extending and expanding on them (Creswell and Creswell 2017). Qualitative approaches include methodologies such as ethnography, grounded theory, case studies, phenomenological research, narrative research etc. Incidentally but importantly, the suitability of interpretivist approach employed for the present research also enabled the adoption of qualitative approach as the strategy of inquiry.

3.4 CASE STUDY METHODOLOGY

Within the gamut of qualitative approach, case study methodology is chosen as an appropriate research methodology for the present study. It is one of the most widely used research methods within the qualitative approach. For the sake of brevity, the shortcomings of adopting other methodologies are not discussed. However, the suitability of using case study methodology in the context of the present research is discussed below.

Researchers utilise case studies to explore a real-life contemporary system and develop an in-depth analysis of a case, often a program, event, activity, process, or one or more individuals (Creswell and Creswell 2017). It provides an in-depth understanding of the nature and complexity of the phenomenon under study. Cases are bound by time and activity, and researchers collect detailed information using a variety of data collection sources and procedures over a sustained period of time (Stake 1995; Yin 2009). Also, the case study approach may lead to new and creative insights and can have high validity among practitioners (Eisenhardt 1989; Voss et al. 2002). The unit of analysis in the case study research method might be multiple cases (a multi-site study) or a single case (single-site study).

The applicability of case study approach for the present study is particularly favourable due to several reasons. These include:

1. Case study approach is especially appropriate for answering, 'what', 'why' and 'how' questions, which the research questions of the present study also seek to address.
2. The given phenomenon can be studied in its natural setting and context, and relevant theory is generated from the understanding gained through observing actual work practices, which in the present case is crew work practices.
3. The method is best suited in circumstances when the phenomenon is not well understood, and the relationships between the variables in the phenomenon are too

complex to be controlled by experimental research approaches, *which is also the case of the present study.*

4. The subjects are studied in real-life conditions which are in progress so that the information generated is accurate and not lost by time.

Furthermore, case studies are particularly suitable for developing new theories besides extending and refining them further in related contexts (Yin 2009; Voss et al. 2002; Eisenhardt 1989). With theoretical underpinning in the mainstream organisational and management literature, the present study aims to *extend and refine theory* in the construction context. The case study approach facilitates such an approach that needs ongoing interaction between empirical data and existing theory. Hence, considering the afore-mentioned reasons, choosing case study research for the present study can be justified as appropriate.

The present study uses a multiple case study approach. Multiple case studies facilitates generalisation beyond the specifics of a single case and enables the comparison and contrast of findings from different environments (Meyer 2001; Yin 2009). Multiple case studies approach is also perceived to provide a stronger base for theory building and extension practices rather than single case studies approach, as the proposed theory is grounded in a varied and hence more complex empirical evidence (Yin 2009).

3.5 CASE STUDY APPROACH TO SAMPLING, RELIABILITY, RESEARCHER BIAS AND VALIDITY

Case study methodology adopts a specific approach to sampling that differs from quantitative methods. For instance, quantitative methods target representative populations that enable findings to be generalised to larger populations. In contrast, case study approach is far more selective in scope (Yin 2009). Any use of multiple-case designs entails following a replication, not a sampling logic, and an investigator must choose each case carefully (Yin 2009). The cases serve in a manner similar to multiple experiments, with similar results (a literal replication) or contrasting results (a theoretical replication) predicted explicitly at the outset of the investigation (Yin 2009).

Case study approach to sampling also focuses on what is called ‘theoretical sampling’ which aims to select a sample based on the compatibility of the informants to the issues that are of theoretical importance to the study (Boyatzis 1998). For instance, the present research identified the need to focus on work crews and their onsite practices and the issues of theoretical importance have been made apparent by virtue of the analysis of the existing literature discussed in Chapter 2. An important step in case study approach to sampling is the development of a rich, theoretical framework. The theoretical framework later becomes the vehicle for generalizing the research outcomes and derivatives to new cases, like the role played in cross-experiment designs (Yin 2009).

Case study approach is accommodated with three major design challenges such as reliability, validity and bias. These challenges can be addressed by adopting methods that can prevent potential errors in the research method (Yin 2009) as defined underneath:

- Reliability – demonstrates that the operations of a study – such as the data collection procedures can be repeated, with the same results
- Construct validity – identifyies correct operational measures for the concepts and phenomenon being studied
- Internal validity – seeks to establish a causal relationship, whereby certain conditions are believed to lead to other conditions, as distinguished from spurious relationships
- External validity – defines the domain to which a particular study’s findings can be mapped, extended and generalized)

- Bias – refers to characteristics that may cause the informant to give a different response than they would have otherwise given in a less biased environment (Rosnow and Rosenthal 1997)

Several tactics can be used to overcome the aforementioned challenges and should continue to be applied throughout the subsequent conduct of the case study, not just at its beginning (Yin 2009). Table 3.1 presents the various tactics and when they can be used to address the aforementioned case study challenges.

Table 3.1 Case study design challenges and tactics to apply

S. No	Case study design challenge	Tactic	Phase of research in which it can be applied
1	Reliability	Use of case study protocol Develop case study database	Data collection
2	Construct validity	Use multiple sources of evidence Establish chain of evidence	Data collection
3	Internal validity	Do pattern matching Do explanation building Use rival explanations	Data analysis
4	External validity	Use theory and replication logic in multiple case studies	Research design

With respect to generalisation of findings from case study research, Greene and Caracelli (1997) argue that *particularity rather than generalisability* is the hallmark of a good qualitative research. This intended generalisation can be facilitated by conducting additional case studies and generalising those findings to the new cases (Yin 2009). It is the same as the replication logic used in experimental research. This method of attaining generalisation in case studies is characterized as ‘analytic generalization’ and has been contrasted with another way of generalizing results, known as ‘statistical generalization’.

3.6 DATA COLLECTION METHODS

Data collection in case study research is conducted across a variety of sources such as documentation, archival records, direct observation, interviews, participant-observations, audio-video recordings, and physical artefacts (Yin 2009; Eisenhardt 1989; Miles and Huberman 1994). Each source is associated with an array of data or evidence. Researchers point out a major strategy to minimise the shortcomings of qualitative research which is to combine multiple data collection methods within a single case study. In this approach, the advantages of using one method balance out the disadvantages of other methods (Leonard-Barton 1990). Additionally, this approach is effective in overcoming some of the design challenges in a particular case study such as construct validity, internal validity, external validity, and reliability.

The present study uses documentation, direct observations (site visits, conversations during visits, attendee in meetings, discussions, and events), interviews and video recordings as the main sources of data collection. An over-arching case study protocol is developed to logically use the various data collection methods to overcome the aforementioned case study design challenges. The various data collection methods used in the present research are discussed briefly in the following sub-sections.

3.6.1 Direct observations

Case study, by dint of the natural setting where it takes place, creates an opportunity for direct observations to be made (Yin 2009). Observations can be made across the range of formal to casual data collection activities. Formal observations include using observation instruments as a part of case study protocol and recording certain types of events and behaviours during field visits (Yin 2009). This can also involve observations of meetings, sidewalk activities, site visits etc. Informal observations include making visits to construction sites and temporary workspaces provided for workers, site engineers' and managers' and having informal conversation with them, and also attending onsite and offsite meetings (Yin 2009). Observations are usually recorded as field notes (Yin 2009). The present research largely utilised informal site observations. The details of the observations conducted are discussed in the respective chapters (i.e., Chapter 4 and Chapter 6).

3.6.2 Interviews

Interviews are one of the most important sources of evidence in case study research. Interviews are more along the lines of guided conversations rather than structured queries to prefixed questions (Yin 2009). Although researchers try to maintain a consistent line of inquiry, the actual stream of questions in a case study interview is likely to be fluid and contextual rather than rigid (Rubin and Rubin 2011, Yin 2009). Hence, in the process of conducting an interview with an informant, researchers follow *a consistent line of inquiry*, as reflected by their case study protocol, and at the same time carry out *conversational-type discussions* in an unbiased manner (Yin 2009). By operating at two levels, researchers are mostly satisfied with the needs of their inquiry being met as they simultaneously put forth friendly and non-threatening questions during the interview process (Yin 2009).

Generally, there are three types of interviews – structured, semi-structured, and unstructured interviews. The present study utilised semi-structured interviews. A semi-structured interview is a hybrid type of interview which lies in between a structured and unstructured interview (Wahyuni 2012). Semi-structured interviews, composing of both open and closed questions, allow the usage of predetermined themes and questions as in the case of a structured interview, while at the same time, keep enough flexibility to enable the informants to talk freely about any topic raised during the interview process (Wahyuni 2012). Semi-structured interviews are thus especially effective in enabling the informants to be more expressive on the subject of interest (Flick 2009). When adopted, such a process enables the informant to respond in an articulate and expressive manner and allows the researcher to place the responses of the informant in their context, which often results in rich and rounded information about the cases (Yin 2009). Along with interviews, informal conversations, and attendance at crew meetings and events (such as safety talks, pre-brief meetings, etc.) have also been carried out in the present research. These informal conversations also form an important component of evidence in a case study approach as Leonard-Barton (1990) point out that any fact relevant to the stream of events describing the phenomenon is a potential datum in a case study where context is given paramount importance. The details of the interviews conducted are discussed in the respective chapters (i.e., Chapter 4 and Chapter 6).

3.6.3 Documentation

Documentation can take many forms such as letters, memoranda, e-mails, minutes of meetings, diaries, calendar notes, agendas, announcements, progress reports, written reports, and other internal records of the cases (Yin 2009). One of the main advantages of using documentation as a source of data is that they are stable and hence can be reviewed repeatedly. More specifically, documentation may contain appropriate details of the events (covering a span of time) which is of significant relevance in case-based approach (Yin 2009). Documents can be also used to corroborate and augment evidence from other sources (Yin 2009).

The present research utilised *minutes of meetings of toolbox meetings*, *foreman group meetings*, *sub-contractor meetings*, and *foreman's site diaries* as various documentation evidence. As the study aims to understand crew-based work practices, the demographic and work-related details of the crew, their attendance records, work allotment records, crew progress reports, and productivity reports are collected and analysed in the case studies conducted. The details of the documents collected are presented and discussed in the respective chapters (i.e., Chapter 4 and Chapter 6).

3.6.4 Video recordings

Video recordings of onsite construction activities are carried out as a part of time studies conducted to determine the productivity of the study crews. Video recordings are also used as a main source of observation evidence in the context of onsite construction activities and crews. Standard smartphone device-based camera is used to video record the onsite construction activities chosen for the present study. The details of the time studies and video recordings conducted are presented and discussed in the respective chapter (i.e., Chapter 4).

For each phase of the study, a case study protocol is used. Case study protocol presents the logic which informs the application of the various data collection methods discussed previously. The case study protocol used in each phase of this research is discussed in the respective chapters (i.e., Chapter 4 and Chapter 6).

3.7 METHODS FOR DATA ANALYSIS

Central to effective case research is the coding of the data collected. It is important to try to segment data into categories (Miles and Huberman 1994; Glaser and Strauss 2017). The existence of good documentation of observations and multiple sources of evidence allows a chain of evidence to be established. The present study uses thematic analysis for analysis of the data collected. The next sub-section discusses the method in brief.

3.7.1 Thematic analysis

Thematic analysis is a method used for identifying, analysing, and reporting patterns/themes within data. It minimally organises and describes the data set in (rich) detail. However, it often goes further and interprets the various aspect of the research topic (Boyatzis, 1998). The following steps are carried out in the course of thematic analysis (Braun and Clarke 2006):

a. Familiarising with data

This step requires the researcher to be fully immersed and actively engaged with the data by firstly transcribing the collected data and then reading (and re-reading) the transcripts and listening to the recordings. Initial ideas should be noted down in this step. It is an important step in which the investigator should get familiarized with all aspects of the data and have a comprehensive understanding of the content of the interaction. This step provides the foundation for all subsequent analysis.

b. Generating initial codes

Once the researcher is well familiar with the data, the next steps involve identifying preliminary codes, which are the features of the data that appear interesting and meaningful. Several codes can be generated, and it helps to provide context to the collected data.

c. Searching for themes

The third step in the process is to start the interpretive analysis of the collated codes. Relevant data extracts are sorted (combined or split) according to overarching themes. The researcher's thought process should allude and align to the relationship between codes, subthemes, and themes.

d. Reviewing themes

In this step, a deeper review of identified themes is carried out. It allows the researcher to combine, refine, separate, or discard initial themes. Data within themes should cohere together meaningfully, while there should also be clear and identifiable distinctions between themes. This is usually done in two phases, initially the themes need to be checked in the context of the coded extracts (phase-1), and then for the overall data set (phase-2). A thematic 'map' can be generated from this step.

e. Defining and naming themes

This step involves 'refining and defining' the themes and potential sub-themes within the data. Further analysis can then be carried out to enhance the identified themes. Naming of themes and working definitions (relating to the developing framework) that capture the essence of each theme are done in this step.

The procedure described so far is applied in the present research to analyse the collected data. As previously mentioned, details of data collection and analysis processes and methods followed in each stage of the research is discussed in respective chapters, i.e., Chapter 4 and 6.

3.8 CONCLUSION

The chapter outlined the philosophical positioning of the present research and the overall research approach adopted. It elaborated the stage-wise progression of the research and presented how the outcomes of the first stage lead as input to the second stage of the study. The chapter presented the overarching methodology adopted by the present study. It also provided an overview of the various data collection and analysis methods used in the various stages of the present study. The next chapter aims to address the first research objective of the study. It explores how the work practices of onsite construction trade crews influence their productivity.

CHAPTER 4.[1]

WORK PRACTICES OF ONSITE CONSTRUCTION CREWS AND THEIR INFLUENCE ON PRODUCTIVITY

4.1 INTRODUCTION

The previous chapter presented the research methodology and broad outline of research methods adopted for each stage (Stage-1 and Stage-2) of the research. The present chapter aims to address the first research objective of the study – to identify the work practices of onsite construction crews and their influence on productivity.

As mentioned in Chapter 3, addressing research objective-1 forms Stage-1 of the study. The first step in investigating the above research objective lies in appropriately designing the research with specific data collection and analysis methods. The next section presents the methodology and approach adopted for Stage-1 research.

4.2 RESEARCH DESIGN – CASE SELECTION STRATEGIES AND APPROACH

To explore the proposition that crew work practices considerably influence onsite construction productivity, a case study methodology was adopted. Since the primary focus of the study was on crew work practices, in order to study them in real time, and in a natural setting, a case study based approach was found to be most appropriate (Yin 2009). Also, as the nature of crew work practices are not well documented, the case study approach allows exploring this with a

[1] Shorter version of this Chapter is published in the Journal article co-authored with Prof. Satyanarayana N Kalidindi and Prof. Perry Forsythe. The citation is as follows:

Loganathan, S., P. Forsythe, and S. N. Kalidindi. 2018. "Work practices of onsite construction crews and their influence on productivity." *Construction Economics and Building*, 18 (3): 18-39.

relatively in-depth understanding of the nature and complexity of the phenomenon (Yin 2009). Within the case study approach, a mixed-method approach to data collection and analysis strategy was adopted.

Project based crews usually work together over time, perform similar operations from one project to another, and the major trades are independent of each other. The rebar trade activity was chosen because it not only enables the crew to be studied independently of other major trade activities, but also facilitates studying interdependent sub-crews by splitting the activity into different tasks of rebar cutting, rebar bending, stirrups fabrication and onsite rebar tying.

In order to leverage potential differences between productivity of rebar crews, the project manager on the case study assisted in the sample selection. As the study was carried in the middle of the project, the manager could identify a high-performing and an average-performing crew, based on floor cycle time assessment and an evaluation made in consultation with relevant site managers. This pragmatic approach was useful, in the absence of standard on-site productivity evaluation techniques. It also had the benefit of providing face vadility (Gravetter and Forzano 2003) in reflecting the perspectives of those directly involved in managing the components relevant to the research (i.e., work crews and CLP).

The selected project was a residential complex involving seven 4-storey apartment buildings. The two buildings were managed by different site engineers/managers of the main contractor. Figure 4.1 shows the project site layout indicating the location of the two buildings considered for the study. The main contractor supplied materials, but the physical work was undertaken by sub-contract labour.

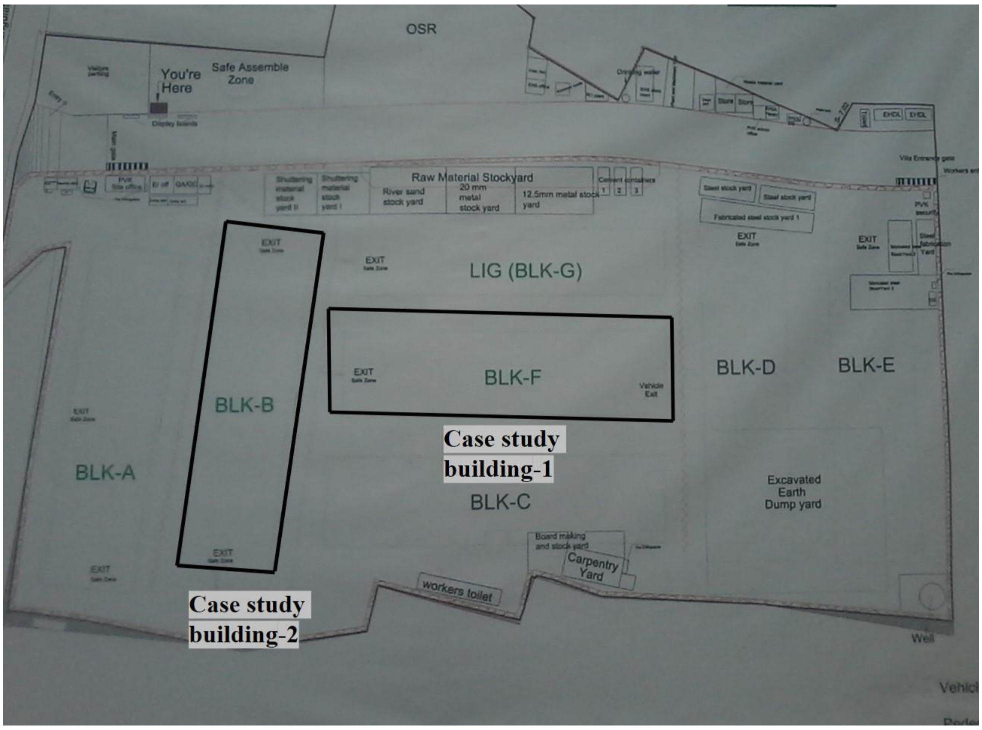

Figure 4.1 Project site layout and location of the case study buildings

Two different labour sub-contractors managed the two chosen crews – a high performing crew (HPC) and an average performing crew (APC). The HPC and APC consisted of 18 and 23 members respectively. While the APC had 23 crew members, the average crew strength maintained by them during the duration of the study activity was 20. The crew faced issues with regards to absenteeism and relocation of crew members to different work stations, which are later discussed in brief. Therefore, it is reasonable to compare crews of sizes 18 and 20 given that it is very difficult to obtain an exact comparison in real world circumstances and given that other variables have been controlled for. Table 4.1 summarises the similarities and differences of the two study crews with respect to the design of the case study.

Table 4.1 Case study parameters

Parameter	High performing crew (HPC)	Average performing crew (APC)
Crew size	18 members	23 members
Quantity of work	Reinforcement of 112 columns (8 MT)	Reinforcement of 112 columns (8 MT)
Test variables	Productivity of the study crews, Work practices of the crews	
Control variables	Activity scope, material availability, work environment and overall site conditions	

By selecting the two study crews who are undertaking identical work on two separate buildings in the same project provided a high degree of control on variables to match case study circumstances. The test variables included the productivity of the study crews and the work practices they followed during work execution. The control variables included the activity scope, material availability, work environment and overall site conditions. The methods utilised for collecting data on test parameters are discussed in the following section.

4.3 DATA COLLECTION METHODS AND PROCESS

As mentioned, the study activity is reinforcement activity. Each crew was engaged on reinforcement of 112 columns, constituting a total work quantity of eight metric tonnes (MT). The reinforcement activity involved four key, value-adding tasks including rebar cutting (KT1), rebar bending (KT2), stirrups fabrication (KT3), and onsite rebar tying (KT4). The steel reinforcement was cut and bent onsite. The study was conducted when the crews were placing rebar on second-floor columns in their respective buildings. This meant the crews had acquired initial experience in this activity before the study. The mixed-methods data collection included field observations, individual /group interviews and time studies (using time lapse video recordings). Table 4.2 outlines how the different data collection methods were used appropriately for different purposes at various stages of the study to help overcome the challenges in reliability, validity, and triangulation of data (Yin 2009).

The identification of work practices through field observations, and the reasons for following such practices were verified and validated through interviews with crew members and foreman. The productivity data collected through time studies was used to explain and evaluate the relationship between CLP and work practices. The findings from the study were presented and discussed with the senior site engineers and project managers, to help support the validity of findings. This also helped triangulate the study findings.

Table 4.2 Purpose and description of various data collection methods

Method	Type of data collected	Purpose and description	When it was used
Time study	Quantitative	• Video recording of individual tasks carried out by sub-crews/ individual crew members to measure and analyse productivity	• Carried out from the start to completion of the activity • All tasks of the activity were recorded for 10 sample cycles
Field observations	Qualitative	• Focused on examining the crew work practices during planning, organisation, and actual execution of work onsite	• Carried out periodically, for about 3-4 times a day, and each observation period lasted for 30-45 minutes • Observations carried out from start to completion of the activity, covering all task
Individual interviews/ Group interviews	Qualitative	• *Individual interviews/ group interview sessions with crew members and foreman* – to understand crew characteristics, how crews and foreman plan, organise, and execute work, key concerns and strategies for managing work • *Interviews with managers*- the identified practices and findings from the study were presented and discussed	• Carried out three times (each approx. at the end of 30-35% activity completion) for about 30 minutes with either individual crew members or by small groups (i.e., as sub-crews) • Separate interviews were carried out with foreman • Carried out after compiling all the findings - as a means of reinforcing "face" validity

4.4 DATA ANALYSIS

Analysis of the time study (quantitative) data was carried out to determine the time taken to complete one task unit (represented as task/min). Early work by (Adrian and Boyer 1976) remains instructive in setting out the main issues involved in measuring at this level of detail. For instance, there is the need to identify a production unit which can be visually measured, a production cycle relating to the time between consecutive occurrences of the production unit, and a leading resource as required by the production method (Forsythe, 2014; Adrian and Boyer 1976). A few studies adopt a similar approach in rebar placement/reinforcement activity in different contexts (Forsythe 2014; Jarkas 2010). However, overall activity productivity is measured as installed quantity/actual hours, i.e., Kgs of steel tied/total input hours.

Analysis of the qualitative data was carried out in three steps. First, the data reduction process was carried out to sharpen and organise observation and interview data. This was done by writing summaries of the observational data and transcribing the interview data. Second, coding was undertaken using the summarised and transcribed data to identify the emerging specific and broad themes of work practices. Third, using the matrix technique of data display, the themes and patterns of similarities and differences among the high and average performing crew were made (Miles and Huberman 1994).

4.5 PRODUCTIVITY ANALYSIS OF THE STUDY CREWS

As mentioned, the rebar activity involved four key, value-adding tasks including rebar cutting (KT1), rebar bending (KT2), stirrups fabrication (KT3), and onsite rebar tying (KT4). Interspersed through this, waiting, transportation and storage tasks occurred – which are commonly referred as non-value adding and non-value adding but necessary tasks (Thomas and Daily 1983). Figure 4.2 shows the pictures of the various key tasks.

Table 4.3 presents productivity data of the HPC and APC for the four key tasks. Table 4.3 also presents more detailed sub-tasks for each of these key tasks, based on different rebar diameters and task categories. For example, KT1a-e represents rebar cutting tasks for four different bar diameters and categories. As part of this, Table 4.3 provides description of task units, crew size and number of task units produced per cycle, total number of time study cycles carried for each task (in each crew), total input time considering all cycles for each task, productivity achieved per cycle for each task: measured as task unit/minute, and percentage difference in productivity between crews. At least 10-15 sample cycles are generally needed for a statistically valid time study (Zandin 2001). In this study, a sample of 10 cycles was gathered for each sub-task, and for each crew. The 10 cycles were considered adequate as there was no significant variation noticed between each cycle. Therefore, for a total of 35 task units which included measurement of 10 cycles, the resulting data gathering involved 350 cycles per crew and 700 cycles in total for the overall productivity study.

Figure 4.2 Pictures of the key tasks involved in the study activity

Table 4.3 Productivity study outputs of individual tasks for high performing crew (HPC) and average performing crew (APC)

Task code	Task category	Task name	Description of one task unit	Crew size per cycle		No. of task units produced per cycle in HPC and APC	No. of time study cycles carried for each task in HPC and APC	Total no. of task units produced considering all cycles in HPC and APC	Total time taken considering all cycles (in min:sec)		Productivity obtained for each task (Total no. of tasks completed/total time taken)		Percentage differences in productivity between HPC and APC (in %)
				HPC	APC				HPC	APC	HPC	APC	
KT1a	Rebar cutting	8mm rebar cutting (Type-A)	One rod cut	3	2	8	10	80	64:3	80	1.24	1.00	24
KT1b		8mm rebar cutting (Type-B)	One rod cut	3	2	12	10	120	72	84:3	1.67	1.42	17
KT1c		12mm rebar cutting	One rod cut	3	2	3	10	30	28:18	34:48	1.06	0.87	22
KT1d		16mm rebar cutting	One rod cut	3	2	3	10	30	12:42	16:18	2.42	1.85	30
KT1e		20mm rebar cutting	One rod cut	3	2	3	10	30	9:3	9:48	3.23	3.16	2
KT2a	Rebar bending	12mm rebar bending	One bend rod	2	2	1	10	10	2:18	3:18	4.59	3.14	46

Continued in the next page

Task code	**Task name**	**Task name**	**Description of one task unit**	**Crew size per cycle**		**No. of task units produced per cycle in HPC and APC**	**No. of time study cycles carried for each task in HPC and APC**	**Total no. of task units produced considering all cycles in HPC and APC**	**Total time taken considering all cycles (in min:sec)**		**Productivity obtained for each task (Total no. of tasks completed/total time taken)**		**Percentage differences in productivity between HPC and APC (in %)**
				HPC	APC				HPC	APC	HPC	APC	
KT2b	Rebar bending	16mm rebar bending	One bend rod	4	4	1	10	10	5:48	7:18	1.82	1.39	31
KT2c		20mm rebar bending	One bend rod	4	4	1	10	10	7:12	10	1.40	1.00	40
KT3a	Stirrups preparation	Type-A stirrups preparation	One stirrup fabrication	1	1	1	10	10	3:48	4:18	2.87	2.39	20
KT3b		Type-B stirrups preparation	One stirrup fabrication	1	1	1	10	10	3:12	3:18	3.21	3.14	2
KT4	On-site rebar tying	Stirrups & bend rod placing and tying	One column tying	1	2	1	10	10	269:7	388:3	0.04	0.03	44

It can be inferred from Table 4.3 that the unit productivity of the HPC, considering all the key tasks, on average was 25% higher than the APC. In some cases, the unit productivity of the HPC was significantly higher than the APC which includes 12mm rebar bending (46% higher), onsite rebar tying (44% higher) and 20mm rebar bending (40% higher). In some cases, less difference in unit productivity between HPC and APC was noticed, which includes 20mm rebar cutting and type-B stirrups fabrication (both only 2% higher). However, the overall activity's productivity of the HPC was 7.94 Kg/hr (total quantity=8000 Kg; total input hours=1008 hours), and APC was 5.50 Kg/hr (total quantity=8000 Kg; total input hours=1454 hours). Hence, considering the overall activity completion, the HPC was 44% more productive than the APC. As mentioned earlier the two crews' undertook identical work processes on the same project and contextual factors such as activity scope, material availability, work environment and site conditions etc. were very similar. It was thus reasonable to conclude that work practices were the main differentiator influencing productivity differences between the crews. The next section therefore discusses the influence of the identified crew work practices on onsite crew productivity.

4.6 WORK PRACTICES OF THE HIGH AND AVERAGE-PERFORMING CREW: DISCUSSION

As indicated in Table 4.2, the researcher made direct observations onsite and recorded the work practices at regular pre-defined intervals during each study day. These field observations were explained, verified and validated through interviews with crew members and each foreman. As mentioned, to triangulate the study findings, it was also presented and discussed with the senior site engineers and project managers.

In the HPC, the head foreman/labour sub-contractor (LSC) had 15 years of experience in the trade and had been with the main contractor for 10 years. The HPC consisted of a leading hand with 10 years of experience and managed the crew in the head foreman's absence. Most of the HPC members had been working with the head foreman for more than six years. The head foreman treated the crew's skilled workers as his core workers and maintained good relationships with all the crew members.

The APC also included a head foreman and a leading hand. Similar to the HPC, the head foreman had 13 years of experience and had been with the main contractor for two years. However, the crew's head foreman only occasionally visited the project, and the crew was mainly managed by the leading hand with nine years' experience. Many crew members had been working with the head foreman for two to three years. This head foreman also treated all his highly skilled workers as his crew's core workers.

Table 4.4 compares broad themes based upon specifically coded work practices that emerged from the analysis of the field observations and transcribed interview data. These included:

- Work preparation and execution strategy
- Group formation and stability (skills and experiences)
- Avoiding duplication (of non-value adding tasks)
- Crew social cohesion
- Internal and external leadership

The above-mentioned themes are discussed in more detail, under dedicated sub-headings, with respect to the high and average-performing crews, below.

Table 4.4 Comparison of broad themes and coded practices between high and average performing crew

Broad theme	Coded practice	High performing crew (HPC)	Average performing crew (APC)
Work preparation and execution strategy	Review of detailed drawings	Head foreman reviewed and simplified the drawing details as short notes	Head foreman was not involved in drawing reviews – leading hand reviewed and verbally communicated the details
	Arrangement of materials before work execution	Head foreman, leading hand and core members checked the availability and quality of materials	Leading hand checked the availability and quality of materials
	Overall work execution strategy	Foreman developed an overall work execution plan and communicated to the crew	A meso-level plan was made by the head foreman, and no communication was made to the crew
Group formation and stability	Formation of sub-crews	Purposive formation of sub-crews by matching crew member's skills with tasks	Random allocation of work to crew members
	Relocation/shuffling of crew members to different work locations	No relocation/shuffling of crew members to different work locations	Relocation/shuffling of crew members to different work location and also to other projects
Avoiding duplication of non-value adding tasks	Transportation of processed materials	Minor excess movements observed	Major excess movements observed
	Storage of processed materials	Less over production and less unwanted storage of processed materials	Less over production but unwanted stock of processed materials

Continued in the next page

Crew social cohesion	Teamwork processes and practices	Pre-task briefs, de-briefs and backing-up behaviours were noticed	Minimal interactions were noticed between the crew members and head foreman about tasks
	Share knowledge about tasks and progress	Shared mental models facilitated crew members' interactions and work progress was discussed between crew members and head foreman	Absence of shared mental model and less involvement of members to know about other crew members tasks and their progress
	Task and team cohesion	Overall, the crew was found to be cohesive, both task and interpersonal cohesion	The crew was found to be less cohesive
Internal and external leadership	Inspection and feedback	Head foreman was regularly involved in quality checks to avoid rework	Less frequent quality checks, reworks observed
	Leadership style	Head foreman generally followed a centralised crew management approach. Core members were also involved in decision making	Head foreman was occasionally present onsite. The crew was centrally managed by the leading hand
	Coordination with other trades	Head foreman was predominantly involved in coordination	Less experienced leading hand was predominantly involved in coordination

4.6.1 Work preparation and execution strategy

Work preparation and execution strategy involved review of job-related drawings, materials arrangement, and determining an overall job execution strategy. In the HPC, the head foreman reviewed the column layout and detailed design drawings to check for any changes in the rebar details from the previous floor and paid particular attention to details that his crew were not familiar with. He simplified details regarding the number of rebar rods to be cut and bent, prepared his own notes, and communicated these to his crew. Figure 4.3 shows the pictures of the chit notes used by the HPC head foreman. In this way, he tried to minimise material wastage during rebar cutting, rework and quality-related issues. This head foreman also made sure his crew had all needed material for work the next day. He checked for sufficient stock of rebars onsite before executing the activity.

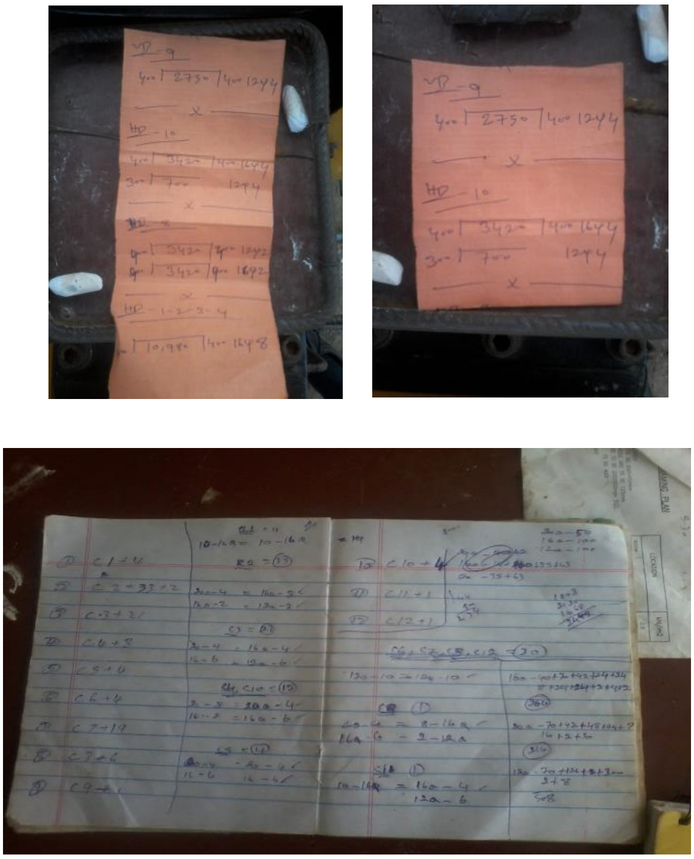

Figure 4.3 Pictures of the HPC head foreman's chit notes

In case of APC, the head foreman reviewed the detailed drawings with the leading hand and the crew, and discussed changes in rebar details. However, there were no simplified notes given to the crew on the rebars to be cut and bent. The leading hand along with the core crew members had to figure out these details on their own. There was some wastage of rebar because of the absence of the overall cutting details being provided to workers. Figure 4.4 shows the pictures of wastage of rebars in APC and palletisation practice of stirrups in HPC and APC. The leading hand had to coordinate with the main contractor on material availability.

Figure 4.4 Palletisation of stirrups in HPC and APC and wastage of rebars in APC

Figure 4.5 depicts the actual work execution approach adopted by both the crews from activity start to completion. As indicated, the HPC took seven days, while the APC took nine days to complete the activity. The horizontal bars indicate the various tasks within the activity. The bars move from left to right in a given day, i.e., from start of the day at 8:00 am to end of the day at 5:00 pm. As can be seen in Figure 4.5, the HPC executed the activity with minimal parallel tasks in a given day as compared to the APC. This can be seen by simply noting that the number of rows in the figure for HPC is much shorter than the APC. As a further example, on day-1, almost all the crew members of the HPC were engaged in the transporting rebars from yard to work station for cutting. After substantial transport of rebars, part of the crew was involved in rebar cutting. In the APC, after moving some initial stock of rebar, rebar cutting and stirrups fabrication was carried out on day-1. Similarly, for all other days, the APC engaged members to carry out parallel tasks within a day which was less the case for the HPC. This also caused additional difficulties to the APC, in terms of problems with coordinating inter-dependant yet parallel tasks in a way that provided smooth and overall continuity in executing the activity. In this context, Thomas et al. (2004) argued that symbiotically-related crews underperform when compared to sequentially-related crews. Here, clearly, the pace of installation involves this need where the likes of the rebar tying sub-crew is dependent on the pace of bending sub-crew and stirrup fabrication. Further, the pace of bending sub-crew in turn depends on the pace of cutting sub-crew. The same study also indicated that symbiotic crews incurred a 25% increase in labour resource compared to sequential crews (Thomas et al. 2004). The present study also indicates that the APC, which exhibited a greater emphasis on symbiotic relationships than the HPC, consumed 44% more labour resources. Hence work preparation and organisation significantly influenced crew productivity.

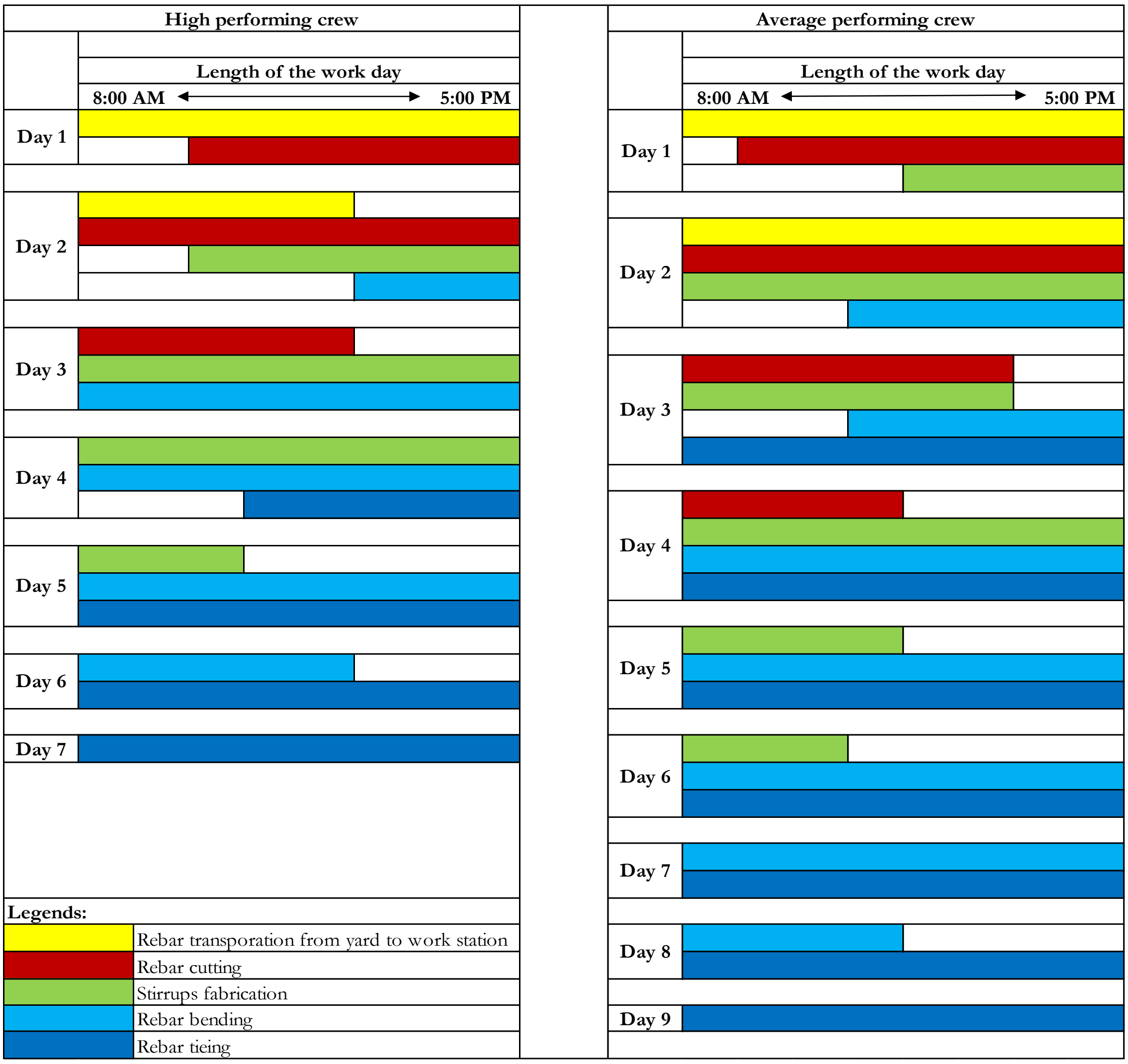

Figure 4.5 Actual work execution approach of the study crews

4.6.2 Group formation and stability (skills and experiences)

Group formation and stability involved forming well-structured and stable work groups from available workers for daily site processes and came about the differences between the HPC and APC. In the HPC, for each of the four key tasks, dedicated crew members/sub crews were formed except during the all-inclusive transporting of rebar materials. The head foreman knew the skill-level of each worker, hence assembled appropriate sub-crews for the various key tasks. He utilised a rule-of-thumb for each of the sub-tasks, for example, during an interview, he mentioned '*a skilled worker can fabricate 900-1000 stirrups per day*'. He benchmarked individual's skill levels against such heuristics and allocated tasks accordingly. The head foreman also allowed the leading hand to take control of the tasks that he had less involvement with, from that point onwards. The head foreman also assessed the risk-levels of certain tasks and allocated the most experienced crew members with the requisite skills and capabilities for the most demanding tasks. For instance, in the case of rebar tying, the HPC head foreman deployed more experienced crew members to reinforce columns that are located in the corners and along borders of the buildings concerning safety. This aligns with findings in other studies that indicate preventing errors in high-risk tasks improves productivity and reduces the likelihood of accidents (Mitropoulos et al. 2009; Mitropolous and Cupido 2009).

The reliability of the less skilled HPC members contributed to better workload distribution, better support, and housekeeping. Also, the pairing of semi-skilled and unskilled workers with the skilled workers was carefully executed by the HPC head foreman. For example, in case of a sub-crew with four workers (for 16 and 20mm rebar bending), two skilled workers, one semi-skilled and one unskilled worker were brought together. From safety perspective, studies have identified that this practice facilitates socialisation process and is also a systematic attempt to create shared accountability of less experienced workers (Mitropolous and Cupido 2009).

In the APC, the crew formation and stability lacked the same logic and technique in matching crew members' skills to tasks. Even though the head foreman knew each member's skill level, he only visited the site occasionally and hence his involvement in day-to-day work organisation of the work was less direct. The leading hand was often more involved in the formation and allocation of tasks to sub-crews and specific crew members within. Even so, the head foreman often shuffled crew members out of their existing crew into another, thus destabilising the original crew. With stable crews, the head foreman could have estimated work duration more reliably and would better know crew capabilities including individual strengths and weaknesses. This can be related to other studies on turnover of crew members, where for instance, low levels of turnover were considered to be important in preventing errors and accidents onsite (Mitropolous and Cupido 2009). Further, crew stability and reliability have already been recognised as important factors affecting productivity (Dai et al. 2009; Thomas and Sudhakumar 2014).

4.6.3 Avoiding duplication of non-value adding tasks

Duplication of non-value adding tasks significantly impacted on productivity and mainly related to transportation and storage of processed materials. Figure 4.6 depicts the process undertaken by both crews including the transportation and storage of materials between key tasks. In Figure 4.6, steps 1 to 15 depict the main process followed by both the crews. However, within this structure it can be seen that the lower half of the figure shows additional non-value adding steps that only applied to the APC due to additional transportation and storage of materials i.e., including the grey-boxed portion incorporating steps NV-1 to NV-7 and steps 13a and 13b.

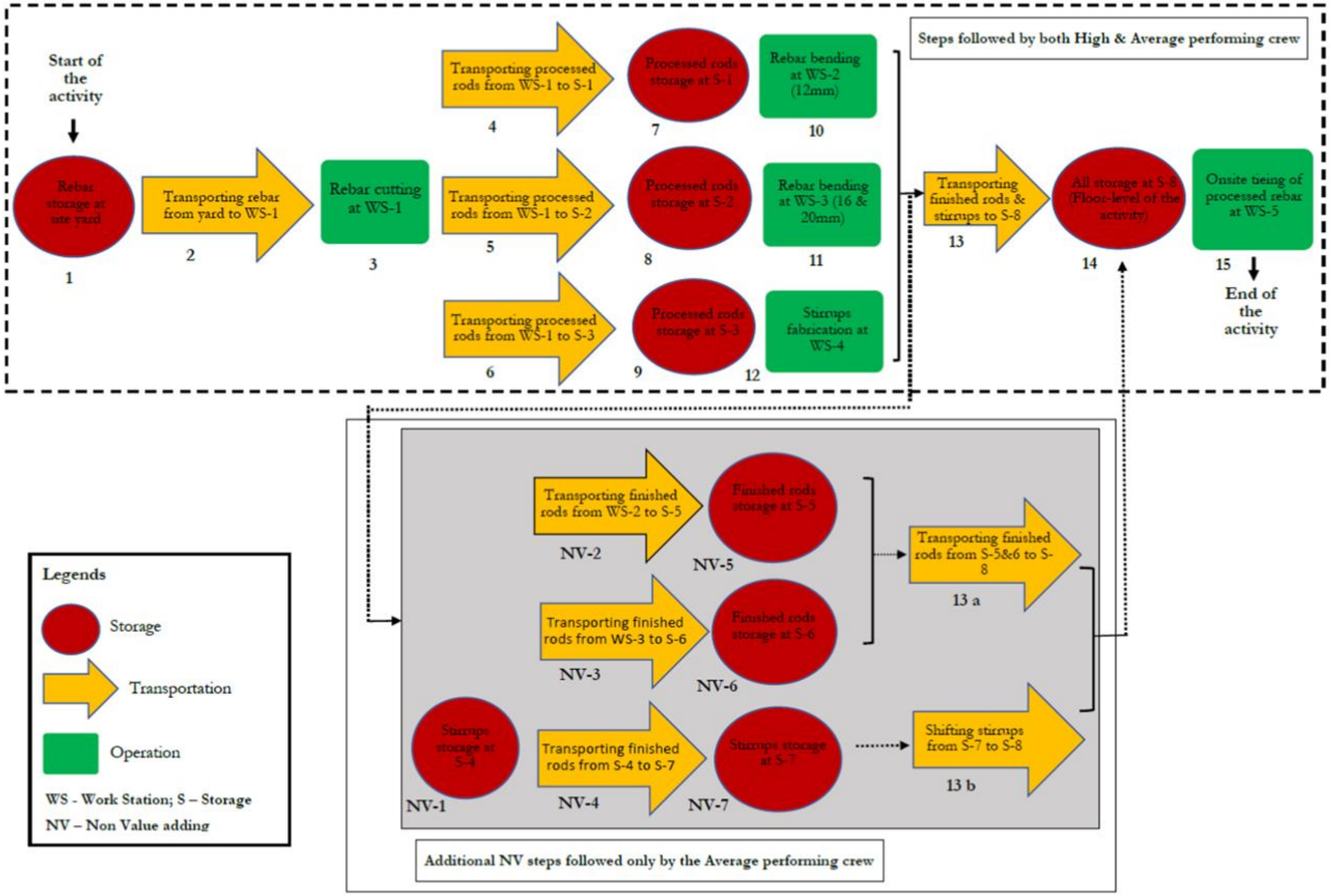

Figure 4.6 Process duplication of transportation and storage tasks.

They could have avoided the steps NV-1 to NV-7, while steps 13a and 13b could have been carried out as a single step like in the HPC. With better material handling practices, they might have significantly reduced their labour hours, and in turn, increased crew productivity. During one of the interviews, the leading hand of the APC said '*it is difficult to manage the whole crew all alone...it is difficult to note what each person is doing*'. He further explains as '*…some crew members may just spend time in transporting some materials from one end to another end, without coordinating with others and checking whether it is appropriate to store materials at this place'.* This shows the influence of tasks duplication on crew productivity.

4.6.4 Crew social cohesion

Crew social cohesion refers to the non-technical communication needed for affective coordination and assimilation of crew members. At the beginning of each day, the HPC head foreman briefed his crew on what needed to be done that day - commonly referred to as team briefings. On a few occasions, informal team de-briefings at the end of the day conveyed what was achieved against what was planned that day. Team briefings contributed to team performance in several ways such as the development of a shared mental model, facilitating situational awareness and error management, and the ability to adapt to changing situations (Kozlowski and Bell 2003). For example, in healthcare settings, the use of preoperative checklist and team briefings between surgeons and nurses has been found to reduce communication problems during surgery (Lingard et al. 2008).

Backing-up behaviour was also noticed among the HPC crew members. Backing-up behaviour occurs when crew members assist someone who is unable to complete his or her task on-time and/or help the person correct a mistake (Salas et al. 2008). Porter (2005) found that backing-up behaviour was positively related to performance in teams where some members had excessive workloads. Some practices relating to backing-up behaviours such as cleaning up the work area, organising the tools and materials for other team members were noticed in the HPC.

In the APC, some members followed similar practices such as backing-up behaviours and cross-monitoring of other members' performance. However, unlike the HPC, team briefings were not organised by the APC's head foreman. This led to a lack of shared awareness about the various crew member tasks, for example, the additional material handling processes alluded to above. Also, the shuffling of crew members in the APC (mentioned previously) also caused lack of bonding between the crew members as different work habits and methods lead to disagreements and reduced cooperation. However, team cohesion was high in the HPC since there was greater crew stability due to consistent work roles.

4.6.5 Internal and external leadership

In some ways, a construction work crew can be compared to sporting teams (soccer, basketball etc.), where success depends on the coach's understanding of the situation, creating the right tactics, selecting the team according to those tactics and establishing strong teamwork so they offer more as unit, compared to a disparate group of individuals.

Crew leadership involved work inspection, feedback, coordination with other crews and overall crew management. With regards to internal leadership, the HPC head foreman was regularly involved in quality checks to avoid rework. Whilst he followed a centralised crew management approach, the core members were also involved in crew management and decision making. Here, autonomy represents the capacity of a system to make its own decisions about its actions. Researchers suggest that increased autonomy can enhance group performance as it gives a sense of pride in the crew, when managing tasks by themselves; thereby conferring 'ownership' of the task (Hinze 1981; Salas et al. 2008). However, the generally top-down approach in construction only serves to reduce autonomy in given crews (Hinze 1981; Dai et al. 2009). While the HPC head foreman provided a degree of crew autonomy, this was not apparent in the APC.

With regards to external leadership, in coordinating with other trade crews, the HPC head foreman directly coordinated with the foremen of other crews, such as formwork crews. He did not want the presence of the formwork crew to pressurise his crew and therefore negotiated around this position. Whereas in the APC, the head foreman was not directly involved in coordination with other crews as this was delegated to the less experienced leading hand. Apart from lack of experience, this also carried with it a second problem of the leading hand having limited time to negotiate with other crews, as he was already fully occupied in physically executing work as well as trying to concurrently manage it.

4.6.6 Validation of the identified work practices

The above in-depth case study of HPC and APC identified five broad themes of work practices. As said, the identification of work practices was carried out through extensive field observations, and the reasons for following such practices were verified and validated through interviews with crew members and foremen. To triangulate the study findings, it was presented and discussed with the senior site engineers and project managers. However, in order to further externally validate the above identified work practices, field observations and interviews with other crews executing different construction activities were conducted. These included formwork shuttering, concreting and reinforcement activities. Figure 4.7 shows these study activities. The details of the crews studied, and the data collected from them are presented in Table 4.5.

Table 4.5 Details of the activities studied for validation of the identified work practices

Activity studied	**Crew and work details**	**Field observation details**	**Details of interviews of crew members and their foremen**
Formwork shuttering	No. of carpenters: 15 No. of helpers: 20 Footing and slab formwork shuttering	• Focused on examining the crew work practices during planning, organisation, and actual execution of work onsite	• Interviews were carried out with crew members. Observed work practices were presented and discussed
Concreting	No. of masons: 2 No. of helpers: 5 Column and slab concreting	• Carried out periodically, for about 3-4 times a day for about 3 days, and each observation cycle lasted for 30-45minutes	• Separate interviews were carried out with the crew's head foreman after compiling all the practices - as a mean of reinforcing 'face' validity
Reinforcement	No. of barbenders: 20 No. of helpers: 23 Column and slab reinforcement	• Observations carried out until new work practice was observed	

Figure 4.7 Pictures of study activities

The study of the additional activities presented in Table 4.5 was carried out to validate the work practices identified earlier in the case study. The observations were focused on examining the crew work practices during planning, organisation, and actual execution of work onsite. The researcher was directly involved in making these observations on the additional study activities. The observations were supported by follow-up interviews with the study crews and their foremen. For instance, as mentioned in Table 4.5, in the case of the concreting crew, observations were carried out periodically for about 3-4 times a day for three days. Each observation period lasted for about 30 to 45 minutes. Observations were transcribed and compiled. Interviews were then carried out with the crew members first, followed by interviews with the head foreman to validate the work practices observed. The idea of conducting the interviews with the additional study activities foremen was to check and confirm if there is any coded work practice emerged other than what was identified earlier in Table 4.4. The study of additional activities concluded that all the broad theme of work practices that emerged and presented in Table 4.4 is validated and that no new work practice emerged at this stage. This validated the identification of work practices presented in Table 4.4.

4.7 LINKING IDENTIFIED THEMES OF WORK PRACTICES WITH THE LITERATURE

The themes of crew work practices identified in Stage 1 of the present research provides an alternative approach to manage onsite productivity. Table 4.6 achieves the comparison by cross referencing factor numbers used in Table 2.1 (*Chapter 2 – Literature Review)*, which are shown within parentheses in Table 4.6. This serves to show commonality between work practices identified in the present study that impact on productivity, and isolated productivity factors in the extant literature. What this means in practical terms, is that these isolated factors can be mediated through crew-based work practices, thus providing a more practical and centralised means of managing onsite, relative to what would otherwise be an isolated and disaggregated set of factors. The identified practices, which bundle isolated factors together, can help to realistically improve onsite crew productivity. The validity of this perspective is also based on the previously mentioned finding that crew productivity can vary significantly but is not necessarily explainable when looking purely at individual worker productivity measurement.

Table 4.6 Mapping broad themes of practices with critical factors affecting CLP

Broad themes of practices identified by this study	Related critical factors affecting CLP from the existing literature
Work preparation and execution strategy	Clarity of technical specifications (B-2) Availability of drawings onsite (B-4) Availability of tools and equipment (B-5) Availability of materials (B-6) Poor planning and scheduling of activities and tasks (B-11)
Group formation and stability	Unbalanced distribution of resources (B-9) Crew size and composition (C-2) Absenteeism and turnover of labour (C-5) Pulling people off a task before it is done (C-7)
Avoiding duplication of non-value adding tasks	Site layout (B-1) Methods of working (B-3)
Crew social cohesion	Communication difficulties between supervisor/foreman and worker (C-6) Teamwork among workers and crews (C-8) Motivation of labour (C-9) Working culture (C-10) Linguistic differences between workers, crews and supervisors (C-13) Respect for workers and crews (C-15) Stress and work-life balance of human (C-16) Improper coordination & cooperation among workers and crews (C-17) Respect and recognition for craft worker suggestions/ideas (C-18)
Internal and external leadership	Inspection delay (B-8) Competency of supervisors and foreman (C-3) Availability of proper work front (C-12) Respect and recognition for craft worker suggestions/ideas (C-18)

4.8 CONCLUSION

The case study conducted on a residential project compared a high-performing with an average-performing crew, in unveiling the influence of crew work practices on productivity.

The former exhibited 44% higher productivity than the latter. It was found that work practices significantly influenced the productivity of each crews, as most other project and activity-specific variables were relatively controlled by the virtue of the chosen research method. The high-performing crew was found to have adopted better work practices compared to the average-performing crew.

The Stage 1 of the present research identified five broad themes influencing this difference including: work preparation and execution strategy; group formation and stability; avoiding duplication of non-value adding tasks; crew social cohesion and; internal and external leadership. The identified crew based work practices suggest that crews - as distinct from individual workers - can be seen as important when evaluating CLP. Also, it makes conceptual and practical sense to focus on work crews as a central and mediating variable, instead of a long list of isolated and disaggregated factors impacting on productivity. The identified crew work practices determine the outcomes of the first stage of the research.

In the second stage of the research, it is proposed that the identified work practices can be collectively studied through the lens of 'teamwork'. By conceptualising crews as teams, the heterogeneity of team-based skills and behaviours of crew members and their impact on performance can be more readily understood. The next chapter presents the conceptual framework which is developed to analyse the influence of teamwork processes and practices of onsite construction trade crews on productivity. Chapter 5 addresses the second objective of the present research.

CHAPTER 5.[1]

INFLUENCE OF TEAMWORK ON TRADE CREW PRODUCTIVITY: FRAMEWORK

5.1 INTRODUCTION

Research in construction labour productivity (CLP) had often tended to focus on measuring individual worker output (e.g., m^2/worker/hour) and while this provides a useful measure of performance in broad benchmarking terms, it is relatively uninformative in terms of how and where to improve performance. For instance, it does not delve into the complexities of how to get the best out of the holistic crew as an interactive unit. Importantly, this takes into account the adage that the total effectiveness of a group, each interacting with one another, is greater than their effectiveness when acting in isolation from one another.

Findings from Chapter-4 indicated that the broad themes of identified work practices influenced the productivity performance of trade crews. This forms stage 1 of the present research. The identified crew based work practices suggest that crews - as distinct from individual workers - can be seen as important when evaluating CLP. Therefore, it is proposed that the identified work practices can be collectively studied through the lens of 'teamwork'. As mentioned in Chapter-4, by conceptualising crews as teams, the heterogeneity of team-based skills and behaviours of crew members and their impact on performance can be more readily understood. So, it is proposed here that the productivity of trade construction crews,

[1] Shorter version of this Chapter is published in the Journal article co-authored with Prof. Perry Forsythe. The citation is as follows:

Loganathan, S., and P. Forsythe. 2020. "Unravelling the influence of teamwork on trade crew productivity: a review and a proposed framework." *Construction Management and Economics*. 38 (11): 1040-1060.

and the teamwork they display, plays a significant role in highly labour-intensive building construction projects, and requires further investigation to improve productivity outcomes (Hewage et al. 2011; Raoufi and Fayek 2018). Figure 5.1 shows the linkage between stage 1 and stage 2 of the research. The stage 2 research aims to develop a conceptual framework to analyse the influence of teamwork processes and practices of onsite construction trade crews on productivity.

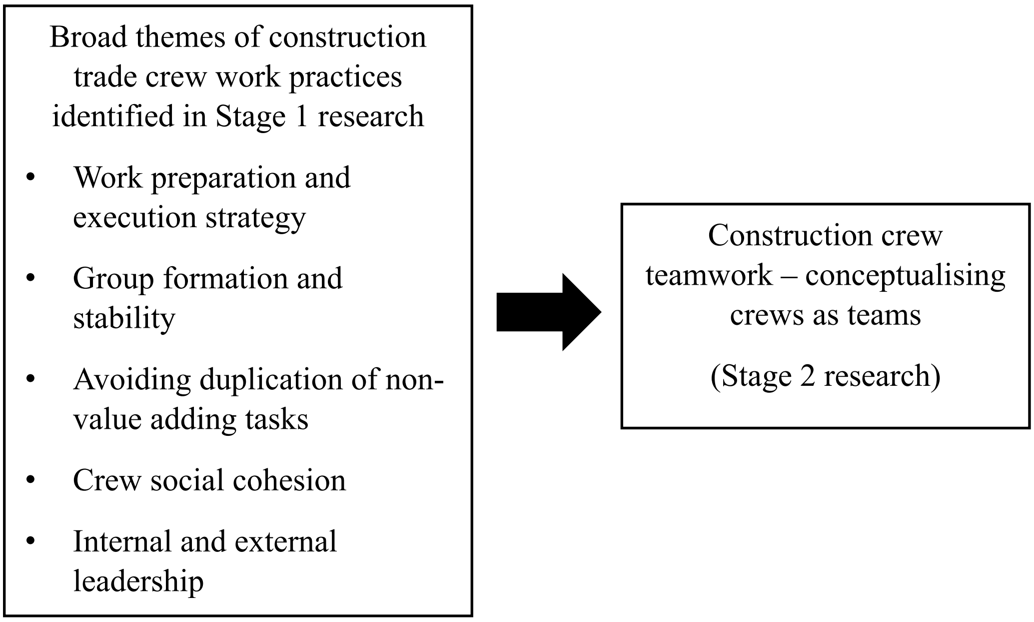

Figure 5.1 Linking stage 1 and stage 2 research

The basic issue is not new; in past times, well known reports such as ‘Constructing the Team’ (Latham 1994) and ‘Rethinking Construction’ (Egan 1998) initiated the need for greater emphasis on teamwork and integration. But the study of onsite trade crews and helping them to work efficiently together, differs significantly from the proliferation of managerially oriented teamwork research that has been undertaken since these reports. The difference between managerially based teams and physical trade teams is crystalized by Devine’s (2002) theoretical work in the field of organisational psychology and management. He identifies two broad categories of teams based on clusters of task characteristics and from this, identifies: executive teams and physical teams (Devine 2002). Executive teams are those that primarily focus upon processing and integrating information for decision-making, addressing workflow issues, designing products and services, and/or coordinating work functions (Devine 2002; Honts et al. 2012; Ceri-Booms et al. 2017). These include design teams, project management teams, advisory teams, command teams and negotiation teams (Devine 2002; Honts et al. 2012). Physical teams are those teams where performance depends upon the successful execution of physical task-related actions (Devine 2002; Honts et al. 2012; Ceri-Booms et al. 2017). These include production teams, service teams, transportation teams, military teams, and sports teams (Devine 2002; Honts et al. 2012).

Studies have indicated that team type will influence the structure and perceived importance of different KSAs (knowledge, skills, and abilities); this will vary between team types and according to the primary tasks involved (Li and Gevers 2018; Shemla et al. 2016). For instance, executive teams were found to value processes such as planning and strategising more highly than physical teams (Honts et al. 2012). Also, executive teams value planning and strategising processes more than monitoring and coordinating processes (Honts et al. 2012; Ceri-Booms et al. 2017). On the other hand, as physical teams work more in structured tasks, they value monitoring and coordination processes more than executive teams (Honts et al. 2012). In many physical teams an appointed leader performs most of the planning functions, for instance a foreman for construction crews. Moreover, studies have also indicated that the importance of the team processes will also vary between different type of teams (e.g., executive, and physical teams) (Gibbs et al. 2017; Shemla et al. 2016).

While a considerable amount of research has been conducted on construction project management teams, less attention has been paid to these onsite physical construction teams. For instance, managerially focused teamwork (within project management teams) include the likes of information sharing, BIM, monitoring, controlling, data interrogation, analysis, planning, designing and integrating across separately contracted parties (Fong and Lung 2007; Ramalingam and Mahalingam 2018; Hosseini et al. 2018). However, teamwork in desk-based environments is considerably different from teamwork in onsite trade crew environments – at core, they are physical "doers" and not desk-based workers. They work less in virtual environments (Hosseini et al. 2018) and more in physically dynamic environments. The context is more akin to a quasi-production setting than an office-based setting. Each member has a sequential role characterised by the likes of setout work, material handlings, installation, and finish-off tasks. It requires intuitive understanding and balance between workers in optimising production and in making sure bottlenecks and under-utilised workers are avoided.

Despite the obvious importance of the 'crew' dimension to productivity, as discussed in the previous chapter (Chapter 4), construction management research has tended to overlook, assume, or deemphasize 'teamwork' when accounting for onsite productivity. There is subsequently a need to understand the mechanisms of teamwork, where underlying the functioning of trade crews in physical onsite construction activities.

The present chapter therefore aims to adapt and synthesise models from other physically orientated teamwork environments, to apply to construction trade crews, which will be merged with the CLP literature. The aim is to develop a conceptual framework for hypothesising and testing the explanatory impact of teamwork on construction trade crew productivity. An initial descriptive framework is presented in Figure 5.2 to frame the basic focus of the research which is developed further in the ongoing discourse.

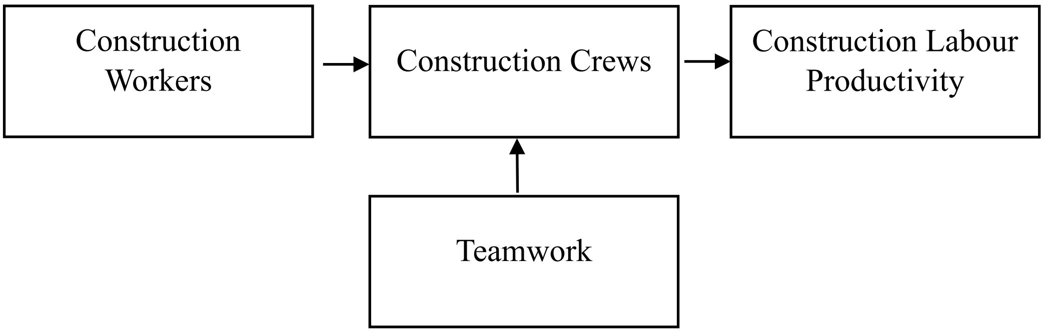

Figure 5.2 Basic conceptualisation of the proposed framework

The chapter is structured as follows: the following section provides a critical review of the CLP literature under the broad theme of teamwork; it is followed by introducing concepts from the mainstream organisational psychology and management literature about crew related teamwork as a behavioural phenomenon. The framework is developed in stages by merging the concepts of teamwork and productivity, in the context of onsite construction trade crews.

5.2 HARNESSING TEAMWORK DIMENSIONS THAT IMPACT ON CREW PRODUCTIVITY

Chapter 2 provided a critical review of the literature on CLP and highlighted that the literature has inadequately addressed the 'crew' aspect of CLP. The measurement and productivity models developed so far lacked explanatory power at a detailed level, in knowing how and where to improve labour usage. The literature paid scant attention to the complexity of social construction, interactions, and interdependencies at this level, in explaining productivity – instead it attempts to explain productivity through simplified and linear cause-and-effect relationships (Dolage and Chan 2013). Chapter 2 concluded that there is lack of conceptual development of such crew related issues in the CLP literature. However, Chapter-2 also highlighted that on analysing the factors affecting CLP, it is still apparent that individual dimensions of productivity can still be seen through lens of a crew-centric perspective.

In order to advance the above discussions, a systematic triple-stage cascading content analysis of the CLP literature is carried out to productivity factors that could be dealt with through the lens of trade crews and teamwork. The first two stages of the triple-stage cascade-type content analysis is already carried out and presented in Chapter-2 in section 2.3. Here, in the present chapter, further distillation of the crew and human-related factors is carried out from stage-2 of the cascade-type content analysis. Therefore, Figure 2.7 in Chapter-2 is further expanded to add stage-3 thereby bringing in the crew teamwork theme. Figure 5.3 represents the triple stage cascade-type content analysis of the CLP literature. While doing so, the crew based work practices that was identified in Chapter-4 is utilised to further refine the dimensions.

In stage-3, the 19 (out of 44 from stage-2) factors were ultimately compressed into five individual dimensions listed below.

- *Communication among workers and crews*
- *Crew orientation*
- *Coordination among workers and crews*
- *Crew leadership*
- *Respect and recognition of workers and crews*

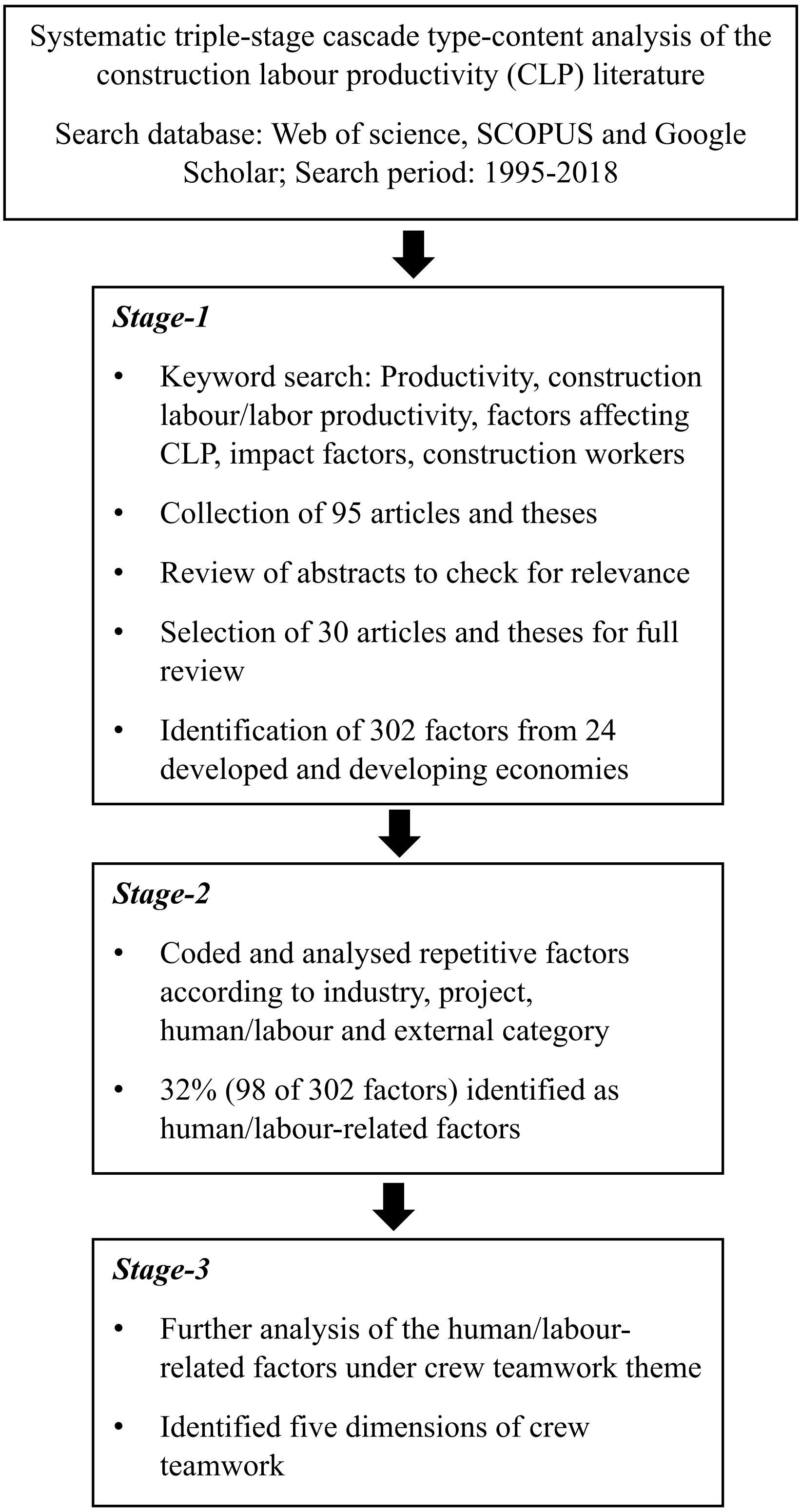

Figure 5.3 Triple-stage cascade-type content analysis of the CLP literature

In order to provide further detail, the categorisation of content loading onto each of the five dimensions of crew teamwork impacting on CLP, is shown in Table 5.1.

This analysis of the CLP literature highlights the finding that common content in the CLP literature - previously expressed as free-standing and therefore fragmented impacts on CLP - can now be expressed collectively under the central construct of crew teamwork, as defined in Table 5.1. The aim of this is to provide greater explanatory power by conceiving crew teamwork as a mediating construct.

Table 5.1 Summary of critical factors affecting CLP in relation to the context of teamwork of construction trade crews and workers

S. No	Factors / Combination of factors relating to teamwork of construction crews and workers	Authors (indicative examples)
1	***Communication among workers and crews*** Clarity of instructions and information exchange; Communication problem among craftsmen and supervisors; Lack of periodic meeting among site personnel; Communication system; Communication problems with foreign workers	Naoum (2016) Jarkas and Bitar (2012) Dai et al. (2007)
2	***Crew orientation*** Lack of team spirit among craftsmen; Clear and daily task assignment; Team/group integration during construction; Unfriendly working atmosphere; Relations with workmates; Giving responsibility; Sharing problems and their results; Poor relations between management and workers; Team-spirit of the crew; Trust among workers and crews; Love and belongingness	Naoum (2016) Hewage et al. (2011) Thomas and Sudhakumar (2014)
3	***Coordination among workers and crews*** Improper coordination within and between crews; Crew interference; Interference from other trades or other crew members; Group co-ordination/overcrowding on site; Labor interference and congestion; Improper coordination of subcontractors	Naoum (2016) Thomas and Sudhakumar (2014) Jarkas and Bitar (2012)
4	***Crew leadership*** Incompetent supervisor; Lack of experience of supervisor; Delay due to unclear or inadequate instructions; Fair performance reviews; Foremen allowing crafts to work autonomously; Foremen people skill; Leadership skills of supervisors; Improper plan of work	Jarkas and Bitar (2012) Hasan et al. (2018) Hewage et al. (2011)

Continued in the next page

5	***Respect and recognition of workers and crews*** Respect for craft workers and foremen; Disregard of craft worker suggestions/ideas; Lack of recognition of good and efficient workers; Disregard of crafts' productivity improvement suggestion; Worker participation in decision-making; Not being informed of the contribution of craft workers' work to the project; Receiving compliments for doing a good job; Work satisfaction	Jarkas and Bitar (2012) Thomas and Sudhakumar (2014) Dai et al. (2007)

5.3 AN ALTERNATIVE PERSPECTIVE: INVESTIGATING TEAMWORK FROM THE ORGANISATIONAL PSYCHOLOGY AND MANAGEMENT DISCIPLINES

Whilst the previous section provides teamwork dimensions that tap into the intersection between construction crews and productivity, there is still a need to synthesise this information into a more complete conceptual framework that aims to provide extended explanatory power about how teams work, in dynamic day-to-day work environments. The mainstream organisational psychology and management literature has been called upon for this purpose.

The selected literature derives from a keyword-based search from databases including PsychINFO, Web of Science, SCOPUS, Business Source Premiere, and Google Scholar. The search process included several inclusion and exclusion criteria to refine publications for detailed review. It was decided to carry out the review process in two phases as shown in Figure 5.4. As can be seen in Figure 5.4, phase wise review of the mainstream psychology and management literature was carried out.

In Phase-1, a conceptual review (Grant and Booth 2009; Rocco and Plakhotnik 2009) was conducted to appraise, gain traction, and get a broader conceptual and theoretical understanding of the mainstream teamwork literature. Given the extensive nature of literature on teamwork, it was decided to compile and conceptually analyse the literature from multiple literature reviews published in this area. In Phase-2, a traditional narrative review approach (Baumeister and Leary 1997; Onwuegbuzie and Frels 2016) was adopted to develop a conceptual framework and derive research directions based on the identified theoretical approaches from Phase-1, within the context of onsite construction crews.

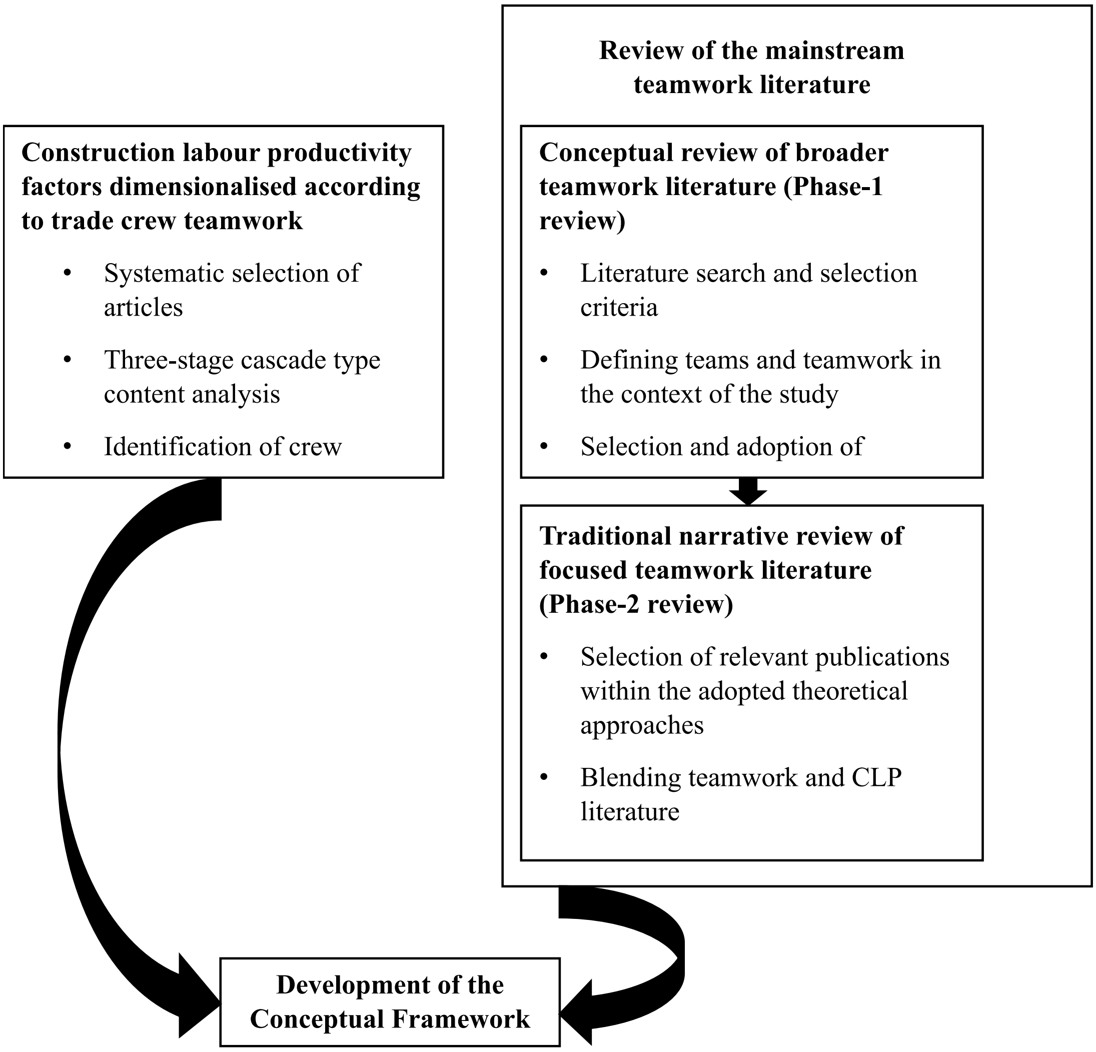

Figure 5.4 Phase wise review process of the mainstream teamwork and CLP literature

In Phase-1, the keywords - teams, groups, work groups, work teams, teamwork, teamworking, team effectiveness, team performance, review, literature review, review of literature and systematic review were used to gather literature from the above-mentioned sources. The keywords were used with the functional combinations of and/or/not in the title of searched publications. The initial inclusion criteria included English peer-reviewed original articles published over the last two decades (from year 2000). The search yielded 192 publications from 14 organisational psychology and management Journals such as *Academy of Management Review*; *Journal of Management*; *International Journal of Human Resource Management*; *Human Resource Management Review*; *International Journal of Management Review*; *Small Group Research*; *Organisational Psychology Review*; *Frontiers in Psychology*; *Annual Review of Psychology, Journal of Applied Psychology*; *Human Factors* to name a few. The articles also included teamwork research in specific discipline Journals such as *Medical Care Research and Review*; *British Journal of Anaesthesia*; *Acta Anaesthesia Scand* focused on Healthcare teams; *International Journal of Project Management* and *Project Management Journal* focused on project management teams; *International Review of Sports and Exercise* focused on sports teams; *Journal of Engineering Education* focused on student teams; *Journal of Product Innovation Management* focused on new product development teams. The identified articles also included those from the special issues on teamwork published in various journals such as *Human Relations* (Vol. 53, No. 11, 2000), *New Technology, Work and Employment* (Vol. 16, No. 3, 2001), *Personnel Review* (Vol. 31, No. 3, 2002), *International Journal of Operations and Production Management* (Vol. 24, No. 8, 2004), *International Journal of Human Resource Management* (Vol. 16, No. 2, 2005); *European Journal of Work and Organisational Psychology* (Vol. 18 No. 3, 2009); *American Psychologist* (Vol. 73, No. 4, 2018) and *Human Resource Management Review* (Vol. 28, No. 4, 2018).

Of the 192 identified publications, those which exclusively studied 'teamwork' as a construct (irrespective of the context), were considered for further review. This mainly included development of teamwork models and frameworks in several disciplines such as healthcare, military, aircraft, sports, student teams, new product development, work and project teams etc. However, studies which focussed on teamwork with single variables of interest such as teamwork and team training; teamwork and knowledge management; teamwork and communication; teamwork and coordination; teamwork and leadership were excluded for further review as these looked at specific industry factors of influence as distinct from more generalizable frameworks. On applying the above inclusion and exclusion criteria, the selection procedure scoped down the initially identified 192 publications to 34 publications for further review.

As mentioned before, the Phase-1 conceptual review was carried out to gain traction and get a broader conceptual and theoretical understanding of teamwork within the context of the mainstream literature. The outcomes of this phase provided an understanding of how mainstream researchers have defined teams, teamwork, typology of teams and teamwork, and the development of team effectiveness and performance models in several disciplines. This further helped in selecting appropriate theoretical approaches to study ‘construction crew teamwork’ in this study.

5.4 MAJOR THEMES FROM THE INVESTIGATION ABOUT TEAMS AND TEAMWORK

Drawing on phase wise review process as represented in Figure 5.4, teams and teamwork in different contexts and the development of team effectiveness models in the mainstream literature are discussed in the following sections.

5.4.1 Teamwork in different contexts

There are several definitions that exist in the literature on defining teams (Kozlowski and Bell 2003; Sundstorm et al. 2000; Salas 1992). One of the widely accepted definitions is by Salas (1992) who defines a team as ‘a distinguishable set of two or more people who interact dynamically, interdependently, and adaptively toward a common and valued goal/objective, who have each been assigned specific roles or functions to perform, and who have a limited life-span membership. It is this definition that has been used in this research as it has an obvious affinity with construction contexts.

Another theme from phase wise review is that teamwork has been clearly studied in different sectors/contexts and at different levels of hierarchy within organisations and projects to understand the effectiveness of team performance. A number of researchers have proposed team taxonomies (Sundstrom et al. 2000; Devine 2002; Kozlowski 2015) to assist in more clearly delineating the tasks a team may engage in and the needed competencies, the stability of team membership, the interaction and communication of team members, and the life span of the team. As alluded to earlier in this paper, Devine’s (2002) team typology has been adopted which provides two broad categories of teams: intellectual/executive teams and physical teams. Of these, as mentioned earlier, the category of *physical teams* fits the ongoing context of this research, concerning trades work onsite.

With regard to this, research on physical teams has been undertaken in manufacturing, healthcare, aviation, military, oil and shipping industry crews (Flin et al. 2002; Lindsjørn et al. 2016; Rosen et al. 2018). Studies in these contexts have accentuated teamwork as an important strategy to improve effectiveness and performance (Flin et al. 2002; Lindsjørn et al. 2016; Rosen et al. 2018). For instance, in the aviation sector, the development of a crew resource management model focused on enhancing the key nontechnical skills and team processes that affect crew planning and decision-making, workload management, situation awareness, communication, and assertiveness of aircraft crews (Flin et al. 2002). Research in healthcare teams identified effectiveness of team processes such as quality of collaboration, shared mental model, communication, coordination, conflict management and leadership are central to the successful provision of patient care (Kalisch et al. 2010; Rosen et al. 2018). In the case of new product development teams, researchers found that leadership, team ability, external communication, goal clarity and team cohesiveness as critical determinants of team performance (Sivasubramaniam et al. 2012). Social loafing, interdependence, conflict, trust and shared mental models are highlighted as team processes that informs facilitation and assessment of engineering student teams (Borrego et al. 2013).

As alluded to above, the identification of team interdependence processes and mediators build further on the understanding of how teams operate from the perspective of the organisational psychology and management disciplines (Flin et al. 2002; Lindsjørn et al. 2016; Rosen et al. 2018). The remaining question is to find out which ones apply most to construction crew settings.

5.4.2 Team effectiveness model

Team effectiveness models build further on the understanding of how teams operate from the perspective of the organisational and management disciplines (Flin et al. 2002, Kalisch et al. 2010, Lindsjørn et al. 2016; Rosen et al. 2018). Team models and frameworks are generally conceived as multifaceted, with an emphasis on both internal (i.e., member satisfaction, team viability) and external criteria (i.e., productivity, safety, and quality performance). The outcomes of the phase wise review indicated that most of the team effectiveness models and frameworks developed to study teams within an industrial and organisational setting, were developed based on the logic of an input–process–output (IPO) heuristic formulated by

McGrath (1964) (Mathieu et al. 2008; Kozlowski 2015; Mathieu et al. 2018). *Inputs* are typically resources available to the team both internally and externally, to execute tasks; *processes* mediate the translation of inputs to outputs; *outputs* represent criteria to assess the effectiveness of team actions. An alternative version of this is the similar use of "mediators" instead of "processes", hence, an input-mediator-outcome (IMO) model. This model, developed by (Mathieu et al. 2008), aims to incorporate all types of factors and mechanisms linking inputs with effectiveness in teams. In the context of IMO model, inputs describe factors that enable and constrain members' interactions. These include team member composition, team structure and organisational contextual factors (Mathieu et al. 2008; Ilgen et al. 2005). Mediators help translate inputs into outputs and it tends to bring together all of the behavioural, cognitive, and affective phenomena existing in teams (Mathieu et al. 2008; Ilgen et al. 2005). Outcomes are results and by-products of team activity that are valued by one or more constituencies. These include performance (e.g., productivity, quality, and quantity) and members' affective reactions (e.g., satisfaction, commitment). The IMO model has been adopted in this research because it is broadly consistent with productivity models. A graphical representation of the IMO model is shown in Figure 5.5.

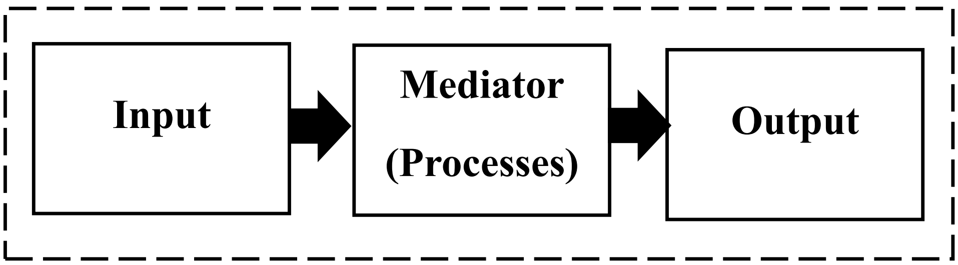

Figure 5.5 Typical IMO team model

In this research, the IMO model simply provides a broad and generalizable scaffold that is useful for hanging and positioning greater explanatory detail that unfolds in the ongoing discussion. For instance, its broadness does little in terms of punctuating the active dimensions for inputs, mediators, and outputs, as relevant to construction contexts. To address this issue, the existing literature is utilised further, to build in-detail about the active dimensions in each category, as relevant to crews and teamwork in construction (and inclusive of the previously mentioned dimensions in Table 5.1).

5.5 DETAILING INPUTS INTO THE TEAM INTERDEPENDENCE FRAMEWORK

As shown in Figure 5.5, the IMO model involves inputs as one of the major components in the model. As mentioned, inputs are typically resources available to the team both internally and externally, to execute tasks. Inputs describe factors that enable and constrain members' interactions. These include team member composition, team structure and organisational contextual factors (Mathieu et al. 2008; Ilgen et al. 2005). In the context of the present study, the two broad categories of inputs, revolve around task and crew-based characteristics. Task-based characteristics include task complexity and task interdependence (Thomas et al. 2004; Nerwal 2012). Crew-based characteristics include crew size and composition and crew flexibility (Thomas et al. 2004; Nerwal 2012). Each of these areas are dealt with in further detail, in the following sections.

5.5.1 Task complexity

Task complexity can be described as the degree to which a task is difficult to execute. Consequently, it also directly relates to productivity, quality, and safety aspects of both the task and the crew performing the task. Task complexity can also be related to member coordination within the crew to complete the task.

Previous research in the mainstream organisational literature indicates that the effect of teamwork behaviours may depend on task complexity, or more specifically, on its two sub-parts, task scope and task structure (Rousseau et al. 2006; Wildman et al. 2012). *Task scope* refers to the extent to which the team task may be divided into several subtasks (Rousseau et al. 2006; Sonnentag and Volmer 2009). For instance, a steel fixing crew can divide the activity into three subtasks – rebar cutting; preparation of rods and stirrups; and tying rebar. Crew members should have distinct competencies for performing different subtasks within the main task, as can be related to the above example. Therefore, a high level of task scope involves several distinct acts that necessitate different competencies (Wildman et al. 2012). Indeed, to handle and piece together every component of the task, team members need to adopt diverse teamwork behaviours (Rousseau et al. 2006; Wildman et al. 2012*)*. In contrast, a low level of task scope has few interconnected subtasks. In this situation, task accomplishment requires only limited teamwork behaviours.

Next, *task structure* is defined as the extent to which members actions relate to outputs in an understandable and predictable fashion (Rousseau et al. 2006). When the task is unstructured, ambiguity remains concerning how to attain expected outcomes (Rousseau et al. 2006; Sonnentag and Volmer 2009). In this situation, work preparation and work assessment behaviours are particularly important to effectively progress towards task accomplishment (Salas et al. 2005; Loganathan et al. 2018). While standard operating procedures may help reduce the uncertainty of unstructured tasks, team members may also need to coordinate, exchange information, share understanding and adjustment behaviours to deal with unexpected performance demands that may arise in the course of carrying out their tasks (Loganathan et al. 2018). When the task is highly structured, members know exactly what they have to do and when they have to do it to get the job done.

5.5.2 Task interdependence

Task interdependence refers to the extent to which workflow arrangements demand the individuals/sub-teams within a team, to interact in order to get the job done (Nerwal 2012). Task interdependence hence characteristically describes the relationships among members within a team (Salas et al. 2005; Wildman et al. 2012). At a lower level of task interdependence, team members do not need to interact to a great extent with one another to integrate their task contributions (Wildman et al. 2012). At a higher level of task interdependence, the work arrangements require that team members work together closely to accomplish the task (Thomas et al. 2004; Wildman et al. 2012). It needs a lot of coordination and communication between crew members to successfully complete the task. Also, it has been observed that team behaviour is likely to improve team performance where task accomplishment requires high interaction among team members (Wildman et al. 2012).

5.5.3 Crew size and composition

Crew size is the number of individuals in a crew/team. Researchers have shown the relationships between the size and performance of crew (Huckman et al. 2009; Ogungbamila et al. 2010). For instance, Campion et al. (1993) identified that crew size was positively related to both productivity and satisfaction and suggested the crew needs to be of a feasible size to accomplish the work assigned to them. Huckman et al. (2009) observed that increasing crew size may lead to increased capacity resulting in high overall productivity. However, Ogungbamila et al. (2010) noted that an increase in team members is often counterbalanced by the team's increased difficulty in arriving at a decision and a decrease in the average workspace of each team member. Also, increase in size beyond a feasible limit might also lead to increased coordination problems and unequal participation of team members. In the context of this study, previous studies have indicated that the size of the construction crew affects its performance and that the crew size has to be adapted to prevailing conditions (Schober 2008). Depending on the circumstances, the variability in crew size is quite considerable for day to day operations (Schober 2008).

Crew composition relates to how a crew is composed in terms of its member's experience, skills and knowledge about tasks. A more heterogeneous crew would mean crew members have more variety of skills, knowledge, and experience level. Researchers have mixed opinion on the homogenous and heterogeneous nature of crews (Tasheva and Hillman 2018). From an organisational perspective, researchers point out four factors that explain the effect of diversity on team outcomes (Jackson et al. 1995). First, the nature of the task - in intellectual and creative tasks, heterogeneity plays a more critical role than homogeneity. Second, the effect of diversity may depend on the outcomes involved - diversity may have a positive effect on team performance but a more negative effect on behavioural outcomes such as team member attrition/turnover. Third, the effect of diversity over time - studies have found that homogeneous groups display better initial performance than heterogeneous groups, but these effects dissipated over time and heterogeneous groups ultimately outperform homogenous groups (Jackson et al. 1995; Tasheva and Hillman 2018). Finally, the impact of diversity may depend on the attributes on which homogeneity-heterogeneity is assessed. Some research suggests that diversity in demographic characteristics may have negative consequences, but diversity in terms of skills and expertise may have positive effects (Tasheva and Hillman 2018).

With insights from the mainstream organisational literature, in the context of this study, it can be said that construction crews are more heterogeneous in nature. Here, heterogeneity is attributed both in terms of professional attributes (such as skill level, experience) and demographic attributes (such as differences in language, culture). For instance, a typical construction crew includes head foreman, foreman, leading hand, apprentice and helper –

which displays the varied nature of professional attributes. In a migrant construction workforce, workers with varied demographic attributes may include language, ethnicity and gender biases. Hence, it is important to include and understand the dynamics of crew composition.

5.5.4 Crew flexibility

Crew flexibility is the ability of the crew members to perform each other's task (i.e., multi-tasking). It can be inferred that if there is higher crew flexibility, then the members have a higher likelihood of performing tasks of other crew members, as required. This may also lead to reduced task completion times, as idle time can be redirected into executing other tasks. Researchers have also found that the higher the crew flexibility, the higher the satisfaction of crew members as the members appreciate the learning, i.e., members feeling of helping their crew members and learning from them as a result of working together (Kozlowski and Ilgen 2006; Nerwal 2012). In the context of onsite trades work, the idea of multi-skilling and multi-tasking is only gradually being established in the construction literature (Fini et al. 2016; Arashpour et al. 2018).

Given the above discussion (concerning task complexity, task interdependence, crew size and composition, and crew flexibility), an improved version of the teamwork construct within Figure 5.5 can now be presented with detailed inputs, as shown in Figure 5.6.

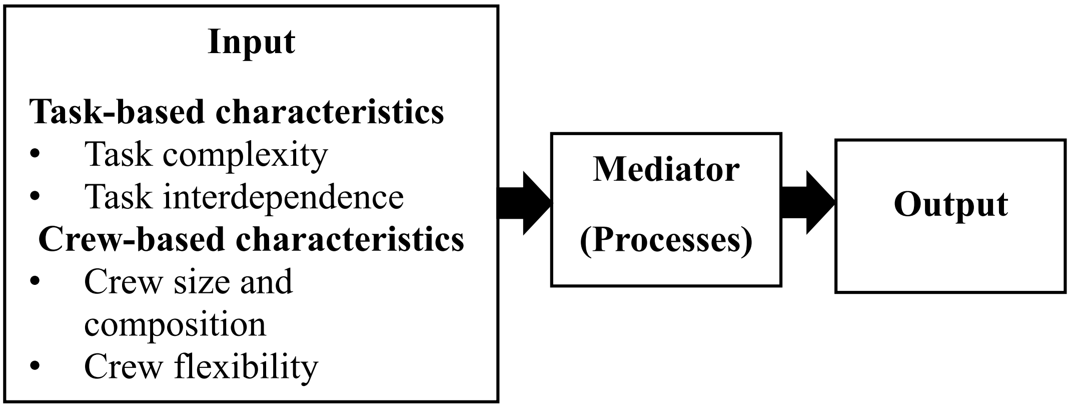

Figure 5.6 Proposed inputs to the framework

5.6 DETAILING MEDIATORS IN THE FRAMEWORK

Mediators represent a broad variety of activities that incorporate processes and mechanisms that translate inputs such as crew and task-based structural interdependencies into outputs such as team effectiveness and productivity. Mediators help translate inputs into outputs and it tend to bring together all of the behavioural, cognitive, and affective phenomena existing in teams (Ilgen et al. 2005). Of the various models available on defining what and how mediators occur in team environment, it is Salas's big five framework (Salas et al. 2005) is thought to best serve the needs of the current research and in addressing the issue of mediators. Specifically, the big five framework was selected because it offers a set of practically realisable components presented in a relatively parsimonious manner and has been developed to examine teams, regardless of the tasks they perform (Kalisch et al. 2010; Lindsjørn et al. 2016; Saghafian and Neill 2018). In addition, the big five framework has been widely adopted in many industries to investigate production levels in teams that coordinate and execute tasks at the workface similar to construction crews (Kalisch et al. 2010; Lindsjørn et al. 2016; Saghafian and Neill 2018). The big five framework specifies five core components of teamwork including: team leadership; mutual performance monitoring; backup behaviour; and adaptability; and team orientation, and three coordinating mechanisms including: shared mental models, closed loop communication, and mutual trust (Salas et al. 2005).

It is apparent from the preceding discussion about Salas's big five framework, that similar themes exist with those derived from the CLP literature discussed earlier in this chapter (refer Table 5.1). To reiterate, these dimensions include communication among workers and crews; crew orientation; coordination among workers and crews; crew leadership; respect and recognition of workers and crews. Overlaps between these and Salas's big five framework are obvious and must therefore be rationalized to form a synthesized and compressed set of dimensions. A relatively simple analysis pertaining to this is shown in Figure 5.7 which serves to show where commonality exists.

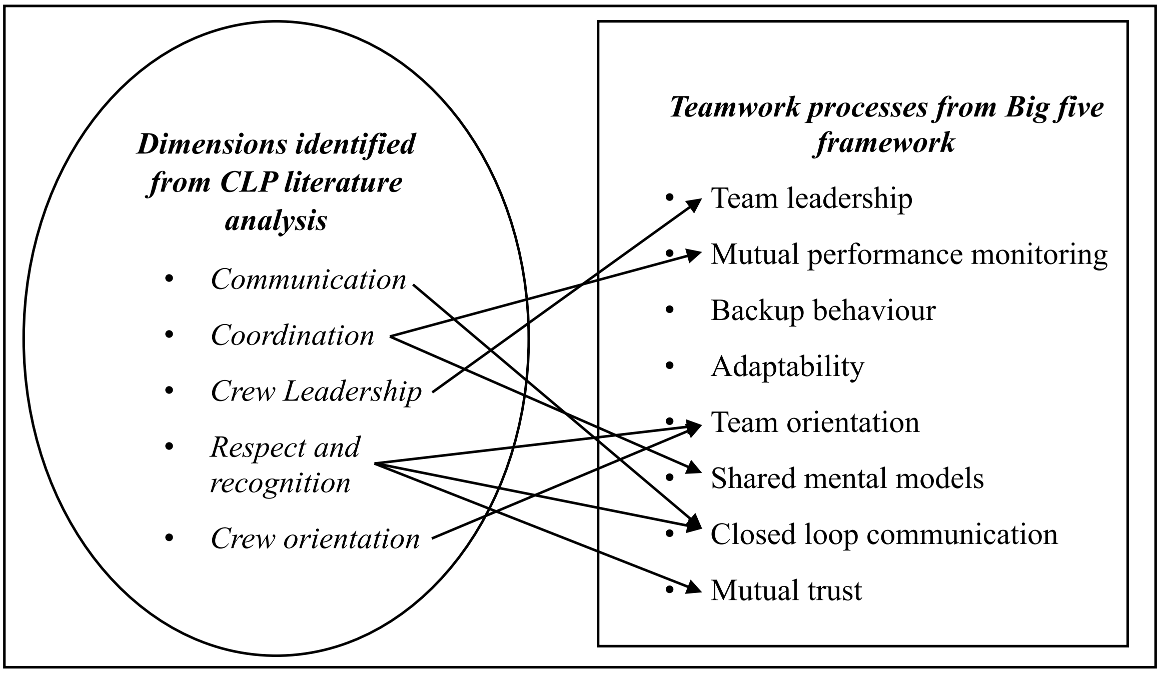

Figure 5.7 Overlap between the variables identified from CLP literature analysis and the big five framework

Hence, it is proposed that a synthesised set of processes that captures both, includes the following: crew leadership, mutual performance monitoring, backup behaviour, adaptability, crew orientation, shared mental models, communication, and mutual trust. Each of the team processes are discussed under dedicated headings that follow.

5.6.1 Crew leadership

Team leadership can be grouped into two basic categories: the development and shaping of team processes; the monitoring and management of ongoing performance (Morgeson et al. 2010; Kozlowski 2015). The leader's developmental role is to establish and maintain coherence and integration among the team members including individual and overall team skills. For instance, Morgeson et al. (2010) provided a framework of team-centric leadership functions that need to be done for the team to meet its needs and function effectively. This included functions such as compose teams, establish goals, sensemaking, encourage team self-management, support social climate to name a few. Effective team leadership also improves mechanisms such as mutual performance monitoring, load balancing, error detection, and resource sharing (Kozlowski 2015; Ceri-Booms et al. 2017). Foremen in construction crews are generally considered to act in this role and is perhaps one of the most important working relationships that directly impacts individual, crew and project performance (Fang et al. 2015). Specifically, due to the complex and dynamic nature of construction work, construction workers rely heavily on their supervisors for task allocation and for ongoing guidance and support (Fang et al. 2015; Loganathan et al. 2018). This means that workers' behaviours and performance are likely to be influenced by their supervisors and their working relationships (Dai et al. 2007; Fang et al. 2015). Crew leadership activities are generally centred around work planning, inspection, feedback, coordination with other crews and overall crew management

(Hewage et al. 2011; Loganathan et al. 2018). Given the above, foreman leadership needs to be further recognised in crew teamwork context.

5.6.2 Adaptability

Adaptability has been defined as the capacity of a team to make needed changes in response to a disruption or trigger (Maynard et al. 2015). It is also the ability of a team to recognise deviations from expected action and readjust accordingly. Adaptability is commonly considered as a team outcome for which the team strives, but some theorists contend that adaptability is best understood as a process that moves the team more effectively towards its objectives (Maynard et al. 2015; Christian et al. 2017). Adaptability also involves the redistribution of tasks and workload among team members to achieve balance during high-workload or time-pressured situations (Burke et al. 2006). Studies have argued that successful adaptation requires anticipation and recognition of unusual conditions that impede work (Christian et al. 2017).

5.6.3 Crew orientation

Team orientation is predominantly attitudinal (Salas et al. 2005). It is the extent to which members have a positive attitude towards working in a team (Rahman et al. 2017; Mathieu et al. 2008). It is not only a preference for working with others, but also a means of enhancing individual performance through the coordination, evaluation, and utilisation while performing group tasks (Mustafa et al. 2017). Conceptually, authors have referred to team orientation as a preference that is less stable than personality traits, but more stable than mere transitory states (Wageman 1995). That is, team orientation is generally viewed as stable enough to affect how individuals respond to a particular situation but can be changed over time through experience (Rahman et al. 2017). When team orientation is high, members may exhibit a greater commitment to work overcoming other forms of differences (Salas et al. 2005).

5.6.4 Shared mental models

Shared mental models help team members understand how the team functions and their role in the team task. It includes four elements (Mohammed et al. 2010; Cannon-Bowers et al. 1993): understanding of the team task; knowledge of the methods and technology used to accomplish the task; understanding of the team members' roles, responsibilities, needs, and dependencies; and knowledge of team members' skills, attitudes, strengths/weaknesses. Shared mental models provide a common framework for individuals to perform in a team by accounting for other team members' actions. The development of shared mental models can be facilitated by before-action/after-action team briefings such as toolbox meetings, cross-training and feedback meetings (Marks et al. 2001; Mohammed et al. 2010). In context of construction crews, foremen are well-positioned to enable the development of shared mental models.

5.6.5 Mutual performance monitoring

Mutual performance monitoring has been defined as the ability to keep track and ensuring things are happening as expected and procedures are being followed (Albon and Jewels 2014; Salas et al. 2005). It helps team members identify errors in each other's work and address these errors through feedback and backup behaviours (Martinez 2015). Salas et al. (2005) summarise these behaviours as noticing other team member's performance; recognising and catching others' mistakes; being aware of other's workload and surroundings.

Mutual performance monitoring is an empirically derived team coordination skill which significantly contributes to team shared cognition and manifest through observable behaviours (Martinez 2015). Communicating intentions before the execution of actions enable mutual monitoring because another crew member can identify an inappropriate intention and correct it before it happens. Mutual monitoring occurs in teams with adequate shared mental models and trust (Memarian 2012).

5.6.6 Backup behaviour

Backup behaviour includes providing feedback and coaching to improve performance; to assist a teammate in performing a task; and to complete a task for the team member when an overload is detected (Porter et al. 2011). It is important that the team self-assess overloads and redistribute the overload accordingly. Porter et al. (2011) found that backing up behaviour was positively related to team performance when teams had a workload distribution problem, but they also predicted and found that its effects decreased as team members' task work knowledge and skills increased over time.

5.6.7 Communication

Communication involves establishing patterns of interaction and enhancing the quality of these patterns (Kozlowski and Ilgen 2006). It is one of the major coordinating mechanisms contributing to success (or failure) of onsite crew teamwork (Hewage et al. 2011). The importance of communication has been highlighted repeatedly around the themes of clarity of instructions and information exchange; communication problem among craftsmen and supervisors; lack of periodic meetings; communication systems onsite and language differences among personnel in the CLP literature (refer Table 5.1). Effective communication also includes obtaining inputs and suggestions from craft workers to improve methods onsite (Dai et al. 2007; Hasan et al. 2018), touching upon previous themes from the CLP literature such as 'respect and recognition of workers and crews'. Conducting regular toolbox meetings, review meetings, availability of appropriate drawings, standard operating procedures are associated with crew level communication onsite.

5.6.8 Mutual trust

Mutual trust has been defined as shared perception that team member "will recognize and protect the rights and interests of all the team members engaged in their joint endeavor"

(Webber 2002). If not achieved, then disagreement, missed deadlines, or intentionally damaging acts against individuals or the team may occur (Costa et al. 2018). By fostering trust among team members, other teamwork behaviours such as mutual performance monitoring and backup behaviour can be interpreted appropriately (Kozlowski and Ilgen 2006; Costa et al. 2018). In the context of this study, previous research has indicated that the level of trust is proportional to the tasks assigned to the workers by their foremen (Santoso 2009). While in some cases, the foreman may need more time to know and understand the workers, in other cases trust declines when the foreman and workers are of different races or nationalities (Santoso 2009). Despite exploration of trust at an organisational level (see for instance Chalker and Loosemore (2016)), explorations of trust at a job site level has received little attention.

Given the above discussion, an improved version of Figure 5.6 can now be presented with detailed mediators, as shown in Figure 5.8.

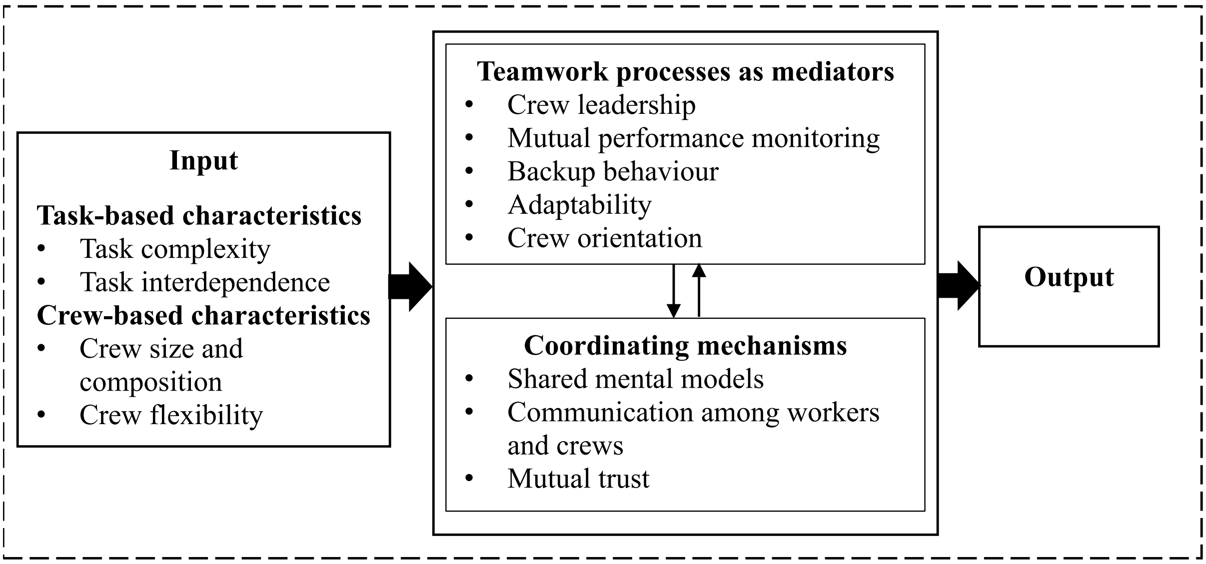

Figure 5.8 Proposed mediators to the framework (inclusive of previously defined inputs)

5.7 DETAILING OUTPUTS IN THE FRAMEWORK

Given the previous discussion, key outputs of the framework can be conceived primarily along two themes including team effectiveness and crew productivity. Here, it would seem that team effectiveness will be an output from the previous stages in the framework but will still be subservient to the primary objective of achieving improved physical productivity. Hence, team effectiveness must result in increased productivity to be worthwhile.

Given this development of logic, the framework is modified yet again, to produce a final version, as shown in Figure 5.9 (inclusive of dimensionalised inputs, mediators, and outputs). As alluded to above, it positions team effectiveness as an initial output which lead to improved crew productivity outputs.

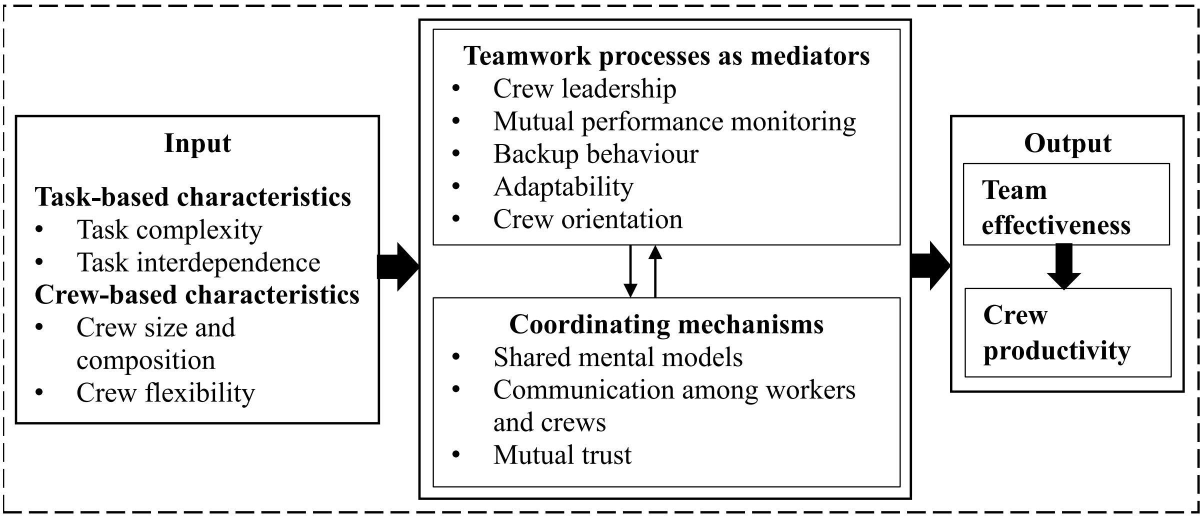

Figure 5.9 Framework for teamwork and productivity for onsite construction trade crews

5.8 CONCLUSION

Existing research in the CLP area pays little attention to the importance of crews and teamwork in achieving improved productivity outcomes. By conceptualising crews as teams, their team-based work processes and practices can be analysed. The mainstream organisational psychology and management literature was used as a vehicle to develop a framework for conceptualising the way that teams dynamically work together, in achieving productivity outcomes. This began with identification of themes in the CLP literature that were categorised through the lens of crew teamwork. The management literature was then used to elaborate the various teamwork processes under the IMO (Input-Mediators-Outputs) model. The framework is developed by elaborating the various components of the IMO model.

The next step in the process is to empirically ground the developed framework and prove its contextual validity. Chapter 6 therefore focuses on the third objective of the research. It examines the team-based skills and behaviours influencing the productivity performance of onsite construction trade crews with empirical field data collected from the Australian and Indian context, based on the developed framework. The focus is therefore to capture the dynamics and context of construction crew teamwork, while concurrently testing the validity of the proposed framework. This would allow the developed framework to be accepted or modified according to the findings of empirical research. The next chapter deals with it.

CHAPTER 6.

TEAMWORK PROCESSES AND PRACTICES OF ONSITE CONSTRUCTION TRADE CREWS: AUSTRALIAN AND INDIAN CONTEXT

6.1 INTRODUCTION

The previous chapter presented the framework developed as a part of Stage-2 of the present research. The framework provides the various elements of teamwork within the context of onsite construction crews. The present chapter aims at addressing the third research objective of the study, i.e., 'to examine the team-based skills and behaviours influencing the productivity performance of onsite construction crews based on the developed framework'. As mentioned in Chapter 1, the present study revolves around two research contexts – Indian and Australian. The theoretical rationale for choosing India and Australia is because of the distinct nature of the respective construction industries in these countries and their associated construction practices. For instance, the Australian construction industry is more formally organised compared to the Indian construction industry, which is largely informal.

As mentioned in Chapter 3, addressing research objective-3 forms the second part of Stage-2 of the study. The first step in investigating the above-mentioned research objective lies in suitably designing the research with specific data collection and analysis methods. The next section presents the methodology and approach adopted for Stage-2 research.

6.2 RESEARCH DESIGN

As the developed conceptual framework suggests, the key elements such as leadership, communication, and adaptability cannot be objectively evaluated. Lurey and Raisinghani

(2001, p. 526) articulated as 'team member perceptions can be extremely valid predictors of the team's effectiveness since team members are central to the work, and thus, they directly influence the team's productivity and satisfaction'. This refers to the applicability of ***interpretivism as the philosophical stance*** for Stage-2 of the study (Merriam and Tisdell 2015). Similar to Chapter 4 which investigated the work practices of onsite construction crews using an interpretivist approach, team-based skills and practices of onsite construction crews are investigated through an interpretivist approach in the present chapter. Interpretivists rely upon the participants' perceptions and knowledge and accept the impacts of participants' own experiences and background on research findings (Creswell and Creswell 2017). The ontology associated with the interpretivist's paradigm is commonly referred to as a ***relativist*** ontology according to which realities could be found in the form of intangible mental constructions that are context-based and shared among many individuals (Guba and Lincoln 1994). Therefore, a ***subjectivist*** view is considered as the epistemological stance.

Within the interpretivist's perspective, ***qualitative research*** is identified as the predominant methodology (Merriam and Tisdell 2015). Furthermore, the teamwork of onsite construction crews is a little-understood phenomenon within construction management research, and hence adopting a qualitative research design is more relevant (Bazeley 2013). Within qualitative research, ***case study approach*** is identified as the most appropriate data gathering strategy to meet the research needs. As less theoretical knowledge is available to explain the dynamics of *onsite construction crew teamwork*, there is a need to understand the dynamics in real-world conditions. As a result, there is a need to capture the dynamics of crew teamwork from the raw data, and then try and make a theoretical sense from it. The choice of using case studies is additionally influenced by other benefits. For instance, case studies allow the collection of data through multiple sources (observations, interviews, documents, reports etc.) thereby aiming to gain an in-depth understanding of the nature and complexity of the phenomenon in real-world conditions (Yin 2009). In case studies, the emphasis is placed on qualifying relationships that are too complex to be controlled by experimental research strategies (Eisenhardt 1989). In addition, case studies are good at providing a detailed longitudinal view of social phenomena (Yin 2009, Eisenhardt 1989). All these features were considered relevant in the selection of *case study research* as a methodology for Stage-2 research.

As noted earlier, data collection in case study research is carried out using multiple sources such as documentation, archival records, interviews, direct observation, informal conversations and dialogues, attendance at meetings/events, participant-observations, audio-video recordings, and physical artefacts (Yin 2009; Miles and Huberman 1994). Each source is associated with an array of data or evidence. Researchers point out that each qualitative research method has its shortcomings, so a strategy to minimise these shortcomings is to combine multiple data collection methods within a single case study (Yin 2009). The advantages of using one method of data collection balances out the disadvantages of other methods of data collection/source of evidence (Yin 2009; Miles and Huberman 1994). This further helps overcoming a few validity and reliability challenges in case study research.

Before describing the techniques used to overcome the validity and reliability challenges of case study approach, human ethics approval process, and the subsequent selection of projects, trade crews, and the data collection process are discussed below.

6.3 HUMAN ETHICS APPROVAL PROCESS

As per the University (University of Technology Sydney Australia) rules and regulations, human ethics approval must be obtained before conducting the fieldwork. Ethics approval aims at ensuring the highest standards of ethical conduct and integrity are adhered to in the research conducted. UTS HREC approval reference number is ETH17-1710.

Before completing the ethics approval process, the researcher must complete a certification course on ‘research integrity for students’ conducted by the Graduate Research School of the University. The course educates and provides awareness about research integrity, code of conduct, risk management, health, and safety during fieldwork.

Ethics approval is an online process, where the researcher submits the application to the University’s Human Research Ethics Committee after complying with the necessary guidelines established by the University of Technology Sydney, Australia. Ethics approval primarily covers the protection of research participants’ data and information. Approval should be obtained on the participants recruitment process for the research, time and location of the research, methods of data collection, storage, security, and protecting the privacy and confidentiality of the collected data. During the ethics approval process, the participant information sheet and consent form prepared by the researcher are verified and approved by the ethics committee.

The participant information sheet is a concise document that provides an overview of the research study, and plans and procedures for data collection. It further provides the contact information of the researcher, so the participants can contact the researcher in case of any concern. The consent form essentially recapitulates the information (provided in the participant information sheet) and ensures that the participants understood and records the understanding of participants. Copies of the participant information sheet and consent form are included in Appendix B.

In addition to the University's ethics approval process, the researcher must comply with the local government and industry regulations to ensure the safe conduct of the research before the data collection process. As per New South Wales (NSW) SafeWork, a 'white card' must be obtained for those whose job causes them to routinely enter operational construction zones (SafeWork, NSW 2020). As the present study is conducted in the context of onsite construction activities, the researcher was required to obtain a white card. The researcher, therefore, has undergone and completed 'National WHS General Construction Induction Training' (through an agency approved by the Govt. of NSW) and obtained a white card.

Furthermore, the organisations where the researcher was associated with to conduct the case studies have mandated the researcher to undergo an induction process before the data collection/fieldwork. In one of the cases, the organisation mandated the researcher to complete and submit the certificate of their detailed online induction program before the data collection process. Therefore, the researcher completed these processes before the fieldwork. These processes have also helped the researcher to understand and get an initial acceptance in the concerned organisation/team before the actual fieldwork. Copies of the white card, the induction process completed by the researcher, and the courses that are completed by the researcher as a part of the ethics approval process are included in Appendix C.

6.4 DATA COLLECTION

The present section describes the cases selected for the study, presents the logic in which the data is collected, various methods used for the data collection, and how the multiple modes of data collection helped overcome the validity and reliability challenges of case study research.

6.4.1 Cases selected for the study

Similar to Stage-1 research, building construction projects were chosen for conducting the case studies. The reasons for choosing building trade crews are that the building crews work together over time, perform similar operations from one project to another, and they are independent of other trades, enabling them as a practical case for study. Both Australian and Indian contexts had three case studies each. The unit of analysis is ‘crew’.

6.4.1.1 Cases studied in the Australian context

Table 6.1 shows the description of the cases in the Australian context. The cases are named as: case LIARD, ATROUS and KHAKI.

Table 6.1 Description of the cases in the Australian context

Description	Case LIARD	Case ATROUS	Case KHAKI
Study trade	Steel fixing	Curtain wall façade	Brickwork façade
Trade scope	18 levels (floors)	7 levels (floors)	18 levels (floors)
Trade crew size	10	19	19
Avg. trade cycle time	2 weeks	2.5 weeks	1 week
Data collection levels (survey, observations & interviews)	Level 7, 12 and 17	Level 3, 5 & 7	Level 7, 13 and 18
Case study duration	6 months	4 months	6 months

Case LIARD is a steel fixing crew in an institutional building. The scope of the crew is steel fixing activity of a lift core structure for 17 levels (a *floor is referred to as a level*). The size of the crew is 10 members, which involved seven steel fixers and three helpers. The cycle time of the activity was two weeks per level. Data collection was carried out in level 7, 12, and 17. The study was conducted for six months. Figure 6.1 shows case LIARD building.

Figure 6.1 Case LIARD (black boxed portion in the figure indicates the area of the study activity – lift core steel fixing area)

Case ATROUS is a curtain wall façade crew in a commercial building. The scope of the crew is fixing curtain wall façade for 7 levels. The activity involves four major activities which include loading façade stillages, preparation of façade panels, installation of façade panels and installation of pelmets and smoke seals. The size of the crew is 19 members. The activity involved installation of about 255 vision panels totally in 7 levels. The cycle time of the activity was 2.5 weeks per level. Data collection was carried out in level 3, 5, and 7. The study was conducted for four months. Figure 6.2 shows case ATROUS building.

Figure 6.2 Case ATROUS

Case KHAKI is a brickwork façade crew in a high-rise residential building. The scope of the crew is brickwork façade activity for 18 levels. This involves 942 square meters of brickwork façade construction per floor for 18 floors. In other words, it accounted for 18,000 bricks per floor. The size of the crew is 19 members, which involved 12 brick masons (*brickies*), five labourers, one carpenter, and one carpenter helper. As per the crew's head foreman's comment, a brick mason can construct 250 bricks per day. Hence with 12 brick masons present in the crew, the cycle time of the crew is six days/week/level (i.e., 250 bricks X 12 = 3000 bricks/day for a total of 18000 bricks per level). Figure 6.3 shows Case KHAKI.

Figure 6.3 Case KHAKI building and the brickwork face 3D model

6.4.1.2 Cases studied in the Indian context

Table 6.2 shows the description of the cases studied in the Indian context. The cases are named as case SAFFRON, WHITE and GREEN.

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Table 6.2 Description of the cases in the Indian context

Description	Case SAFFRON	Case WHITE	Case GREEN
Study trade	Reinforcement	Curtain wall façade	Brickwork
Trade scope	5 levels	27 levels	5 levels
Trade crew size	22	21	18
Avg. trade cycle time	2.5 weeks	2 weeks	2 weeks
Data collection levels (survey, observations & interviews)	Level 1, 3 and 5	Level 11, 15 & 19	Level 1, 3 and 5
Case study duration	4 months	5 months	4.5 months

Case SAFFRON is a steel reinforcement fixing crew in a residential building project. The scope of the crew is steel reinforcement fixing/rebar placement for floor slabs for 5 levels (a *floor is referred to as a level*). The size of the crew is 22 members, which involved 11 steel fixers/barbenders and 10 helpers. The cycle time of the activity was 2.5 weeks per level. Data collection was carried out in levels 1, 3, and 5. The study was conducted for four months. Figure 6.4 shows case SAFFRON.

Figure 6.4 Case SAFFRON showing the ongoing reinforcement activity

Case WHITE is a curtain wall façade crew in a commercial building project. The scope of the crew is fixing curtain wall façade – for 27 levels. The activity involved the installation of façade panels on 27 levels of the building. The size of the crew is 21 members. The cycle time of the activity was two weeks per level. Data collection was carried out in levels 11, 15, and 19. The study was conducted for five months. Figure 6.5 shows case WHITE.

Figure 6.5 Case WHITE showing the ongoing façade activity

Case GREEN is a brickwork crew in a residential building project. The scope of the crew is brickwork construction for four levels. The size of the crew is 23 members which involved 13 brick masons and 10 helpers. The cycle time of the crew is 2.5 weeks per level. Data collection was carried out in levels 1, 2 and 5. The study was conducted for 4.5 months. Figure 6.6 shows Case GREEN.

Figure 6.6 Case GREEN showing the ongoing brickwork construction activity

6.4.2 Data collection process and methods

In each case project, the trade crew carrying out a cyclic construction activity is chosen for the study. As mentioned, the unit of analysis is crew. The data collection involved an episodic study of the chosen trade crew from start to completion of their trade activity in the project. In each case project, the episodic data collection process was carried out at three different levels, depending on the overall scope of the respective activity and their cycle time. Three steps were followed within each cycle of the data collection process.

- In step-1, construction crew teamwork psychometric survey instrument (adopted version of the Nursing Teamwork Survey (NTS) developed by Kalisch et al. 2009 – attached as Appendix A) was used to get scores of the crew members' perceptions towards teamwork in their crew. The scores provided by the crew members on various aspects of teamwork helped the researcher to get an understanding of which dimensions are rated high, moderate, and low. The survey also helped gather an understanding of the scores of teamwork dimensions both at individual and group level. As the survey was administered episodically at three different levels, the rise and fall of teamwork scores at different levels was also noted by the researcher. Altogether, the survey provided insights and context to the interviews that was conducted in step 3.

- In step-2, direct field observations and interactions were carried out for a duration ranging from one to three hours to observe the teamwork practices within the study crew. The aim of conducting field observations was to gather practical insights into the behavioural aspects of teamwork. The field observations provided data around how crew members organise themselves at work and their communication and coordination practices with their fellow members. The observations also provide context to the interviews that was conducted in step 3.
- In step-3, interviews were conducted with the crew members. Interview sessions kicked off with briefing on the survey scores (from step 1) and the observed teamwork practices (step 2), which lasted an average of 10-15 min. The main part of the interviews lasted around 30-40 min and was recorded after receiving interviewees' permissions. Debriefing-style interviews were conducted to understand the underlying factors affecting the teamwork scores given by the crew members. The field observations provided context to the interviews. For instance, observation of particular practices followed by the crew members helped the researcher to pick them and discuss with the crews as how such practices are evolved, why they are followed and how it is helping them to improve their teamwork. Therefore, the episodic data collection process at different levels involved three steps – teamwork survey, field observations and interviews – that was conducted one after the other. While the data collected at each step provided context to the next step, the step wise data collection process was also followed to ensure that the data collected at each step is validated in the next step.

As mentioned in Table 6.1 & Table 6.2, the episodic three-step data collection process was carried out for the three cases each in the Australian and Indian contexts, at three different levels. The brief details of the data collected in the case studies are presented in Table 6.3 below.

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Table 6.3 Quantity of data collected

S. No	Description of the data type	Amount of data collected
1	Psychometric survey conducted	3 times per case – for all the 3 cases
2	Direct field observations	Case LIARD – 3 hours Case ATROUS – 8 hours Case KHAKI – 20 hours Case SAFFRON – 20 hours Case WHITE – 25 hours Case GREEN – 20 hours
3	Semi-structured interviews	Case LIARD – 10.5 hours Case ATROUS – 18 hours Case KHAKI – 30 hours Case SAFFRON – 20 hours Case WHITE – 20 hours Case GREEN – 20 hours
4	Foreman group meetings (as an observer)	Case ATROUS – 2 meetings; 30 minutes each Case KHAKI – 1 meeting; 2 hours each Case SAFFRON – 3 meetings; 1 hours each Case WHITE – 3 meetings; 1 hours each Case GREEN – 4 meetings; 1 hours each
5	Toolbox meetings (as an observer)	Case KHAKI – 5 meetings; 20 minutes each (approx.)
6	Sub-contractor's meetings (as an observer)	Case KHAKI – 2 meetings; 1 hour each
7	Archival records – Foreman site dairy (naturalistic data)	Case KHAKI – 6 months records; 120 dairy pages
8	Archival records – toolbox meeting records (naturalistic data)	Case KHAKI – 6 months records; 48 pages
9	Still photographs	255 still photographs in total including all the six cases
10	Video recordings	3 video recordings – in case KHAKI • Video 1: 2 minutes and 05 seconds • Video 2: 2 minutes and 44 seconds • Video 3: 6 minutes and 49 seconds 7 video recordings – in case SAFFRON each 5 minutes (approx.)
11	Participant observer	Case KHAKI – the researcher worked as a co-worker with the crew for a day

As mentioned in Table 6.3, as a part of the episodic data collection, the psychometric survey, direct field observations and interactions, and semi-structured interviews were conducted in all six cases at specific intervals. Also, the researcher, as an observer, attended five toolbox meetings which were conducted during the week's beginning by the crew's head foreman. Toolbox meetings were conducted to discuss the safety issues, the week's plan, and the coordination requirements for the week within the crew. The researcher also acted as an observer in two sub-contractor meetings and three foreman group meetings which were conducted at the project and organisational levels. In addition to that, archival records such as foreman's site diary notes and toolbox meeting records of the foreman were collected for the overall study duration, i.e., six months in case KHAKI. The foreman recorded all the major incidents and issues that occurred on the site, which was considered as *primary naturalistic data* for further analysis (Silverman 2015). Naturalistic data is *naturally occurring data* without the interference of the researcher (Silverman 2015). Such naturalistic data can also provide a deeper understanding of the actual field conditions. Also, the diary study method captures the thoughts, decisions, and emotions of individuals in situ – when they are working in their natural job setting (Menches and Chen 2014).

As mentioned in Table 6.3, 255 still photographs and six video recordings of the activities were captured during the data collection process to display certain teamwork practices of the study crews. The three video recordings from case KHAKI spanned the duration of 2:05 (minutes: seconds), 2:44, and 6:49 and the seven video recordings from case GREEN spanned the duration of 5 minutes (approx.) each. Usage of still photographs and video recordings are recently found in construction management research (Hamid and Dutt 2019) as they complement other forms of qualitative data collected in the field.

After gaining wider acceptance among the study crew in case KHAKI, the researcher acted as a participant observer for a day with the brickwork crew. The researcher co-worked with the brickwork crew for a day and carried out the daily activities of the crew. The real-time experience of the researcher in the field (*with the study crew*) also provided a deeper understanding of the context in which teamwork occurs. The experience has helped the researcher with better introspection and analysis of the data. Altogether, extensive data were gathered during the data collection process. Figure 6.7 to 6.12 displays the pictures of the study activities, archival records collected, and meetings attended by the researcher as an external observer.

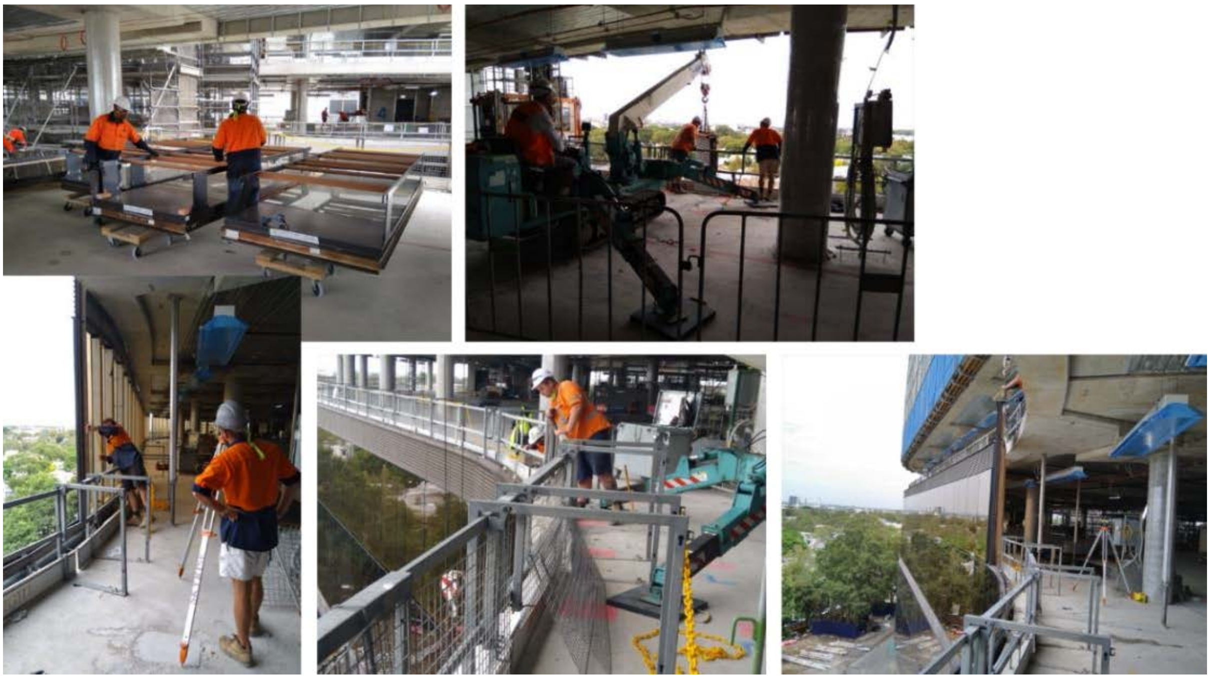


Figure 6.7 Pictures of the curtain wall façade crew (Case ATROUS)

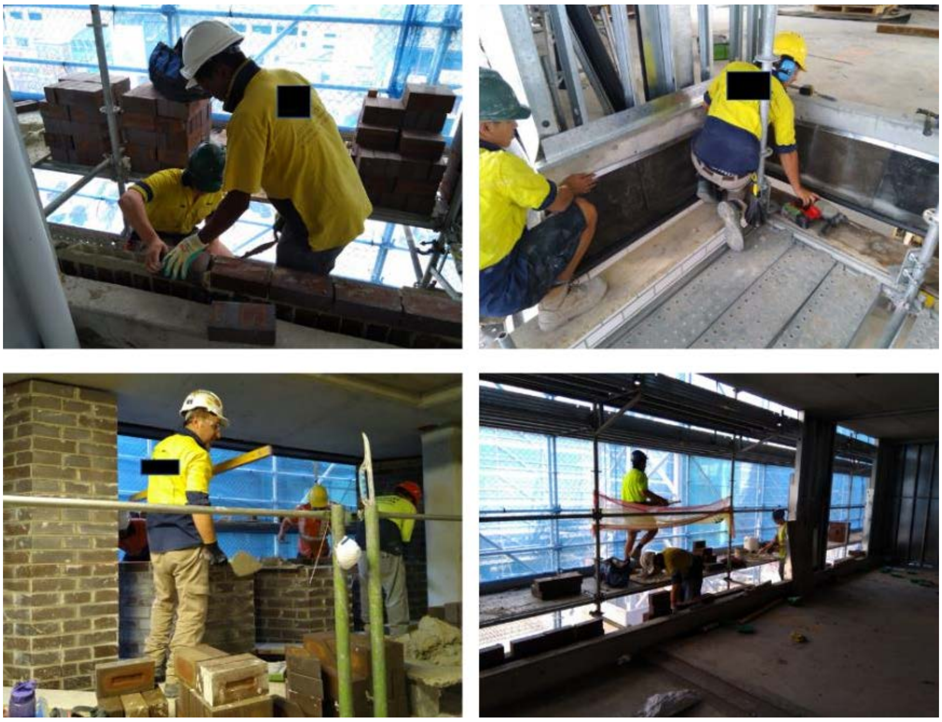
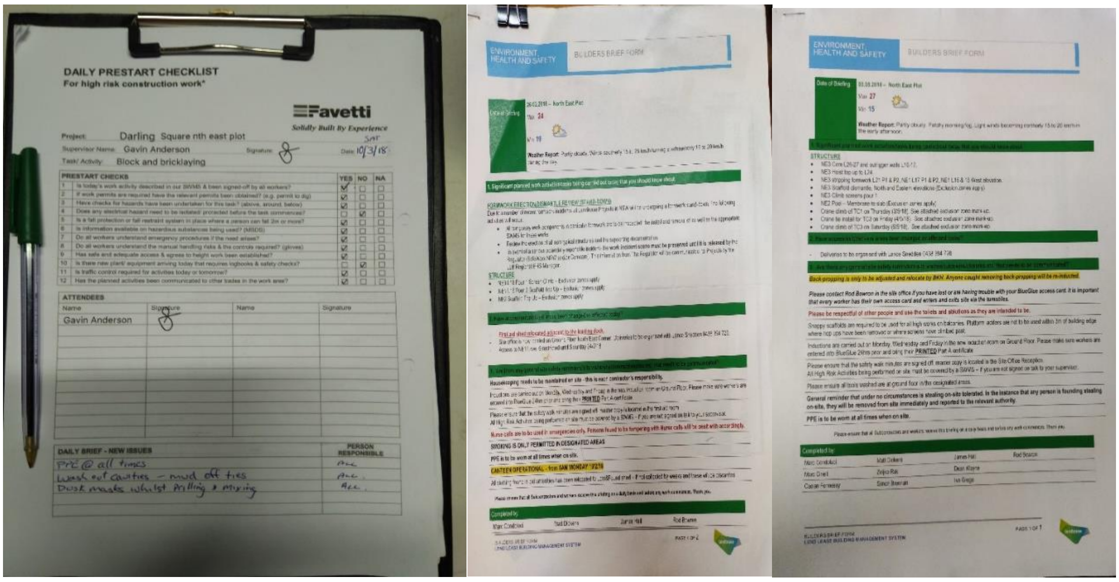


Figure 6.8 Pictures of the brickwork crew (Case KHAKI)



(a) (b)

Figure 6.9 Sample of (a) Daily prestart checklist and (b) Builder's brief

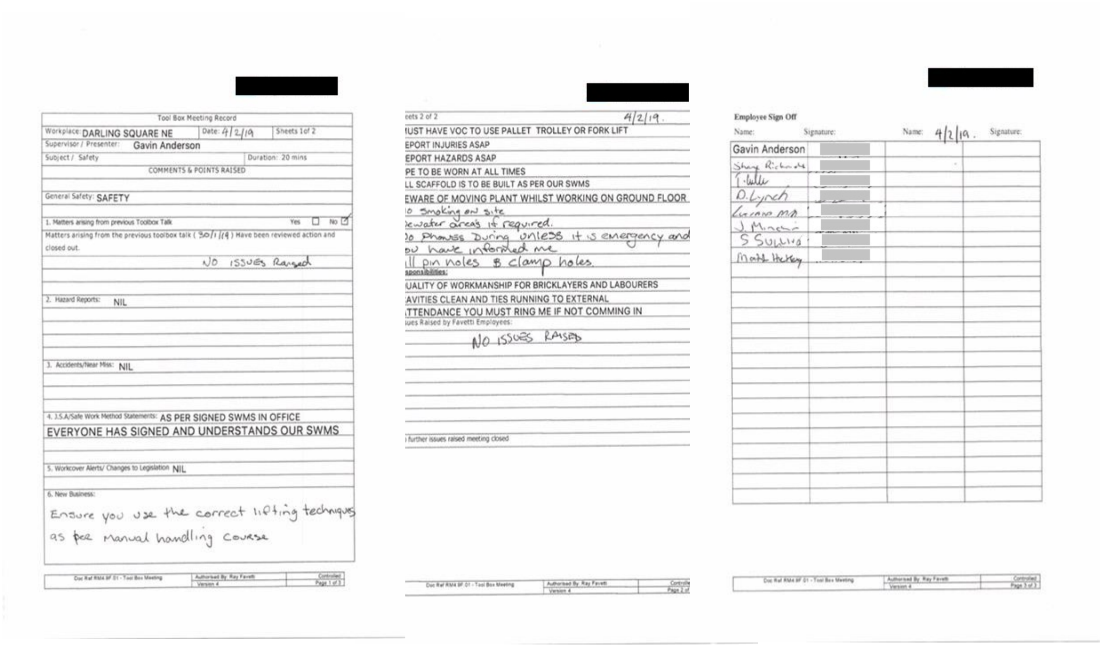


Figure 6.10 Toolbox meeting record sample

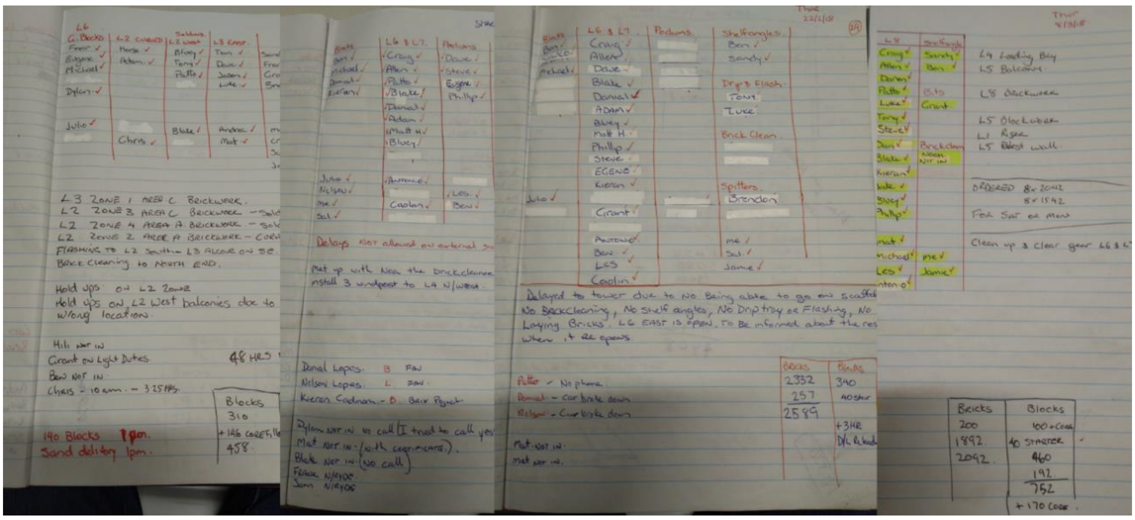


Figure 6.11 Foreman's site dairy samples

(a) **(b)**

Figure 6.12 Pictures of (a) Toolbox meeting and (b) Sub-contractors' group meeting (the researcher attended the meetings as an observer)

6.4.3 Techniques used to overcome case study design challenges

As mentioned earlier in Chapter 3, reliability, validity, and bias are the key design challenges in case study research. While *validity* is concerned with the data collected being accurate and meaningful, *reliability* is concerned with the data collected and insights garnered being applicable to a broader segment than just the field of the study (Eisenhardt 1989; Yin, 2009). *Bias* refers to characteristics that may cause the participant to give a different response than they would have otherwise given in a less biased environment (Rosnow and Rosenthal 1997). Table 6.4 exhibits the techniques implemented to overcome these challenges in Stage-2 case studies.

Table 6.4 Techniques used to overcome case study design challenges in Stage-2 case studies

Design challenge	**Techniques to overcome challenges**	**Implementation in this research**
Reliability	Use case study protocol in the data collection phase	Standardised data gathering methods, same survey instrument, and interview protocol were followed in all the cases Pilot testing of data gathering sheets and survey instruments were done
Construct Validity	Use multiple sources of evidence Key informants reviewing interim findings of the study	Triangulation using different data sources: field/site and meeting observations, interviews, informal dialogues, foreman site diary notes, meeting records Member checking to determine the accuracy of findings; presented the data collected and discussed the interim findings to foremen at different stages; presented interim findings in foreman group meetings
Internal Validity	Pattern matching, explanation building and addressing rival explanations in the data analysis phase	Thorough explanations both within a case and cross-case analysis.
External Validity	Use replication logic in multiple case studies	Setting up standardised data gathering methods, same survey instrument and interview protocol were followed in all the cases; conceptual framework/a priori codes are applied in each case during data analysis.
Bias	Enabling a conducive environment	Provided interviewees preference to participate in group interviews or conducted individual interviews otherwise Recordings were carried out with the interviewee's permission The interview guide included several open format questions to provide flexibility to informants

6.5 DATA ANALYSIS METHODS AND PROCESS

First, the collected qualitative data were transcribed. The collected qualitative field data, including direct field observations, semi-structured interviews, foreman site dairy notes, and meeting records were transcribed. Second, the transcribed data were coded. Coding stands at the centre of any qualitative analysis, and a key process to consider is to follow a proper procedure for generating codes (Miles and Huberman 1994). The steps undertaken for coding the collected qualitative data were presented earlier in Chapter 4 in Section 4.4. The data analysis fundamentally aimed at examining the commonalities across the transcripts to pool together elements of data to form sub-themes and themes, and then examining relationships to identify how different sub-themes and themes relate to each other (Gibson and Brown 2009).

The developed themes were then compared to the *a priori* codes presented in the developed framework, presented in Figure 5.9, in Chapter 5. Bazeley (2013) indicates that an effective method to extract meaning through coding the transcripts entails converging on similarity, comparison, and contrast against *a priori* codes. Such an approach was deemed suitable for the present study, where the objective is to transform the developed conceptual framework to suit the context of the study (Lewins and Silver 2007). Therefore, the analysis process was primarily aimed at grounding the empirical data using the variables presented in the framework, thereby customising, and contextualising the framework to suit the context of the study. This form of qualitative analysis is also termed as analytic induction where the researcher aims to achieve a fit between the collected data and a formulated explanation of the phenomenon under question, i.e., the developed framework in this case (Bryman and Burgess 1994; Merriam and Tisdell 2015). Such an approach also facilitates ensuring that research findings remain connected to the existing body of knowledge while creating new knowledge (Bryman and Burgess 1994; Bazeley 2013).

6.6 TEAMWORK PROCESSES AND PRACTICES

As provided in Figure 5.9 in Chapter 5, the developed conceptual framework identified crew leadership, mutual performance monitoring, backup behaviour, adaptability, crew orientation as *mediators' teamwork processes*, and shared mental models, communication, and mutual trust as *coordinating mechanisms teamwork processes*. The following sub-sections use the identified processes in the conceptual framework (presented in Figure 5.9) as guiding tenets to ground the collected data from the Australian and Indian cases. By grounding the collected data with the guiding conceptual framework, modified teamwork processes have emerged and the same is discussed in the following sub-sections.

6.6.1 Crew Leadership

As mentioned in Chapter-4, a construction work crew can be compared to sporting teams (soccer, basketball etc.) from a few perspectives, where success depends on the coach's understanding of the situation, creating the right tactics, selecting the team according to those tactics, and establishing strong teamwork so they offer more as a unit, when compared to a disparate group of individuals.

Crew leadership involves conducting regular meetings with the crew members, maintaining workloads and work timings of the crews, making regular work inspections, providing feedback and appreciation, devising appropriate incentives, making informal relationships with the crew members, and training the leading hands to make them as crew leaders.

6.6.1.1 Crew Leadership in Australian Cases

In all the case projects in the Australian context, regular work meetings such as toolbox meetings (TBMs) and daily pre-starts (DPS) are carried out by the foreman. TBM is predominantly a safety meeting/talk organised by the head foreman and safety officers. In all the case project sites in the Australian context, TBM was conducted during the week's beginning, i.e., Monday mornings. Typically, TBMs are conducted in the project site offices and last for 15 to 20 minutes. In TBMs, every safety-related crucial information is communicated to the team members, which includes topics related to workplace hazards, ensuring complete usage of personnel protective equipment (PPEs), required safety training for the upcoming site activities etc. Apart from sharing information, TBMs also aim to promote knowledge sharing among workers regarding safety and various project-related information within the team. This project-related information includes project progress (whether the project is on-time/behind schedule/ahead schedule), quality-related information, materials movement and inventory, approvals from project client, main contractor/consultants, and management-related tasks pertaining to site activities. At the project site level, sub-contractor's meetings are headed carried out by the main contractor. The foremen provide all work-related information to the sub-crews and other crew members in these meetings. During the meetings, it was observed that the foremen ensure all the provided information is understood by the sub-crews and they are clear with their deliverables for the week (as discussed in the TBMs) and for the day (as discussed in the DPS).

In one of the discussions in Case ATROUS, the foreman mentioned '*when I conduct TBMs, I randomly pick crew members and ask them to repeat what I mentioned in the meeting…it is not doubting them as whether they have heard rather check if they understood the tasks rightly...*'. The foremen also attend the sub-contractor's meetings that are carried out once a week to discuss and resolve all interface and coordination-related issues at the project site level. In one of the meetings with the foreman of Case LIARD, he remarked that, '*I do not want my crews to resolve any major issue related to interface or coordination at the work location...when my teams go to work locations, their time is meant to be spent productively for* *the work that was planned for them…I am here to resolve the issues in the sub-contractor's meetings on the interfaces my sub-crews would have with other contractor's crews…*' Resolving interface and coordination issues by the foreman at his level was also much appreciated by the crew members. During one of the interviews with a sub-crew (as a group) in Case LIARD, the crew members commented that, '*we interface with the formwork crew…since the formwork crew predominantly has non-English speaking members, we find it difficult to converse with them…our leading hand and foreman talks to them and resolve issues related to work coordination…this saves our time at work'.* They continued saying, '*we also do not have a cultural gatekeeper in our sub-crew who can liaise with them…the leading head shares their cultural background and can speak fluent English…this helps us with our work*'.

In the Australian context case projects, a 5-day work week is followed, i.e., from Monday to Friday. It was observed that the work timings followed for a given day were 06:30 am to 02:45 pm. The workday starts at 06:30 am for foremen and labourers/helpers and 06:45 am for all skilled workers. In one of the discussions with Case KHAKI, the foreman commented, '*Every day, I am the first person to come to work…I have to come and check if things are ready for my crews…when they come, I have a quick daily pre-start (for about 5 minutes), check their PPEs and discuss with them as a group regarding the day's plan and sort out issues if any'*. He continued saying '*the labourers and helpers also come at 06:30 and arrange tools and materials for the crews…it is a regular practice we follow on our site*'. In addition, it was observed that Saturday work hour (extra workday) depends on the performance of the crew members (mainly attendance) during the week. In most cases, Foremen are not accepting crew members to work on Saturday if they take a day off during the week. However, during tighter deadlines, the crews also worked on Saturdays. With respect to maintaining the attendance of workers onsite, the foremen make plans for the next day considering the absentees. Case ATROUS have pointed out that, '*I insist all the crew members and the heads* *of sub-crews report about their absence at least a day before (excluding emergency situations)…this helps me to plan better'…maintaining attendance and motivating crews to be regular at work is a major task I do on a day to day basis'*. Nevertheless, the foremen are also particular about their workload when they ask crews to work on Saturdays. In one of the group foremen meetings in Case KHAKI's organisation, the foreman of Case KHAKI pointed out that '*it is difficult and unrealistic for a person to work continuously for 6 days…he lifts about 2000 Kgs/day (*Case KHAKI is a brickwork crew*)…he expects a relaxed weekend, so he is energetic for the next week'*. This exhibited one of the good leadership capabilities of the foreman.

Providing appropriate feedback and appreciation for good work practices are considered essential in maintaining performing teams at work. During one of the interviews with the foreman of Case ATROUS, he pointed out, '*be honest…100% tell them the truth…tell them what's going on…it is what it is…and above all, tell the same thing to everyone…only by doing this, you can promote good teamwork within your crews*'. He mentioned '*I cannot be partial when I provide feedback and appreciation…I need to maintain consistency in the way I provide feedback and appreciation to my crew members*'. In Case KHAKI, the foreman identifies the best practices and uploads them in a mobile application 'Tradeup' that records work progress and daily site activities. Such activities of the foreman motivate sub-crews to be competitive and maintain standards in the work. It is considered as a means of providing open appreciation for their good work. Apart from feedback and appreciation, incentives provided to sub-crews and crew members were also noted, particularly in the Cases LIARD and KHAKI. For instance, in Case ATROUS, the foreman noted that '*when I observe a productive sub-crew/crew members who have achieved beyond their weekly targets, I ask them to leave at 1 pm on Friday…leaving work 2 hours early* (work closes at 3 pm*) is an incentive we have devised in our site*'. In Case KHAKI, the foreman remarked that 'f*or guys who have* *consistently achieved 400 bricks/day, a dinner coupon or movie ticket is provided as an incentive*'. He emphasised saying '*a set of non-negotiable KPIs should be devised to provide incentives for productive sub-crews and crew members'*. He added, '*it is so important for us to motivate them through these rewards and incentives so that they stick with us…when you reward them as a team, it enables them to build a better relationship both at work and outside*'.

In Case KHAKI, the researcher observed that few crew members practiced having lunch with the foreman at his office. The researcher observed that such informal catchup with the foreman helped them build a better relationship with their foreman. The foreman opined that 'I like to have such brown bag lunches with my crew members…these lunches also provide you with an opportunity to talk about certain work-related issues…we learn from each other…above all, I see it as a means for building better relationship'. He continued saying, '*I believe in building good relationships…it enables teamwork…it happens when you share things that are beyond your work to your fellow crew members…these causal catch-up meetings enable creating good team culture at work*'. Similarly, in Case LIARD, the foreman remarked, '*I do regular formal meetings (including toolbox and daily pre-start meetings) with my sub-crews and crew members…however, I have observed that certain things get resolved only during my informal visits to sites or during my informal discussions with my fellow crew members'*. He continued by saying, '*they open up to me only when it is an informal discussion…these could be some basic coordination issues with other crew members, but they want to make it a lighter discussion and do not want to talk about such issues during the regular meetings'*. He added, '*as a leader of the crew, I need to understand such dynamics and enable a work environment where everyone works together productively*'.

Another important component of crew leadership is the development of leading hands as future crew leaders. The foreman of Case ATROUS was seen often quoting, '*leading hands is the foreman's eyes and ears*'. The foremen of all case projects in the Australian context believed that the leading hands must take more responsibilities, be proactive, tech-friendly (willing to adopt new technologies) and possibly be a good cultural gatekeeper. In all the case projects, it was observed that the leading hands were briefing their foreman about the work progress, coordination, and quality issues within their crew. These inputs were collectively addressed by the foreman during the toolbox and daily pre-start meetings. The leading hands were providing specific inputs to the foreman and ensured that the instruction of the foreman reaches their crew members. To a certain extent, it was noted that the leading hands were also exhibiting leadership at their crew level by resolving team-related issues without taking them to the foreman. In one of the instances in Case ATROUS, two crew members do not want to work together. They had some differences in opinions about work and other non-work-related things. They independently reported it to the leading hand of the crew. The leading crew at first spoke to them individually then he had a group meeting and resolved the issue. The leading hand commented '*I should try to solve such issues from my end first before I take it up with the foreman…I do not want them to be apart as they were already working together since the start of the project…there is a learning curve both professionally and personally…we need to take care of such issues and resolve it as early as possible*'. These resolutions signified the importance of the leading hand's role within a crew and exhibited his quality of becoming a foreman. It signified the equal importance of problem-solving within the team when compared with the physical progress of the work.

Based on the analysis, the dimensions of crew leadership include crew meetings, maintaining workloads and work timings of the crews, feedback, appreciation, devising incentives, and training leading hands and senior crew members. Table 6.5 below presents the number of instances of occurrence of each of the dimension in Australian cases.

Table 6.5 No. of instances of occurrence of crew leadership dimensions in Australian cases

S. No	Crew leadership dimension	No. of instances of occurrence
1	Crew meetings	63
2	Maintaining workloads and work timings of the crew	72
3	Feedback, appreciation, devising incentives	95
4	Training leading hands and senior crew members	39

6.6.1.2 Crew Leadership in Indian Cases

In all the case projects studied in the Indian context, the foremen in the Indian case projects had daily start-up meetings with the crew members. There is no observation of regular weekly meetings between the foreman and the crew members (like the TBMs in the Australian context), in the Indian context. Regular weekly meetings are conducted between site engineers and the project manager. Nonetheless, meetings are primarily informal in the Indian context. Unlike the Australian scenarios where the foremen ensured that the crew members understood what was discussed in the meeting or the crew members voiced their concerns in the meetings, such situations were not observed in the Indian context. In one of the interviews with a sub-crew in Case GREEN, the crew members opined that *'the foreman's conversations are largely one-way…he does not want to listen to us…he instructs us what to do and closes the meeting…'*. This particular comment indicates the case that the foreman wants to be authoritative with his instructions. The sub-crew further added that *'the foreman does not discuss with us how to execute the work, he just instructs us what to do and how to do…there are tasks which are unique and complex…we expect that the foreman discusses such tasks to us before we execute…but he does not do it that way…he instructs us how to do from his perspective and* *closes the meeting'*. This indicates clearly that the foreman is not inclusive and participatory, and the observation from such study is that instances like this resulted in crew members executing the tasks with insufficient confidence and morale, also causing reworks and loss of time.

In all the case projects studied in the Indian context, a 6-day work week is followed, i.e., from Monday to Saturday. In some cases, certain crews work on Sundays too. It was observed that typically crews work from 8:00 am to 8:00 pm, following a 12-hour workday schedule, meaning 8-hour general work duty + 4 hours overtime. The 4-hour overtime work was generally followed in the Indian cases. However, as indicated before, a 5-day and 8-hour/workday schedule was commonly observed in the Australian cases.

Regarding maintaining workloads and work timings of the crews, it was observed that the foremen in Indian cases were largely disorganised with little clarity around the work's overall progress. While the foreman in Case SAFFRON was found to be organised on the daily tasks and kept track of the milestone activities, the foremen of Cases WHITE and GREEN were not found to be organised and did not keep track of the milestone activities. In one of the interviews with the foremen of Case SAFFRON, he mentioned that *'I keep track of the overall progress of the project…we work in interface with formwork shuttering, electrical conduiting and concreting crews…I talk to those foremen and find out their work plan and plan and monitor my activities accordingly*. It was observed that since reinforcement work lies between completion of formwork shuttering and electrical conduiting, and concreting, the foreman of Case SAFFRON was found to keep track of their timelines to ensure timely completion of his portion of work. In a different instance, in Case GREEN, it was noted that the foremen did not keep track of the interdependent activities. In one of the interviews with the foreman of Case GREEN in this regard, he mentioned that *'I check with the site engineer about the work plans of the formwork and plastering crews…my site engineer interfaces with them'*. However, in this regard, the respective site engineer commented *'typically I want the foreman to do all such site-related coordination…I am not at the site all the time…if the foreman does not know the work plan of interdependent crews in detail, it hampers the work'*. He continued, *'the foreman should plan his work in connection with the interdependent activities…accordingly, he should align his crew members and guide them step by step…I am not handling his crew members…if he does not know things in detail, his crew members will not have enough directions at work'*. This indicated the difference in crew leadership skills exhibited by the Indian foremen in the cases studied.

Regarding maintaining workloads among the crew members, the foremen in the Indian context were largely concerned about the distribution of workload among their crew members considering their skill levels; however, they did not consider their fatigue due to long working hours throughout the duration of the project. This is reflected in the work schedule followed in the Indian cases, where the typical work week consisted of a 6-day work week with 12 hours per workday. In this regard, in one of the interviews with the foreman of Case GREEN, he mentioned, *'these workers are migrants…their native place is around 750-1000 KM away from this site…they want to earn more before they go to their native place for the next festival, so they do not bother about their fatigue…they just work'*. It was observed that while the crews work for longer durations, there is no systematic planning and execution of tasks that would make their efforts more meaningful. The crew foremen should be trained on these aspects to govern the crews effectively with timely execution of plans.

Providing appreciation, feedback and dissemination of good practices are considered critical for maintaining performing teams at work. In all the case projects studied in the Indian context, dissemination of good site practices was carried out at the project level (among the project site engineers/managers and engineers to foreman), but, they were not outwardly observed at the crew level (from site foreman to crew members). There was no obvious observation of a formal feedback system and dissemination of good practices by the crew foremen or the site engineers. In an interview with one of the crew members in Case GREEN, he mentioned that *'it would be good if we know the best practices followed by other crews…we do not discuss these…we observe practices followed by other crews and try to implement it…but there is no formal exchange of ideas'*. Also, providing incentives to crews who achieve production targets more than what was planned for the week was not commonly observed in the Indian cases. In some instances, it was observed that the foreman provides incentives to the leading hand of the crew or a particular crew member (who shares responsibilities with the foreman for managing the crew) but rewarding the productive crew members/sub-crews of the week/month (as the case in the Australian context) was not observed in the Indian cases. In this regard, the foreman of Case GREEN remarked, ' *I prefer to provide incentives to crew members who manage a sub-crew and the leading hand/ crew members who train semi-skilled/unskilled crew members…this helps me, so I provided some incentives to them'*. In a different instance, when asked about incentives to a sub-crew in Case WHITE, they commented *'we have not come across any incentives…in fact, we do not get overtime charges although we understand that we are supposed to be paid 1.5/2 times more than what we get paid for the general duty hours'*. Moreover, it was also observed that crew members get paid the same hourly pay as they get for the general duty hours. They do not get extra charges for overtime duty hours. Along these lines, it was also observed that when a sub-crew/crew member identifies a better-paying site, they leave the present site and join the newly identified site for better remuneration and recognition of work. Timely release of payments to workers is also recognised as a significant issue causing absenteeism and turnover of these workers from job sites (Loganathan and Kalidindi 2016). Crew leadership should aim to address this issue.

As mentioned in the Australian context, another important aspect of crew leadership is training the leading hand and crew members to become future crew leaders. It was observed that the foremen in Indian cases train their leading hand and crew members more towards the social side of managing the crew instead on technical grounds. The foremen expect the leading hand and experienced crew members to coordinate and arrange materials for them, manage the attendance of the crew, and satisfy their daily needs at the workplace and labour camps. The foreman ensured the crew's technical guidance. The following comment by the foreman of Case WHITE corroborates it *'I want leading hands and senior crew members who can help me manage the crew by arranging things for them both at the workplace and in the labour camps…I can guide them technically at work'*. As, the foremen in Indian cases provided incentives to the leading hand and crew members who share responsibilities in managing the crew in social terms. The foremen kept dependency on them about work-related issues. While managing the crew in technical terms is so important to deliver quality work, it is equally essential for foremen to train their workers to technically manage things with limited guidance. The foremen should focus on the wholistic development of the leading hand and senior crew members as future crew leaders. All these findings together corroborate with the recent research on this topic that summarises the dimensions of leadership, which could create a conducive learning environment for workers. The research finds that *workers know more than managers about what needs to be improved in production processes; people are more likely to commit to improvements that they have had a hand in designing; developing people so that they have the skills and knowledge to act on the information they have at the workface will help them solve problems* (Mossman and Ramalingam 2022). Based on the analysis, Table 6.6 below shows the number of instances of occurrence of each of the crew leadership dimension in Indian cases.

Table 6.6 No. of instances of occurrence of crew leadership dimensions in Indian cases

S. No	Crew leadership dimension	No. of instances of occurrence
1	Crew meetings	37
2	Maintaining workloads and work timings of the crew	54
3	Feedback, appreciation, devising incentives	47
4	Training leading hands and senior crew members	84

6.6.1.3 Comparison of Australian and Indian Cases

Hersey and Blanchard's (1974) classification of leadership styles based on task and relationship behaviour indicates four categories of leadership, as depicted in the below figure:

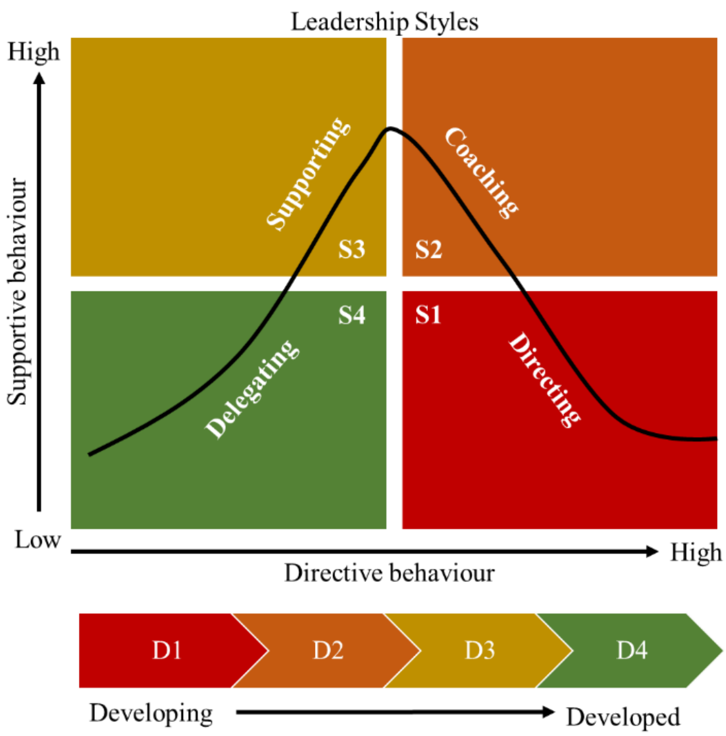


Figure 6.13 Hersey and Blanchard situational leadership model

According to the leadership model depicted in Figure 6.13, an administrator may have a high or low task and related behaviour (Hersey and Blanchard 1974). The combination of task and relationship behaviour provides four types of leadership. As can be seen in Figure 6.13,

- *High Task-Low Relationship (S1) is directing/structuring/telling* leadership style where the leader is orderly and more directive. The role of each subordinate is well composed in this style.
- *High Task-High Relationship (S2) is a coaching/selling* leadership style where the leader directs and assists the subordinates.
- *Low Task-High Relationship (S3) is a supporting/encouraging/participating* leadership style where leaders contribute less direction but high assistance to the subordinates. The leader's work is only to make policy and entrust it to the subordinates to achieve goals.
- *Low Task-Low Relationship (S4) is delegating* leadership style where the leader contributes neither instruction nor support.

Construction crew leadership can be analysed using the above leadership model. It can be summarised that crew leaders, i.e., the foremen of construction crews in the Australian cases tend to be largely coaching and supporting, and the foremen in the Indian cases tend to be directing and coaching. The behaviours can be observed based on the various dimensions of leadership behaviours that they have exhibited, which include conducting regular crew meetings with the crew members, maintaining workloads and work timings of the crews, making regular work inspections, providing feedback and appreciation, devising appropriate incentives, and training the leading hands to make them as crew leaders. Table 6.7 summarises the crew leadership dimensions in the Australian and Indian context.

Table 6.7 Crew leadership dimensions in the Australian and Indian context

S. No	Crew leadership dimension	Australian context	Indian context
1	Crew meetings	• Daily prestart (DPS) and weekly toolbox meetings (TBM) are conducted at the crew-level • Meetings are formal • Informal caucus meetings conducted during field visits	• Daily start-up meetings between the site foreman and crew members • Weekly meetings between site engineers and project manage • Meetings are largely informal
2	Maintaining workloads and work timings of the crews	• Structured work timing • Over time is not a priority • Workload provided based on work priority too • Fatigue of crew members is considered	• Long working hours with significant over time work • No systematic division of workload • Fatigue of crew members not considered
3	Feedback, appreciation, devising appropriate incentives	• Presence of formal feedback system • Dissemination of good practices at crew level • Incentives provided for performing members of the crew	• Lack of formal feedback system • Dissemination of good practices at project level • Absence of formal incentives; informal rewards provided to crew members
4	Training leading hands and senior crew members	• Coaching and supportive behaviour is observed • Informal and on the job training is provided	• Directive and coaching behaviour is observed • Informal and on the job training is provided training

6.6.2 Mutual Performance Monitoring and Backup Behaviour

Mutual performance monitoring among crew members was exhibited in several ways. It includes dimensions such as having small talks with other crew members, displaying backup behaviour, caring for each other, and having a buddy system in the workplace.

6.6.2.1 Mutual Performance Monitoring and Backup Behaviour Dimensions in Australian Cases

During one of the discussions with a sub-crew in Case ATROUS, a crew member mentioned, '*chit chat with your mates and work…it makes you work easier*'. He elaborated, '*we usually used to have these small spicy conversations at work…we do hard tasks…it is not a desk-based job…you have to talk to people and ease up things when you feel so*'. In another instance in Case LIARD, a crew member mentioned, '*having conversations with your workmates help you in several ways…mainly, it is a way to monitor your co-worker and ensuring he is doing OK'*. In a different discussion with a crew member in case KHAKI, he mentioned, '*…having casual conversations with your co-workers will help you understand them better*'. He expounded that, '*it is important to gather a basic understanding of how your co-worker works…gaining such understanding will help appreciate his work practices and how he is oriented towards his work*'. Mirivel and Fuller (2017) identify these casual conversations as small talk. Small talk and, more generally, *social talk* at work is one obvious means by which people establish and nurture collegial relationships (Mirivel and Fuller 2017). Although small talks include discussions about how people spent their weekend, what movies they have seen, what sport they are currently involved with, and so on, they also have little direct relevance to the workplace business at hand, they are by no means irrelevant in the overall context of the project/organisation (Mirivel and Fuller 2017). Sometimes, the conversation also slowly moves from social talk to work talk (Mirivel and Fuller 2017).

During one of the interviews with a crew member in Case LIARD, he commented, '*work quicker and faster!!...if you work quicker and faster, the day goes faster and productive as well*'. It was observed that this particular worker in Case LIARD largely remained enthusiastic throughout the workday. His enthusiasm and quickness at work motivated others also to remain enthusiastic at the workplace. It is one form of exhibiting backup behaviour at the workplace. Backup behaviours are essentially the actions that arise from mutual performance monitoring (Cooper 2016; Salas et al. 2005). Research has shown that backup behaviours can include a team member coaching or providing verbal feedback to another member, helping a team member behaviourally by carrying out actions, or completely assuming a task for a teammate (Cooper 2016; Marks et al. 2001). During one of the observations in Case KHAKI, two crew members (along with a helper) were constructing a lengthy wall, as depicted in Figure 6.14. Here, it was observed that one of the crew members always ensured that the other member was building along. The crew members backed up each other by providing time to time back feedback on alignment. They also ensured that both worked at the same pace. Even if one of the members finished a layer of brickwork quicker than the other, they waited for both to finish and moved to the next layer. These helped to attain perfect alignment of the wall constructed and avoided rework. Figure 6.15 shows the display of backup behaviour between the crew members, as one member helps the other members in attaining brickwork alignment.

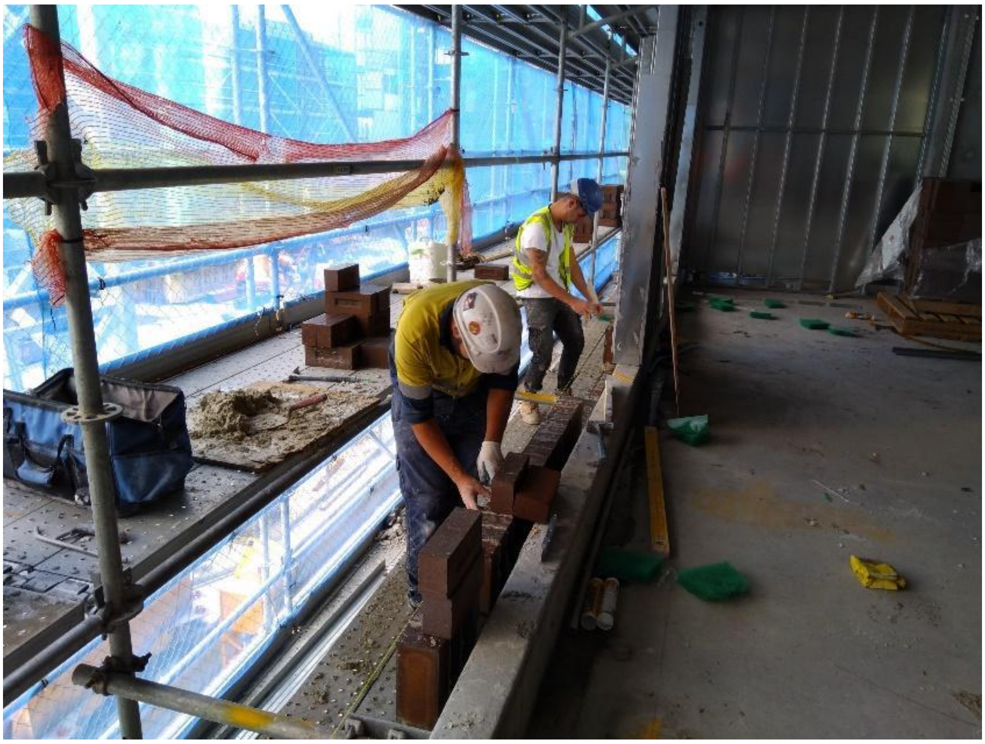


Figure 6.14 Crew building a lengthy wall

Figure 6.15 Display of backup behaviour

The crew members also exhibit caring for each other: both at the task level and at the interpersonal level. At the task level, the crew members (in all the cases in the Australian context) largely watch out for each other for safety. The crew foremen also re-iterate certain things related to the safety of individuals and their co-workers in the toolbox meetings. These include:

- Watch out for each other for safety
- Report injuries and hazards ASAP
- Make sure nothing is obstructing your swing, keep aware of your surroundings; always watch what you are doing, and what your co-workers are doing

These instructions also create a sense of caring among the workers. During one of the interviews with a crew member in Case ATROUS, he elaborated, '*interact with your workmates and work…so you may feel happy and positive…isolated work won't work sometimes buddy!*'. In another instance in Case LIARD, one of the crew members recalled that one of his co-workers was not doing well with his personal life. He mentioned, '*he was going through a tough time, personally…certain days he looked upset at workplace…whenever I noticed that he was not OK, I played music…I believe it helped him*'. He further elaborated by saying, '*listening to music and work…chit chat with your workmates and work makes you work easier and help to maintain healthier relationships with your workmates too*'. This relates to the 'buddy system' in the workplace. In Case LIARD, *buddy system* was getting introduced at that point in time (during the data collection period of the researcher). The buddy system clubs a new worker joining the project site and an experienced worker of the organisation, who will act as the buddy to the new worker. The buddy helps the new worker to get oriented in the workplace and in the larger organisation. The buddy system also helped in creating a caring team culture in workplaces. In the context of construction safety, Rowlinson and Jia (2015) identified that with a caring team culture, workers remind each other of the early symptoms of heat illness and watch over each other. They identified that buddy help is found to be effective prevention at the reactive stage of the heat illness intervention (Rowlinson and Jia 2015). It was also identified that a worker could communicate his own perception on the issues at the workplace or otherwise to co-workers and receive timely help. Such mutual performance monitoring processes and practices together aid in developing self-managing crews in workplaces. In self-managing teams, members observe their teammates' performance, watch for deficiencies, and provide feedback to one another (Nickdoost et al. 2022). This will enhance team coordination, ultimately resulting in higher team performance levels (Nickdoost et al. 2022; Marks and Panzer 2004). Furthermore, watching co-workers progress inspires other team members to focus more on their task accomplishment (Nickdoost et al. 2022; Gafni and Geri 2010).

Based on the analysis, the dimensions of mutual performance monitoring and backup behaviour include small talks, backup behaviour, caring for each other and buddy system. Table 6.8 below presents the number of instances of occurrence of each of the dimension in Australian cases.

Table 6.8 No. of instances of occurrence of mutual performance monitoring and backup behaviour dimensions in Australian cases

S. No	**Mutual performance monitoring and backup behaviour dimensions**	**No. of instances of occurrence**
1	Small talks	53
2	Backup behaviour	47
3	Caring for each other	63
4	Buddy system	35

6.6.2.2 Mutual Performance Monitoring and Backup Behaviour Dimensions in Indian Cases

In all the case projects studied in the Indian context, behaviours relating to mutual performance monitoring were observed through backup behaviours, caring for each other and an informal buddy system at the workplace. As mentioned before, the construction workforce in India consists of a significant portion of migrant workers. The migrant workers come from different parts of the country to work on large construction projects in urban areas. Some of the crews consist of crew members who are their family members/extended family members, their community members who share the same religion/caste, and neighbours/friends. In most cases, the crew members are from the same village/town. In such cases, backup behaviour among them is clearly observable. Furthermore, the skilled workers train the semi-skilled and unskilled workers on the job; hence backup behaviour is explicitly observable in these cases. In this regard, during one of the interviews with the leading hand of Case WHITE, he indicated that *'it is an informal duty for the skilled workers in the group to train the semi-skilled and unskilled workers…since some of them know each other personally, they do not consider it as a duty to train them'*. In a different instance, in Case GREEN, a skilled crew member indicated that *'my foreman wants me to train my sub-crew members…he wants me to track their daily production…and more importantly, am also equally responsible for their safety at the workplace'*. He continued saying, *'as some of these workers are new to construction and as I know their family members, I consider this as my duty… '*. These comments indicate that as the crew members are connected to one or another in personal terms, and backup behaviours observed were not formal and were not asked for as observed in the Australian context, it was more relational and informal in the Indian context. An explicit sense of caring behaviour among each other was found in the Indian context. This also signifies the importance of having an informal buddy system at the workplace and, more importantly, in the labour camp.

In labour camps, experienced crew members take care of newly joined and younger crew members by ensuring their daily needs are met and helping them settle in. In this context, during an interview with an experienced crew member in Case SAFFRON, he commented that *'apart from training my crew members on construction skills, I also train them on cooking…they assist me in cooking too'*. These kinds of observations were noticeable in the labour camps of migrant construction workers. Caring behaviours exhibited by the crew members at the workplace and in the labour camps helped creating a caring team culture among construction crews in the Indian context.

Backup behaviour was also exhibited in the workplace by the crew members. In Case SAFFRON, the reinforcement crew is divided broadly into three sub-crews: rebar cutting, rebar bending and rebar binding.

- Cutting crew takes care of the transportation of rebar from the steelyard to the workplace and cuts the rebars as per the required sizes provided by the foreman
- Bending crew takes care of bending the rebars as they need to be installed on the worksite and make rebar stirrups
- Binding crew takes care of installation and binding of rebar on the worksite

Figure 6.16 shows the reinforcement crew of Case SAFFRON.

Figure 6.16 Reinforcement crew of Case SAFFRON.

A few unskilled helpers assist all three sub-crews in transportation tasks. It was observed that there is a clear distinction of work between the three sub-crews, and the backup behaviour was noticed among the sub-crews. For instance, the cutting crew helps the bending crew when they have to provide sufficient work front for the binding crew. The cutting crews extend their help in making column stirrups/rings, a repetitive activity. The bending crew helps the binding crew by installing column stirrups/rings when they have a heavier workload. The binding crew helps the cutting crew at the day's beginning by transporting rebars from the steel yard and helping them cut longer rebars (typically requiring more helpers). While all the sub-crews have daily targets, they mutually support each other. This observation portrays both mutual performance monitoring and backup behaviour exhibited by the whole crew. Such backup behaviour also helps them be more effective as a total crew.

While backup and caring behaviours are readily observable within the same crew, there were also observations regarding the exhibition of aggressive behaviour of crew members with different crews. This happens when two crews represent other communities with respect to state, religion, community, caste etc. The issues may arise due to work-related coordination, but they might further become personal issues among the crews. In Case SAFFRON, the researcher observed that the study crew (a steel fixing/reinforcement crew) had issues with the formwork shuttering crew regarding site-related coordination, particularly issues related to the availability of a work front for the reinforcement crew. While the issue got resolved by the foreman of both crews at the workplace, they had issues in the labour camp. The crew members exhibited aggressive behaviour in the labour camp on the same day; however, the issue technically got resolved by the foremen of the crews at the workplace. In this regard, the foreman of Case SAFFRON commented that *'this is the reason we take the upper hand in terms of managing the crew members…while we would ideally want them to be a self-managing crew, it does not happen…it is one of the reasons why we get involved in coordination with* *other crews'*. In sum, it can be concluded that while mutual performance monitoring and backup behaviour are largely informal in nature in the Indian context, careful understanding of the behaviours is important considering the diverse nature of crews from different states representing different religions/caste/communities etc.

Based on the analysis, Table 6.9 below shows the number of instances of occurrence of each of mutual performance monitoring and backup behaviour dimensions in Indian cases.

Table 6.9 No. of instances of occurrence of mutual performance monitoring and backup behaviour dimensions in Indian cases

S. No	Mutual performance monitoring and backup behaviour dimensions	No. of instances of occurrence
1	Small talks	32
2	Backup behaviour	73
3	Caring for each other	115
4	Buddy system	79

6.6.2.3 Comparison of Australian and Indian Cases

Mutual performance monitoring among crew members was exhibited in several ways. It was discussed both in Australian and Indian cases under the dimensions including small talks with other crew members, displaying backup behaviour, caring for each other, and having a buddy system in the workplace. The presence of small talk was observed both in Australian and Indian cases. While small talk facilitated more of a personality-related understanding than work-related understanding in the Australian cases, it was more of a work-related understanding than personality-related understanding in the Indian cases. One of the major reasons was for it is construction crews represented crew members from the same family/extended families/members from the same villages and towns. So, they focused more on work-related information. Backup behaviour was observed in both Australian and Indian cases. It was more formal and asked for in Australian cases, and informal and relational in Indian cases.

Caring for each other was also observed in both Australian and Indian cases. It was largely driven by the organisation considering work-life balance and mental health-related issues in the Australian context and was informal in the Indian context. While formal buddy system was gaining popularity in the Australian context, informal buddy system exists in the Indian context. Table 6.10 summarises the dimensions of mutual performance monitoring and backup behaviour in the Australian and Indian contexts.

Table 6.10 Dimensions of mutual performance monitoring and backup behaviour in the Australian and Indian context

S. No	Mutual performance monitoring and backup behaviour dimension	Australian context	Indian context
1	Small talks	• Presence of small talks observed • Facilitated personality understanding between crew members more than work-related understanding	• Presence of small talk observed • Facilitated work-related understanding more than personality-related understanding
2	Backup behaviour	• Backup behaviour was observed • It was more formal and asked for	• Backup behaviour was observed • It was more informal and relational
3	Caring for each other	• Caring behaviour was observed • It was largely concerned by the organisation with regards to work-life balance & mental health related issues	• Caring behaviour was observed • It was informal and observed both at the workplace and in the labour camps
4	Buddy system	• Formal buddy system is gaining popularity	• Informal buddy system both at the workplace and in the labour camps

6.6.3 Adaptability

Team adaptability can be defined as the degree to which 'a team is able to modify its configuration of roles into a new configuration of roles using knowledge acquired through interaction in the course of task execution as well as through more explicit exploration of transaction alternatives' (LePine 2005). It can be viewed as a latent capability for effectively coping with non-routine task-focused disruptions and making adjustments to deal with changing task demands (Bush et al. 2018; Maynard et al. 2015; Kozlowski et al. 1999).

6.6.3.1 Adaptability Dimensions in Australian Cases

Construction projects are complex and laced with uncertainties. It is therefore necessary for project team members to make necessary changes to meet new circumstances and regulate plans and actions in response to unpredictable situations (Abankwa et al. 2019). Exhibiting flexibility is considered one of the most important aspects of adaptability. In Case ATROUS, the crew members exhibited flexibility in terms of re-distributing tasks during rebar placement of complex structural elements. One of the crew members of Case ATROUS opined that *'we re-distribute tasks during tough times…experienced crew members can handle complex structural elements…so to avoid rework and ensure timely completion of tasks, we re-distribute tasks within our crew'*. In a different instance in Case LIARD, one of the crew members indicated that *'it is helpful when we share workloads among our crew members…when someone in the crew is overloaded it is helpful when we share the workloads…in our crew we share workloads'*. Exhibiting flexibility also facilitates team learning. In Case LIARD, during one of the discussions with the leading hand, he commented, *'when we crew members share tasks during tough situations, it enables learning between them'*. He continued by saying, *'in curved joint portions, it is a bit tougher for crew members to finish the brickwork as bricks form exterior façade in this project…so young crew members (who are less experienced)* *approach experienced crew members to complete this portion…by this way team learning occurs and you also complete such tasks by avoiding rework'*. Exhibiting flexibility is therefore an important aspect of team adaptability.

Another important aspect of team adaptability is situation awareness. Mainstream organisational and management literature indicates that processes that facilitate situation awareness include prioritisation of tasks, establishing contingency planning, team members sharing information on their current task status and capabilities, and a group norm of questioning assumptions and checking each other for conflicting information or perceptions (Bolstad and Endsley 1999). In the context of construction trade crews, executing complex construction activities with zero defects and incidents require greater situational awareness. As construction projects are laced with risks and uncertainties, it is necessary for crew members to be aware of the current situation and adapt themselves to accomplish the tasks effectively and efficiently. In Case LIARD, in the event of a change in design, the crew members met together to understand the deviations the change would cause (from the routine tasks) to execute the activity. Contingency planning was carried out regarding resources. The crew members discussed the roles and responsibilities of each individual with regard to the specific task's execution. Once the crew members got a clear understanding of the methodology and processes to execute the task, they got it approved from the project client team and then the execution began. In Case KHAKI, at the construction juncture of complex joints, there needed careful execution of tasks by the crew members. Here, interface with the scaffolding crew members too played a major role; As mentioned before, the scaffolding crew members largely consisted of non-English speaking members. The researcher as an observer in one of the crew meetings noted the crew members' discussion about the sharing of information between them on their capabilities, questioning assumptions and checking each other for conflicting information or perceptions about the tasks. On each floor, at the construction juncture of complex joints, the crew met together to attain greater awareness of the situation and acted accordingly. By so doing, the team could adapt to the non-routine conditions and display greater team performance. This corroborates with the existing literature on organisational teams that a team's adaptability and performance are observed on how well the team is flexible enough to meet the change in conditions and exhibit greater situational awareness to cope with the change in conditions (Endsley 2017).

Based on the analysis, the dimensions of adaptability include exhibiting flexibility and situation awareness. Table 6.11 below presents the number of instances of occurrence of each of the dimension in Australian cases.

Table 6.11 No. of instances of occurrence of adaptability dimensions in Australian cases

S. No	**Adaptability dimensions**	**No. of instances of occurrence**
1	Exhibiting flexibility	33
2	Situation awareness	37

6.6.3.2 Adaptability Dimensions in Indian Cases

Similar to the Australian case projects, exhibiting flexibility and situation awareness, the two dimensions of adaptability are also observed in the Indian context. Changes are inevitable in construction projects. To address the changes, the project teams have to formulate new plans and actions. In this regard, as mentioned before, crews exhibiting flexibility in terms of re-distributing their task and role responsibilities within them are considered crtical. In Case SAFFRON, the crew members exhibited flexibility in re-distributing tasks during rebar placement in heavy columns of the structure. Heavy columns are larger in size and have complex rebar placement compared to other columns. It was also observed that some heavy columns are boundary columns of the structure where additional safety is required during rebar placement. Here, experienced crew members are paired with relatively younger crew members to complete the work safely without any rework. The project client team also made an additional approval requirement, especially for rebar placement in heavy columns. The project client made a detailed checklist and asked the respective crew to take approvals before rebar placement in heavy columns. This additional requirement also demanded young crew members work with experienced crew members. The crew members exhibited flexibility regarding crew size and composition for such heavy columns.

Exhibiting flexibility also facilitates team learning. In Case GREEN, during one of the discussions with a crew member, he remarked, *'I believe on the job learning…it is the best way to learn construction skills...particularly for brickwork it is even more critical…'*. He continued, *'in a single project, you may not learn all possible complex brickwork joints unless you switch and co-work with others'*. It was observed that to ensure crew learning the foreman shuffled certain crew members within the crew to learn different joints. In this regard, he commented, *'if they can learn different possible brickwork joints (by cross-learning within the crew) it can help them in several ways, particularly they would be adaptable to complex situations'*. Therefore, exhibiting flexibility, forms an important aspect of team adaptability.

Another important aspect of team adaptability is situation awareness. As mentioned before, mainstream organisational and management literature indicates that processes that facilitate situation awareness include prioritisation of tasks, establishing contingency planning, team members sharing information on their current task status and capabilities, and a group norm of questioning assumptions and checking each other for conflicting information or perceptions (Bolstad and Endsley 1999). In all the case projects in the Indian context, it was observed that construction foremen and leading hands played a major role in addressing the dimensions as mentioned above regarding situational awareness. For instance, in Case SAFFRON and Case

GREEN, it was observed that in crew-level discussions, the foremen prioritised day's/week's tasks with the sub-crews and crew members. Foremen and leading hands enabled crew members to ask questions regarding the tasks, as it helped them to execute work without assumptions. However, it was also observed that while they encouraged crew members to come up with questions and discussions, it was primarily driven by the foremen. The crew members listened to the foremen's instructions. The practice of crew members talking to each other to nullify assumptions about tasks and having discussions among them to share their capabilities when challenging situations appear was not evidently observed. However, foremen and leading hands enabling the crew members themselves to share their information and knowledge regarding the capabilities of the tasks would facilitate greater situation awareness among the crews. Foremen and crew members need to be trained in such areas that would drive better team performance. Based on the analysis, Table 6.12 below shows the number of instances of occurrence of each of the adaptability dimension in Indian cases.

Table 6.12 No. of instances of occurrence of adaptability dimensions in Indian cases

S. No	**Adaptability dimensions**	**No. of instances of occurrence**
1	Exhibiting flexibility	42
2	Situation awareness	31

6.6.3.3 Comparison of Australian and Indian Cases

The dimensions of adaptability included exhibiting flexibility and situation awareness. Redistributing tasks during difficult conditions and role flexibility were observed in the Australian and Indian cases. However, in Indian cases, redistributing tasks during heavy loads and on-the-job training also facilitated flexibility among the crew members. With regards to situation awareness, while crew members discussing and seeking help among each other was observed in Australian cases, foremen facilitated the same in the Indian cases. Table 6.13 summarises the dimensions of adaptability in the Australian and Indian contexts.

Table 6.13 Dimensions of adaptability in the Australian and Indian context

S. No	Adaptability dimension	Australian context	Indian context
1	Exhibiting flexibility	• Re-distributing tasks during difficult conditions • Role flexibility facilitated team learning	• Re-distributing tasks during difficult conditions & heavy workloads • On-the-job training & role flexibility facilitated team learning
2	Situation awareness	• Crew members enable discussions during challenging situations • Crew members seek help from each other	• Foremen and leading hands facilitated discussions during challenging situations • Crew members seek foremen for help

6.6.4 Crew Orientation

As mentioned in Chapter 5, crew/team orientation is not only a preference for working with others, but also a means of enhancing individual performance through coordination, evaluation, and utilisation while performing group tasks (Mustafa et al. 2017). Crew orientation plays a crucial role in achieving better teamwork among crew members.

6.6.4.1 Crew Orientation Dimensions in Australian Cases

In all the case projects studied in the Australian context, crew orientation is achieved through orienting crew members during meetings, during site visits made by the foremen, development of shared mental models, and initiatives taken to develop a positive attitude/orientation towards work.

In all the case projects studied in the Australian context, the foremen utilised the regular toolbox meetings (TBMs) and other weekly meetings as a means to create orientation among the crew members. In Case KHAKI, the foreman encourages crew members to ask questions so that they are clear about their tasks at work sites. As an observer in one of the TBMs, the researcher observed that the foreman mentioned the following to the crew members, '*open up here…let's discuss the issues and resolve it here...if you have any questions, ask…let's discuss and resolve it before we move forward*'. When the researcher asked why he was so particular about crew members asking questions in the meetings, he commented, '*it is a means of getting them oriented towards work…if they are agreeing towards what needs to be done then there won't be any major issue at work*'. In Case ATROUS, the foreman showed the scrap materials collected during one of the TBMs. He mentioned '*by showing the waste collected, it gives me with an opportunity to preach best practices and orient them to follow such practices…unless you show and orient them, they are not going to fully change for good*'.

Crew orientation also happens through site-level meetings organised by the main contractor, where selected sub-crews and crew members from the subcontractor companies attend the meetings. For instance, in Case LIARD, crane meetings are organised by the main contractor. In the crane meeting, updates on the deliveries and lifts that will be carried out by the crane for the following day are discussed. This discussion helps the sub-crews to plan their activities and logistics. Similar to the crane meetings, safety walks were also carried out to orient diverse crews of the site towards best safety processes and practices. In Case KHAKI, the researcher participated as an observer in one of the subbies meetings (subcontractors meeting). The subbies meetings aim to provide wider orientation about different activities carried out by various subcontractors. An alignment at the project level is attained through these subbies meetings to resolve issues related to coordination, interface, and integration management.

In Case ATROUS, the foreman also utilises such regular meetings to orient workers about their freedom of association in the building and construction industry. The foreman conveys that, '*all employees and contractors have the right to choose whether or not to join a union*'. He mentioned that, '*there should not be any forceful act with regards to joining a union or not, it should be left to the individual*'. As a means to orient people, the foreman commented, '*individual opinions and decisions need to be respected by others, hence we discuss such things transparently in the group meetings*'. These open discussions facilitate fruitful conversations about such sensitive topics.

In Case KHAKI, the foreman utilises team meetings to provide orientation about miscellaneous work processes that should be followed by all the sub-crews and crew members. The crew carried out brickwork activity in Case KHAKI. The company provided cleaning and polishing work to a different agency, as a sub-contract work. However, the foreman mentions to crew members, '*your job is to do some basic cleaning, polishing is next…we are not expecting more than that…so please clean the cavities then and there, on a daily basis*'. The foreman opined '*orientation about such things need to be done at the site level otherwise there may be differences in understanding*'. Productivity is an important topic that is discussed by the foreman during the crew level meetings. The leading hand provides productivity data of various sub-crews and crew members. The foreman discusses the productivity data and orients the crew to achieve the required productivity that should be achieved per day. If there is a significant drop in productivity levels, the foreman discusses the reasons for it and tries to resolve group-level issues in the group meetings. The foreman in Case KHAKI repeats a few common instructions in the group meetings to orient the crew. The instructions are depicted in

Figure 6.17. The foreman remarked '*I repeat these instructions in all the group meetings to ensure that the crew members are aligned towards the processes that we follow at work*'.

Don't smoke on the job
Wear all required PPEs all the time at work
Report injuries/incidents immediately
No texting when you are off you must ring in and inform
Clean cavities with water
Wear dust mask whenever needed
Beware of moving equipment
Don't move the scaffold
Clean your area as you leave the work
Keep all toolboxes closed during the day
No drug and no alcohol on the job

Figure 6.17 Instructions provided by the Case KHAKI site foreman

In all the case projects in the Australian context, it was also observed that the new workers are introduced during group meetings/TBMs. In Case KHAKI and LIARD, even the researcher was also introduced during one of the TBMs. This additionally provided an initial orientation of the researcher to the study crews.

Both formal and informal site visits made by the foremen contributed towards improving crew orientation, in all the case projects studied in the Australian context. During one of the sites visits the researcher made with Case ATROUS foreman, the foreman performed a work inspection of an activity that is getting completed. The foreman gathered all the crew members and discussed all the inspection points that would be checked by the client team during the approval process. He staged a demonstration of members how an inspection will be carried out by the client team to the crew members. He commented, '*all the crew members should gather a similar understanding of the task they perform…if not, it would possibly result in an error or rework*'. This necessitated the importance of *shared mental models,* that provide a common framework for crew members to understand and perform tasks as a team. As mentioned in Chapter-5, the literature on shared mental models in the mainstream management literature indicates that it includes four elements (Mohammed et al. 2010), as depicted in Figure 6.18.

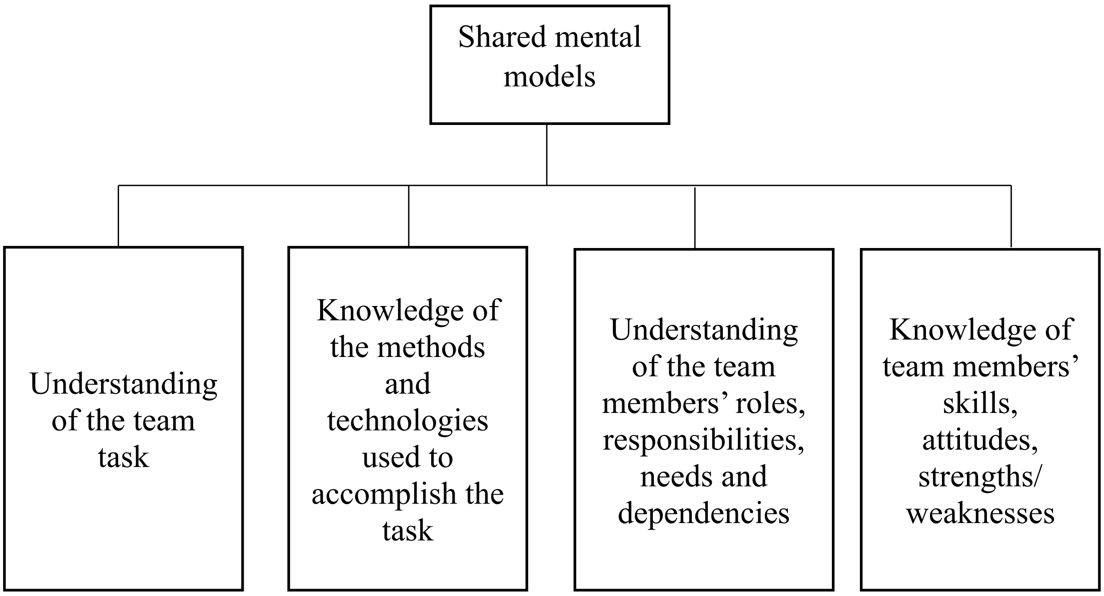


Figure 6.18 Elements of shared mental models

As per the proposed conceptual framework presented in Figure 5.9 (in Chapter 5), shared mental model is considered one of the coordinating teamwork mechanisms. However, during the analysis of the collected data, it emerged as a dimension within crew orientation, i.e., shared mental model act as a means of facilitating crew orientation within the studied crews. Accordingly, shared mental model is placed as one of the dimensions that facilitate crew orientation rather as a broader coordinating teamwork mechanism. Recent research in mainstream organisational literature also highlights that the development of shared mental models among team members facilitates better crew orientation (McComb 2017; Harvey et al. 2019). The following extracts and discussions from the data provide empirical evidence for positioning shared mental model within crew orientation.

In Case LIARD, one of the crew members demonstrated certain operations that are executed by the crew. He commented, '*in the past, I have utilised this methodology…I wanted to demonstrate this to my fellow crew members so that we are aligned towards the task, and we effectively do it together*'. This act of a crew member in Case LIARD facilitated the development of a shared mental model, where knowledge on the methods used to accomplish the task was disseminated. In Case LIARD, the foreman also makes sure that one-of-the-kind complex site operations are visually represented on the site using an iPad, so the crew members can observe and follow similar steps. The foreman elaborated that, '*visualisation helps…it makes it easy for the crew members to look at the visual, discuss as a group and understand how to execute the task without any rework…I try to use these visual charts wherever possible, on my sites'*. The foreman ensured that the physical copies of visual charts are pasted around the work location, which helped the crew members to gather a similar understanding of the task.

It is necessary for the crew members to work within their strength areas when it comes to discussions with other crews onsite. For instance, in Case KHAKI, the crew members have to interact with the scaffolding crew to resolve interface-related issues. However, the scaffolding crew members predominantly speak Mandarin and are developing their local language skills. Hence the foreman has instructed the crew members to take the help of him/the leading hand or the client team members onsite to discuss with the scaffolding crew, especially about precautionary things. The foreman mentioned to the crews that, '*scaffolding crews*

English is getting better but still talk to me/leading hand and don't need to talk to them directly'. He further mentioned to the researcher that, '*this is so important…we do not want any miscommunication which would essentially result in a safety issue or rework'.* In another instance in Case KHAKI, the leading hand was specific about the roles and responsibilities of the crew members. It was highlighted when one of the crew members adjusted a back-prop which must be done by the scaffolding sub-contract crew. He mentioned, '*back-prop is only to be adjusted and relocated by them (referring to the scaffolding sub-contract crew)…anyone caught removing back-propping will be re-inducted*'. He continued, '*under no circumstances are any scaffold or formwork screen elements to be modified, adjusted or removed by any parties other than the scaffold crew (no exemptions)'.* These kinds of specific orientations need to be done at the work locations.

Another important variable that emerged within crew orientation is '*developing and sustaining a positive attitude toward work*'. During one of the discussions with the foreman in Case KHAKI, the foreman mentioned about a particular worker who did not want to talk about productivity or entertain any discussions on productivity. He mentioned that, '*attitude matters…a brickie did not want to talk about quantities…on an average, we lay 250 bricks/day…he did not like to talk about these numbers…but that is the way it is done here*'. He elaborated saying, '*I tried giving him an understanding that productivity is tracked on a regular basis to help us improve and address the issues if there is a drop in productivity…however, he did not appreciate it…and finally, he moved out of the work*'. He emphasised the importance of having a positive attitude at work. In another instance, the foreman was quoted saying, '*there was another brickie who lays the required amount of bricks to be laid for the day by 12 pm and leaves home…everyone in the site literally chased him*'.

During one of the meetings in Case ATROUS, the foreman wanted to address a particular coordination issue that was ongoing at the site at that time. He addressed the crew members saying, '*when you have an issue, look at the issue, don't walk away…have an attitude that we need to fix the issue…else ring me, we will fix it together'*. He elaborated saying, '*it is necessary for the crew members to have an attitude of looking at the issue and solve them rather moving away from them*'. Since construction involves coordination and managing changes (change in scope, methodology, design, execution plan etc.), the stakeholders should have a positive attitude towards resolving issues and discharge collaborative action as early as possible. This is crucial with respect to productivity and completing projects on time within budget.

Orientation about technologies and newer construction methodologies was also carried out at the project sites. It was found necessary that systematic orientation about technologies and methodologies is essential for crew members, so that they would start utilising it comfortably. During one of the discussions with the leading hand of Case ATROUS, he mentioned, '*not everyone here knows how to use an iPad…it helps them to locate the details very clearly…3D drawings in the iPad will help them to visualise the construction elements so they can avoid issues related to interfaces*'. He continued by saying '*I conduct demo sessions on iPad usage…I feel it helps them…slowly they are picking it up…once they start using it themselves, they will like it and find it very useful*'. Such technological orientations were found to be useful in the project sites.

During his weekly toolbox meetings, the foreman of Case LIARD discusses the best practices that he observed during his site visits in the previous week. This is done as a means of instilling a positive attitude among crew members. In the TBMs, he particularly elaborates on the best practices followed by sub-crews for the whole project site team. In one of the instances, a particular sub-crew also encouraged the other crew members to visit them during break times.

The foremen and the leading hands have repeatedly mentioned, ‘please ask questions, let’s solve the issues as and when they appear’ in all the cases. This seemed to help the crew members to approach issues with a positive attitude. In one of the instances, a crew member in Case LIARD mentioned, ‘the leading hand of my crew is very approachable…he enables us to ask questions rather moving with assumptions when we are stuck with certain things at work’. In a different instance in Case ATROUS, the leading hand said ‘my foreman wants us to get things right before we execute it…he says, ‘get your doubts cleared by checking with me…if I do not have an answer for you, I will check with the client team and provide you the solutions’. Such practices were found to help in developing a positive attitude among crew members.

Based on the analysis, the dimensions of crew orientation include having regular crew meetings, making frequent site visits and providing feedback, developing shared mental models and orienting a positive attitude towards work. Table 6.14 below presents the number of instances of occurrence of each of the dimension in Australian cases.

Table 6.14 No. of instances of occurrence of crew orientation dimensions in Australian cases

S. No	Crew orientation dimensions	No. of instances of occurrence
1	Having regular crew meetings	48
2	Making frequent site visits and providing feedback	52
3	Developing shared mental models	33
4	Orienting a positive attitude towards work	39

6.6.4.2 Crew Orientation Dimensions in Indian Cases

As mentioned, crew orientation is achieved through orienting crew members during meetings, site visits made by the foremen, developing shared mental models, and initiatives taken to develop a positive attitude/orientation towards work. In all the case studies conducted in the Indian context, the orientation of crew members during meetings was not explicit as it was observed in the Australian context. Unlike in the Australian context, it was observed that crew members were not asking any questions during the meetings. The crew-level meetings, i.e., the meetings which the crew foreman conducts with his crew members, were largely one-sided, where the crew foreman provided instructions to the crew. The crew foremen were also not enabling an environment where crew members would raise questions. Such practices did not help the crew members fully orient toward the work. In one of the interviews with a sub-crew in Case SAFFRON, they opined that *'the foremen provide us with the instructions about what needs to be done for the week/day…we will follow it…if we get any questions or need more clarity about the work, we shall figure it out ourselves or ask him when we need more clarity'*. When the researcher asked the sub-crew whether providing more clarity or asking more questions before executing a particular (complex) work helps – the sub-crew commented that *'it may help…but we do not have these collective discussions'*. However, in Case GREEN, the foreman was instructive, and he demonstrated the laying of bricks in complex construction joints to the crew members. During one of those demonstrations, the researcher noted that the foreman explained how to read the drawing of a complex construction joint and physically demonstrated it by laying bricks to the crew members. He commented, *'rather orally given them with instructions, I demonstrate it'*. There was no discussion if the crew members entirely understood how to execute the particular work. This set of evidence provides mixed observations regarding crew orientation. The crew foremen in the Indian context are instructive and do not practice collective orientation of crew members through meetings & site visits – either formal or informal.

An important aspect of crew orientation observed in the Australian context was the discussion around the productivity of sub-crews and crew members. As mentioned, the leading hand in the Australian context gathers productivity data of sub-crews/crew members, and the foremen discuss productivity improvement needed in the crew-level meetings. In all the case studies conducted in the Indian context, it was observed that there was no discussion about productivity at the crew level. The foremen maintained day-wise attendance details on the number of crew members present and their respective daily work hours. While the productivity of crews was discussed in the site-level meetings among the project manager and the site/construction engineers, these discussions do not penetrate until the crew level. Since the crew members are paid on a daily wage basis (not based on the amount of work done), the foremen do not have significant discussions about the productivity of their sub-crews/crew members to them. However, during discussions with the crew members in the Indian cases on this aspect, it was observed that the sub-crews/crew members would like the foremen to have conversations on the amount of work that needs to be done for the day to achieve the milestone activities as per the schedule. One of the crew members in Case GREEN commented that *'we work for 12-13 hours a day…we do not have much idea about how much work needs to be done on a given day to achieve the milestone activity…it would be better if the foreman or the leading hand orient us with the larger targets too rather providing us with only daily targets'*. However, one of the challenges that was observed in the Indian context is the relatively large sizes of crews with varied nature of skill levels. This posed a greater challenge for the foremen to attain better crew orientation than the Australian context. The following comment by the foreman of Case SAFFRON captures it *'orienting them, making them understand the larger milestones of* *the project, and orient them to coordinate is a tough task effectively…rather I would mention (instruct) them what to do on a day-to-day basis'*.

Concerning the development of shared mental models among the crew members (as depicted in Figure 6.18), it has been observed that in the Indian context, understanding the team task was crew-centric. The crew foremen played a major role in the following aspects: upkeeping knowledge of the methods and technologies used to accomplish the task; understanding of the team members' roles, responsibilities, needs and dependencies, and knowledge of team members' skills, attitudes, strengths and weaknesses. It was observed that knowledge about methods and technologies to accomplish the task and knowledge of crew members' skills and capabilities were not crew-centric but foremen-centric. While the foremen oriented the crew to gather an understanding of the task and crew members' skills and capabilities, it was driven solely by him and not through a collective understanding of the crew.

Systematic orientation about specific construction methodologies and technologies to the crew members by the foremen/leading hand/site engineers was necessary for the Australian context. However, in the Indian context, the practice of systematically orienting crew members about new construction methodologies and technologies was not observed. For instance, while the usage of iPads on construction sites by the leading hand and the demo sessions provided by the leading hand to the crew members were found helpful in the Australian context, such instances were not observed in the Indian context. In all the case projects studied in the Indian context, the construction/site engineer uses digital facilities (such as smartphones or iPads) to visualise the construction elements to understand interfaces better and display that to the crew foreman. The crew foreman, in turn explains that to the leading hand and sub-crews only with manual drawings and not with any digital devices. Orientation of crew foremen about such technologies, which would be helpful to the crew members, was not observed in the Indian context. The workers' education and skill level play a role in this situation, but the foremen can perform an active role in orienting workers to newer work processes. During one of the discussions with a crew member in Case WHITE, he commented *'I would like to see the 3D views of the construction elements which we are constructing…while our foreman sees it in the engineer's smartphone, we do not see it…while I can feel that it is not their deliberate action to not to show it to us, the practice is that we hear it from the foreman'.* This specific comment by a crew member provides a view of how challenging it is to develop a shared mental model about work in the Indian context, substantiating the observations made.

Cross-learning best practices between sub-crews/crew members and facilitation of the same by the foremen are found to be an effective means of instilling a positive attitude towards work. While the best practices are discussed at the site level between the construction/site engineers and the foremen, it was not found to have been discussed at the crew level. It was observed that crew members were not rewarded/get incentives considering their productivity and the best practices they display. The practices of rewarding and providing incentives to the crew members (as observed in the Australian context) in the Indian context can instil a positive attitude towards work. This would further orient them better in the workplace. Based on the analysis, Table 6.15 below shows the number of instances of occurrence of each of the crew orientation dimension in Indian cases.

Table 6.15 No. of instances of occurrence of crew orientation dimensions in Indian cases

S. No	**Crew orientation dimensions**	**No. of instances of occurrence**
1	Having regular crew meetings	37
2	Making frequent site visits and providing feedback	61
3	Developing shared mental models	25
4	Orienting a positive attitude towards work	22

6.6.4.3 Comparison of Australian and Indian Cases

As discussed, crew orientation was achieved through orienting crew members during meetings, during site visits made by the foremen, development of shared mental models, and initiatives taken to develop a positive attitude/orientation towards work. While crew orientation through formal and regular crew meetings was observed in the Australian cases, crew meetings were largely informal and were not structured to orient crews in the Indian cases.

Regular site visits and providing timely feedback by the foremen were observed in the Australian and Indian cases, however, the foremen in the Indian context were not utilising site visits and feedback sessions as a means to orient the crew members. The foremen largely remained instructive with less exchange of ideas that would otherwise result in better crew orientation. While development of shared mental models through demonstration of work and use of digital devices in the workplace were observed in the Australian cases, limited involvement of foremen in these areas was noted in the Indian cases. Analysing crew members' performance and devising appropriate incentives based on performance resulted in creating a positive attitude towards work in the Australian context. However, limited observation of providing incentives and sharing of crew members' best practices was noted in the Indian cases. Table 6.16 summarises the crew orientation dimensions in the Australian and Indian contexts.

Table 6.16 Crew orientation dimensions in the Australian and Indian context

S. No	Crew orientation dimension	Australian context	Indian context
1	Having regular crew meetings	• Orientation through regular crew meetings • Meetings as a means to provide crew orientation • Meetings are largely formal	• Crew meetings are not structured & regular aiming orientation • Meetings are largely informal

Continued in the next page

2	Making frequent site visits and providing feedback	• Regular site visits • Repeated instructions that provide work orientation • Crew members ask specific questions to foremen • Providing timely feedback	• Regular site visits • Providing timely feedback • Foremen remain largely instructive rather exchange of ideas
3	Developing shared mental models	• Shared mental model through demonstration of work • Use of digital devices to develop shared mental model	• Limited involvement of foremen to develop shared mental models • Use of digital devices is limited with crew members • Foremen remain largely instructive
4	Orienting a positive attitude towards work	• Analysing productivity of crews and accordingly devising incentives • Sharing best practices of crew members in meetings	• Incentives are not provided to crew members • General best practices are shared by the foremen

6.6.5 Communication

Effective communication among team members is substantial for good team performance. Communication issues would arise due to ineffective means of sharing information, ineffective meetings, and language differences within the project context. Effective use of digital platforms would also improve communication among different stakeholders in projects.

6.6.5.1 Communication Dimensions in Australian Cases

In all the case project sites studied in the Australian context, toolbox meetings (TBMs) and daily start-up meetings (DSMs) played a significant role in promoting the effective communication of information and knowledge among the crew members. As mentioned before, TBM is predominantly a safety meeting/talk organised by the head foreman and safety officers. In TBMs, every safety-related crucial information is communicated to the team members, which includes topics related to workplace hazards, ensuring complete usage of personnel protective equipment (PPEs), required safety training for the upcoming site activities etc. Also, as discussed before, in TBMs, project-related information such as project progress (whether the project is on-time/behind schedule/ahead schedule), quality-related information, materials movement and inventory, approvals from project client, main contractor/consultants, and management-related tasks pertaining to site activities are also shared and discussed by the crew foremen. In this way, TBMs enable communication among project team members as it provides workers to voice their concerns related to their daily site activities and not just pertaining to the dissemination of safety-related information alone.

In Case KHAKI, the head foreman Gav considers TBMs as a means to improve worker engagement. His opinion is that one of the best ways to improve worker engagement is through *practising collective decision-making* for any issues pertaining to the management of site activities. He observed *'I always believe in collective decision making…TBM is a place where I can practice this'*. He opined that *'I am here to solve their problems so why not by involving them'*. Through direct observations made by the researcher in Case KHAKI's TBMs, it was observed that the head foreman Gav always had a detailed agenda and was specific about the topics he wanted to deliberate and discuss in the TBMs. Apart from safety-related information, he discusses the overall progress of the project and other project-related discussions. In fact, the introduction of the researcher was carried out in one of the TBMs by the head foreman. He had thoroughly explained the aim and objectives of the researcher to the project team. Thus, he also took informal consent from the project team members, as they are respondents to the researcher's project.

Craig is a leading hand in Case KHAKI. He has 10+ years of experience in supervising brickwork construction activities. As per the head foreman's understanding, Craig displays fine communication and technological skills. He uses iPad to communicate effectively with his team members, which he believes is an effective medium of communication. He uses iPad to show the various colours and patterns of brickwork involved in the different parts of the case project to his team members. This helps the team members to understand and appreciate the complexity of the brickwork patterns in the project. Craig always expresses his opinion that *'iPad makes our job easier'*. Craig mentions this often during his discussion with his team members and motivates them to start using iPads, as it facilitates effective communication. Craig also utilises 3D models to compare the built-in structure of the 3D models vs other models.

To track the daily progress, Craig counts how many bricks were laid by his team members in different parts of the project on a day-to-day basis. During this activity, he also monitors the quality of work execution and reports it (along with project progress) to the head foreman. Craig's report helps the head foreman to summarise it and provide directions to the masons and helpers during the TBMs or in the DSMs. As mentioned earlier, TBMs and DSMs act as a good channel for communication in the project sites. Such specific inputs by leading hands and head foreman during the TBMs and DSMs are useful to improve team performance, as observed in Case KHAKI.

With regards to progress monitoring, in Case KHAKI, a software application (used in their iPads/mobile phones) was used to record the physical work progress. The application provides progress scores on a day-to-day basis. Whenever there is a decline in the progress score, the head foreman of case KHAKI communicates with the project team and learns the cause behind the decline. He further reaches out to the builder (project client) if there are any discrepancies. Practices such as information gathering by the leading hand and head foreman of the crew, and reporting it to the project level team members (project main contractor/project client) were observed in all the Australian case projects studied. These communications also included appropriate site pictures supporting the escalated issues. The supporting pictures were considered as evidence for the issues escalated and facilitated a complete communication. The leading hand and the head foremen of the case projects always have reminded and ensured that the project teams communicate the issues with evidence collected through documents and pictures. This collectively improved communication in the case project.

'Language barriers' is a significant element that influenced effective communication in the studied case projects. The construction industry in Australia is one of the most culturally diverse industries. 52% of construction workers are born overseas and another 39% are born in non-English speaking countries (Australian Bureau of Statistics 2022). In all the case projects studied in the Australian context, a significant percentage of workers are represented from overseas. These migrant workers represented countries such as the UK, Italy, Spain, China, Lebanon, and Philippines. A significant proportion of these workers also represent non-English speaking countries such as China and Lebanon. During one of the instances in Case KHAKI, there was a need for high coordination with a scaffolding crew who wanted to dismantle the formwork shutters, so the brickwork crew would carry out their work in the area. The brickwork crew found it difficult to communicate and work with the scaffolding crew, as they were from a non-English speaking country. One of the brickwork crew members opined, '*I tried speaking to them through some sign language, but I could not communicate fully…it is also a matter of safety, so I needed to be careful in terms of communication*'. Following this incident, the leading hand stepped in and spoke to the foreman of the scaffolding crew and resolved the issues. In Case ATROUS, there was a mix of crew members from Australian and Lebanese backgrounds. Here, the crew foreman acted as a cultural gatekeeper as he was Lebanese but settled in Australia for about 10 years. He can understand and appreciate both cultures. He opined that, '*I always mix Australians and Lebanese when I make sub-crews for specific tasks…while I have the option of not mixing them, I do not prefer to do it…I do not want them to be in a comfort zone, particularly the Lebanese workers…unless they learn and* *appreciate the culture of this ground, they are not going to work effectively…*' He continued saying, '*if there is any potential problem that I can foresee when they work together, I will immediately step in and make the communication clearer between them*'. Studies indicate that situation of communication barriers is not only about language but the interpretation of instructions, and understanding of signals which will lead to an accident and low performance of crews (Kuoribo et al. 2022). Differences in language and cultural identities result in miscommunication, poor teamwork propensities, conflicts, scapegoatism, and low morale among team members (Kuoribo et al. 2022).

To aid better communication among the project site people, one of the best practices that was observed in every case in the Australian context is the 'builder's brief form' posted in the entry and prime locations of the site. Builder's brief is a daily site brief post that summarises important work activities that will be carried out for the day (which includes significant formwork erection, dismantle, demobilisation, hoist erection, major concreting etc,), and the detailed safety steps that need to be followed when such significant activities are undertaken. It also includes information related to housekeeping, induction meetings, PPE instruction, first aid arrangements, smoke break instructions, site shutdown/closures etc. These communication systems promote better teamwork at the project site level. Information briefed in the builder's brief is further disseminated in daily pre-starts by the crew foreman. The foremen of the project sites receive copies of the builder's brief, apart from it being posted in different locations on the site.

The practice of *caucus meetings*, informal short meetings to discuss specific things with specific crew members was followed in Cases LIARD and KHAKI. These caucus meetings helped crew members gather an understanding of the specific tasks that they need to know before they execute a unique task. In the caucus meetings, the foreman of Case KHAKI repeatedly said, '*listen and follow the instructions…if you don't understand or are unsure of* *something, ask the questions…let us know what you think is right or wrong*'. He opined '*all the crew members need to understand the things in a similar manner…communication gets completed only when I observe that they all understood things in a similar manner*'.

Based on the analysis, the dimensions of communication include regular meetings, language barrier, use of technology for effective communication. Table 6.17 below presents the number of instances of occurrence of each of the dimension in Australian cases.

Table 6.17 No. of instances of occurrence of communication dimensions in Australian cases

S. No	**Communication dimensions**	**No. of instances of occurrence**
1	Regular meetings	57
2	Language barrier	72
3	Use of technology for effective communication	40

6.6.5.2 Communication Dimensions in Indian Cases

In the Indian case projects, the conduct of structured and regular toolbox meetings (TBMs) and daily start-up meetings (DSMs) is not observed. The crew foremen organise informal meetings at the start of the day with the crew members to convey the work plan for the day. In these meetings, issues related to materials arrangement and transportation and equipment arrangements are also discussed. However, these are largely monologic meetings (one-sided) where the foreman conveys what is expected from the crew members for the day. There are formal site meetings conducted at the project level on a day-to-day basis; however, the participation of foremen in these meetings is not regular. The site engineers attend these morning meetings at the project level (organised by the site project manager) and disseminate the required information to the concerned foreman through a top-down flow of information and instruction. Typically, these daily meetings are conducted in the project site offices and last about 15-20 minutes. All crucial information related to project safety is communicated in these meetings, along with discussion related to completion status of different milestone activities is also discussed. These include discussion about daily targets, weekly targets, work crews' productivity, materials and equipment arrangement, and quality-related issues if any. While site engineers voice their concerns during these daily meetings, the meetings are mostly monologic and hierarchal in quality, with the project manager conveying the expectations and discussing the daily and weekly targets.

There are also weekly meetings conducted at the project level, as observed in all the case projects studied in the Indian context. Again, the weekly meetings are conducted at the project level between the project manager (along with the site planning manager/team) and the site engineers. The weekly meetings last for about 45 minutes to 1 hour. Here, detailed discussions on all project-related issues are carried out, including review of weekly targets, issues related to the management of resources (materials and equipment availability and transportation), the productivity of crews, and quality and safety-related issues. While it is not mandatory for site foremen to attend these meetings, available site foremen participate in the meetings to voice their concerns, if any. During one of the interviews with the site foremen in Case SAFFRON, he said, *'I would like to attend these weekly meetings…I would like to voice my concerns to the forum…while the site engineer conveys to me what they discuss in the meetings, I believe direct communication and participation help'*. While regular and structured crew-level meetings such as TBMs and DPS are common in the Australian context, in the Indian context, informal daily meetings by the crew foreman and weekly meetings at the project level are more usually observed. There is no observation of regular and structured meetings at the crew-level conducted in the Indian case projects.

In all the case projects studied in the Indian context, using gadgets to enhance the visualisation of project activities is not so common among construction trade crews. While the project site engineers use their smartphones to show the 3D views of project elements to the site foreman, the practice is not widely observed, as noted in the Australian context. While visualisation helps provide complete communication of what needs to be executed as per the drawings, the practice of using gadgets among construction crews is yet to gain momentum in the Indian context. However, the crew members in India are attracted to the use of devices, as corroborated in one of the interviews with a crew member in Case GREEN, where he commented *'it helps us if they show us the 3D views of the brickwork that we are executing…while we do site marking based on the drawings provided, 3D view lets us know how it will look like once constructed…it encourages us'*. Once the crew members make such visual observations, they gather a collective understanding of the tasks that need to be executed, which in turn and by extension improves interpersonal communication between them.

To keep track of the day's progress, the leading hand of the crew provides details on how much physical work has been carried out for the day. For instance, in the Case SAFFRON, the leading hand provides details about how much rebar has been cut and bent and the number of reinforced columns for the day. The leading hand passes this information to the site foreman and the foreman conveys this to the site engineer. The site engineer, in turn, compiles it and passes this to the project planning manager, who updates the status to the project manager. As illustrated by the flow of work described, multiple and multi-level handling of information is observed in such cases. While software applications have been put into practice in the Australian context for tracking daily work progress where the foreman directly feeds the data in the application, such practices are not prevalent in the cases studied in the Indian context which relies more on manual inter-personal communication. Communication of project progress-related information is crucial in projects and to this end manual handling of information needs to be digitised. This corroborates the literature findings which indicate that construction sites' information is not documented, making it difficult to analyse and monitor the activities at work sites making the availability of information and its communication a challenge (Samanta and Gochhayat 2021).

Similar to the Australian context, language barriers influence effective communication among construction crew members in the Indian context. The construction industry in India is also culturally diverse, like the Australian context, however in a distinct way. The Indian construction industry employs a significant number of migrant construction workers. The migrant workers are internal migrants from different parts of the country. About 95% of the construction workers in India are internal migrants (Loganathan and Kalidindi 2016). The migrant workers largely represented different Indian states such as West Bengal, Bihar, Odisha, Uttar Pradesh, Jharkhand, Andhra Pradesh, Telangana, and Assam (Loganathan and Kalidindi 2016). Although 'Hindi' is the common language spoken on construction sites in India, workers representing a particular state speak the state's local language. For instance, a crew from West Bengal speaks the 'Bengali' language within the crew. This situation (where a crew was representing a particular state speaking the local language of that state) is widely observed in the case projects studied in the Indian context. While this has some advantages, it becomes a language barrier when the crew members do not speak and understand other languages, especially 'Hindi'. For instance, in Case WHITE, the site foreman and the site engineer can speak 'Hindi'. However, only some crew members in the crew could speak 'Hindi' as most of them speak 'Bengali', causing communication-related issues. Consequently, at times the site foreman and site engineer had to communicate through sign language. In another instance, in Case GREEN, the site engineer could not speak 'Hindi' fluently; however, the crew members could speak 'Hindi'. The site engineer found it difficult to instruct the crew, causing supervision issues. The particular site engineer commented, *'since I am unable to speak Hindi* *fluently, I find it hard to communicate with the workers…it becomes an issue when they cannot follow my instructions and priorities…'*. The language issue has also resulted in quality-related issues and rework. The site engineer continued, *'there was one complex brickwork joint…the foreman mentioned to me that he could understand the drawing…while I tried explaining it to him in Hindi, I could not explain it completely…he said he could follow it…however, when they executed the work, it did not come out as per the drawings, so we demolished it…I had to invite another site engineer who could communicate with them well and resolve the issue'*. This highlighted the communication issue about the absence of a shared language between the site engineers/supervisors and the crew members. While the presence of a common language for communication was better in the Australian context, issues with the lack of shared language in the Indian context make it difficult to disseminate and interpret information at all levels.

Based on the analysis, Table 6.18 below shows the number of instances of occurrence of each of the communication dimension in Indian cases.

Table 6.18 No. of instances of occurrence of communication dimensions in Indian cases

S. No	Communication dimensions	No. of instances of occurrence
1	Regular meetings	29
2	Language barrier	69
3	Use of technology for effective communication	25

6.6.5.3 Comparison of Australian and Indian Cases

Crew meetings, language barriers, and the use of technology for effective communication were the communication dimensions discussed in the Australian and Indian cases. In the Australian context, TBM and DPS were formal crew meetings conducted in a regular manner. Informal caucus meetings were also conducted by the foremen during field visits, in Australian cases. In the Indian context, meetings were largely informal between the crew members and the foremen.

The presence of immigrant and migrant construction workers in the Australian and Indian contexts posed language-related issues. While the presence of a common language was noted in the Australian context, the absence of a shared language posed considerable language-related issues in the Indian context.

The use of gadgets such as iPad by crew foremen and leading hands was observed in the Australian context. This resulted in effective communication of drawings using 3D models and digital analysis of information. In the Indian context, the use of smartphone was observed only at the site engineer level, and no use of gadgets was observed at the crew-level. Table 6.19 highlights the dimensions of communication as observed in the Australian and Indian contexts.

Table 6.19 Communication dimensions in the Australian and Indian context

S. No	Communication dimension	Australian context	Indian context
1	Regular meetings	• Daily prestart (DPS) and weekly toolbox meetings (TBM) are conducted at the crew-level • Meetings are formal • Informal caucus meetings conducted during field visits	• Daily start-up meetings between the site foreman and crew members • Weekly meetings between site engineers and project manager • Meetings are largely informal

Continued in the next page

2	Language barrier	• Presence of immigrant construction workers • Issues with cultural connectivity • Presence of common language	• Presence of migrant construction workers • Absence of shared language
3	Use of technology for effective communication	• Use of gadgets such as iPads by leading hands and site foremen was observed • Construction site information documented and analysed digitally	• Use of smartphone by site engineers was observed. No use of gadgets at crew-level • Manual handling of information

6.6.6 Mutual respect and trust

Unlike a permanent organization, construction workers are often temporarily employed and constantly change their worksites once current project is completed; this leads to a lack of shared identity and mutual trust between workers and the project organization (Liang and Zhang 2019; Choi et al. 2017). The study identified four dimensions with respect to mutual respect and trust among construction crews and workers. The dimensions include the use of foul and derogatory language, establishing dominant and bullying behaviours at the workplace, disclosing opinions, and sharing experiences, and recognition of workers and crews.

6.6.6.1 Mutual Respect and Trust Dimensions in Australian Cases

Usage of foul and derogatory language is still prevalent on construction project sites (Adinyira et al. 2020). In a study by Arditi et al. (2013) in Sweden's construction industry, it was found that foul language used on construction sites was particularly considered a major reason why there are few females in the construction industry. The use of foul and derogatory language in the workplace can be viewed as unethical behaviour, displaying a lack of mutual respect among co-workers (Adinyira et al. 2020). In one of the interviews with the leading hand in Case KHAKI, he mentioned that two of his crew members did not go well with each other due to issues related to mutual respect. He elaborated that, '*initially one of the crew members was continuously using foul language with the other one…over time, both were using foul and vulgar language which was not acceptable to other crew members…the other crew members bought this to me, and it resulted in shuffling them to different locations (to different floors) in the workplace*'. He mentioned that, '*it is an industry where you see multi-cultural workforce…some people take it very offensive when they find issues related to improper use of language…there were instances where workers have left the work due to issues related to respect…it is required to follow basic discipline with respect to use of language*'. In another instance in Case ATROUS, the foreman mentioned that, *'one of the crew members reported to me and to my manager in the head office about the issues he has with another crew member…my manager instructed me to transfer the troublesome crew member to a different project'*. He elaborated saying, '*sometimes I need to act like a headmaster to manage these school kids…these are merely respect-related issues arising out of some cultural differences*'. He mentioned that, '*while companies are taking efforts to overcome cultural differences in the workplace, it takes significant time and effort to overcome such issues…it also requires good training'*.

Establishing dominant and bullying behaviours at the workplace was also found to cause issues related to mutual respect in the workplace. According to Einarsen et al. (2002), workplace bullying can be defined as *harassing, offending or socially excluding someone*. In one of the interviews with a crew member in Case ATROUS, the crew member pointed out his leading hand and said that, '*he is so dominant in the workplace…he does not care what others speak…he says what he wants to say and leaves the place*'. He continued saying *'most of our crew members are not happy with his behaviour…this exhibits lack of respect…when you do not treat your workers with respect, they are not going to perform as you expect'*. These statements clearly indicate why companies should encourage practising good behaviours at the workplace, and how it can influence good teamwork and performance. In a different instance in Case LIARD, ostracising group behaviour was exhibited by a particular sub-crew. The sub-crew displayed dominance among the apprentice/trainee workers who represented different cultural backgrounds. This resulted in the development of needless groupism and issues among the crew members in the workplace. The leading hand and the foreman of Case LIARD had to intervene and ease out the conditions. The foreman elaborated saying, '*we need to fix such issues as early as possible…otherwise, these issues would hamper creating a cohesive team at the workplace'*. He continued by saying, *'I need to finish this project with a unified crew …if there is bullying, we should take necessary actions and ensure that a good team culture is created, where everyone respects each other'*.

In Case KHAKI, experience sharing was found to be apparent among some of the crew members. During one of the group interviews with a sub-crew, it was opined that, *'we respect each other's experiences…we share how we dealt with project issues similar to what we are facing in this project…this sharing of experience helps'*. A close interpretation of the above comment provided by the sub-crew indicates that it starts with attaining mutual respect among the crew members. The foreman of Case KHAKI also opined that, '*to enable an environment of mutual respect and trust I need to be honest and 100% tell them the truth…tell them what's going on…it is what it is…and above all, tell same thing to everyone…only by doing this, you will develop and maintain trust with your mates'*. He further elaborated that, *'since construction project sites are multicultural, issues related to respect and trust are unavoidable…success lies in how early a cohesive team is developed by overcoming such issues'*. In a similar discussion with a leading hand of Case ATROUS, he pointed out that, *'we need to significantly consider workers' prior experience to solve issues in the present job'*. He continued saying, *'respecting their prior work experience is equally important to what they are doing in the present job'*. This connects to the recognition of workers and crews in project sites.

As indicated in the previous chapter (in Table 5.1), recognition of workers and crews is identified as an important teamwork dimension in the context of construction crews. Recognition of workers and crews includes regard/disregard of trade crews' suggestions/ideas, lack of recognition of good and efficient workers, disregard of crafts' productivity improvement suggestions, worker participation in decision-making, and receiving compliments for doing a good job. In Case KHAKI, the management of the organisation and the foreman were particular about recognising and rewarding crews and workers for displaying higher performance and better practices in the workplace. For instance, the foreman evaluates the weekly productivity of the project site towards the end of the week and rewards the crews and workers who have achieved beyond the weekly target. The rewards included complimentary dinner passes, movie tickets etc. These rewards and recognition motivated the workers. During one of the discussions with the sub-crew in Case KHAKI, the crew members pointed out that *'it feels good when you get recognised…the foreman here talks to the management and gets us some incentives when we deliver beyond the targets provided and when we display good work practices'*. The crew members elaborated saying, *'we discuss the best practices of the crews in our group meetings and in the weekly toolbox meetings…the foreman and the leading hand observe best practices followed by different people in the workplace and mention them in the group meetings…it provides recognition to your team…it also provides recognition to individuals'*. Similar recognition and reward activities were also observed in Case ATROUS and Case LIARD.

The foreman of Case ATROUS opined that 'respect starts with listening to your workers'. He elaborated saying, 'to enable an environment of mutual respect and trust, active listening to your worker's and crew's suggestions and ideas are important'. Construction foremen should create a workplace culture where workers come forward and provide their ideas and suggestions. Previous researchers have indicated that authoritarian leadership is usually prevalent among construction trade crews (Oglesby et al. 1989; Shohet and Laufer 1991). However, recent research indicates that the present workforce does not accept directions from the manager without knowing the basis or reasons behind the decision (Yap et al. 2020; Nickdoost et al. 2022). The present workforce looks for inclusive leadership where they look for collaborative work culture rather than an authoritarian leadership. Corroborating this, the leading hand in Case LIARD has indicated that, 'it is about listening, appreciating and providing opportunities for workers'. He elaborated saying, 'as a crew leader if I can enable such a positive work culture, I believe workers will remain motivated and perform better'. Studies have also indicated that lack of mutual respect trust and respect leads to unethical behaviour such as bullying or harassment (Nickdoost et al. 2022).

Based on the analysis, the dimensions of mutual respect and trust include foul and derogatory language, establishing dominant and bullying behaviours in the workplace, disclosing opinions and sharing experiences, and recognition of crews and workers. Table 6.20 below presents the number of instances of occurrence of each of the dimension in Australian cases.

Table 6.20 No. of instances of occurrence of mutual respect and trust dimensions in Australian cases

S. No	Mutual respect and trust dimensions	No. of instances of occurrence
1	Foul and derogatory language	42
2	Establishing dominant and bullying behaviours in the workplace	37
3	Disclosing opinions and sharing experiences	54
4	Recognition of crews and workers	45

6.6.6.2 Mutual Respect and Trust Dimensions in Indian Cases

As mentioned before, the four dimensions of mutual respect and trust include using foul and derogatory language, establishing dominant and bullying behaviours at the workplace, disclosing opinions and sharing experiences, and recognising workers and crews. These dimensions are prevalent in the Indian context as well. As discussed before, foul and derogatory language is still commonplace on construction project sites, and it can be viewed as unethical behaviour and a lack of mutual respect among workers/crews (Adinyira et al. 2020). In the Indian context, as mentioned before, the construction workforce has workers with diverse education and skill levels. The workforce is typically categorised as *skilled, semi-skilled and unskilled workers*. The semi-skilled workers technically assist skilled workers and take up supporting jobs that demand technical skills. The unskilled workers are labourers who do transportation works (movement of materials, equipment, and other resources) and support skilled and semi-skilled workers as helpers. In all the case studies conducted in the Indian context, it was observed that unskilled workers are not treated with reasonable respect. In an interview with a site engineer in Case GREEN, he commented that *'unskilled workers are treated as slaves…while it is not good to use that word (slave), they are being treated that way'*. He elaborated, '*the skilled and semi-skilled workers act as bosses to unskilled workers…they assist them everywhere…at the workplace and also in the labour camps…'*. The mindset of treating unskilled workers merely as labour within the crew needs to change.

It was observed that foul and derogatory language was found to have been used more with the unskilled workers. During an interview with the leading hand of Case WHITE, he opined that *'skilled workers do not use good language with the unskilled labourers…while they may even share a similar background (with regards to the native place, community etc.) the culture of not treating unskilled workers with equal respect is prevalent in project sites'*. In this regard, the site engineer of Case WHITE opined that *'maybe it works with them that way…you need to be a bit more aggressive with your words to get things done from them…but I agree it needs to be changed'*. Not treating unskilled workers with equal respect is widely prevalent in the Indian context. Usage of foul and derogatory language, exhibiting dominant behaviour by crew foremen and skilled workers towards semi-skilled and unskilled workers is also equally prevalent in the Indian context. As mentioned, foremen and skilled workers behave *like tough bosses* towards their semi-skilled and unskilled workers. While industry and organisations should take steps to prevent foul and derogatory language, crew foremen should take initial steps in this regard.

During an interview with the foreman of Case SAFFRON, he commented that *'while I monitor and instruct my crew members not to use foul language, they are used to it'*. He continued by saying, *'it takes a lot of time and awareness to bring that change in them…I have been provided training (earlier in my previous site) on this…and that gave me an awareness'*. This particular comment from the foreman indicates that there should be awareness regarding the way of conduct, as most workers do not have a good educational background. However, formal training for workers is much limited or negligible in the Indian context.

Unlike in the Australian context, disclosing opinions, and sharing experiences by crew members within the crew or with the crew foreman was not formal and explicit in the Indian context. During a field observation in Case WHITE, the foreman recalled a particular construction methodology regarding façade installation to his crew members – *'you all may recall that we have utilised a similar approach in a project we worked on a year before…this project is similar to that'*. He tried enabling a discussion with the crew to check whether they could be able to recall the sequence of steps involved in that particular methodology; however it was observed that it was largely the foreman who explained the steps rather than a two-way discussion between him and the crew. In this regard, the foreman opined that *'while they know* *the methodology…they expect me to brief them…they are not forthcoming in sharing their experience'*. He further commented, '*in a way, it is better that I brief them the steps and demonstrate the steps if necessary to avoid rework…'*. In the same regard, a crew member opined that *'it is better that the foreman describes us what to do and how to do…while we have previous experience and can perform the task, it is best that he (the foreman) explains it to the group'*. These instances highlight that there is no open culture of sharing opinions and experiences; this is observed among the crew members and the foremen in the Indian context.

At the project level, it was observed that the foremen were not very participative in terms of opinions and sharing experiences with the site engineers/construction managers. In this regard, the foreman of Case GREEN commented that *'mostly the meetings we have with the site engineers/managers are one-way…they speak, and we listen…they talk about targets…how much work needs to be done for a given day for this week etc…while we know that it is not realistic to have such a target, we do not share our experience as they do not seek for it'*. He continued saying, *'my previous project was even more complex in terms of work execution…we also had tighter deadlines in that project…while I have that experience, it is not so valued here…'*. The foreman of Case SAFFRON also opined that *'learning from the foremen is not so prevalent in the sites…we execute the work in the ground; however our experiences are considered little compared to theirs…'*. In sum, it can be argued that site engineers/managers do not encourage foremen sharing their experience, and the foremen, in turn do not encourage crew members sharing their expertise. If these conditions can be improved, it can enable a culture of mutual respect and trust in the crews.

Special recognition of workers and crews with complimentary dinner passes/movie tickets or similar incentives for attaining higher production targets and displaying best practices were not observed in the Indian context. In the Indian context, it was observed that the wages of the crew members are primarily decided based on their skill levels. Skilled workers are paid higher compared to semi-skilled workers. Leading hands who manage sub-crews are generally paid higher than skilled workers. It was also observed that the foreman maintains varying skill levels to fix wages for their workers. There is no incentive mechanism for crew members who deliver more (achieve beyond targets) or display best practices. The foreman accounts for crew members who perform better (in terms of productivity, rework avoidance etc.) and increases their wage in periodic intervals, nevertheless, specific incentives are not provided to them. In a related discussion with a sub-crew in Case SAFFRON, they remarked that *'it would be good to receive some incentives when you perform more than the usual norm…however, it is not a practice here'*. In turn, the foreman of Case SAFFRON commented that *'I do not receive any incentives from the company, so how do I then can afford to provide incentives to my workers…'*. Recognising workers with incentives or compliments would also contribute to developing performing crews at work.

Based on the analysis, Table 6.21 below shows the number of instances of occurrence of each of the mutual respect and trust dimension in Indian cases.

Table 6.21 No. of instances of occurrence of mutual respect and trust dimensions in Indian cases

S. No	**Mutual respect and trust dimensions**	**No. of instances of occurrence**
1	Foul and derogatory language	49
2	Establishing dominant and bullying behaviours in the workplace	46
3	Disclosing opinions and sharing experiences	27
4	Recognition of crews and workers	29

6.6.6.3 Comparison of Australian and Indian Cases

The four dimensions of mutual respect and trust among construction crews as identified include the use of foul and derogatory language, establishing dominant and bullying behaviours at the workplace, disclosing opinions and sharing experiences, and recognition of workers and crews.

The use of foul and derogatory language and the display of dominant and bullying behaviours in the workplace were noted both in the Australian and Indian construction sites. While organisation-level training and awareness programs were found to have been initiated in the Australian context to eradicate such awful behavioural issues, such programs need to be appropriately devised in the Indian context. An encouraging culture of sharing opinions, experiences, and best practices among the crew members and facilitation of the same by the foremen was found to have enabled mutual respect and trust among crew members in the Australian cases. However, such practices are not prevalent in the Indian context. Recognition of crew members would help them gain respect, trust, and acceptance in the workplace. Table 6.22 summarises the dimensions of mutual respect and trust in the Australian and Indian contexts.

Table 6.22 Dimensions of mutual respect and trust in the Australian and Indian context

S. No	Mutual respect and trust dimension	Australian context	Indian context
1	Foul and derogatory language	• Prevalent on job sites • Training and awareness programs initiated	• Prevalent on job sites • Training and awareness programs needed
2	Establishing dominant and bullying behaviours in the workplace	• Prevalent on job sites • Training and awareness programs initiated	• Prevalent on job sites • Training and awareness programs needed

Continued in the next page

3	Disclosing opinions and sharing experiences	• Best practices discussed during crew meetings • Open culture of sharing opinions and experiences observed	• An encouraging culture of sharing opinions and experiences is not prevalent
4	Recognition of crews and workers	• Best practices recognised in crew meetings • Formal incentive systems are present	• No incentive mechanisms observed • Wages as per varying skill levels and productivity of workers/crews

The above discussions summarise how the various teamwork processes and their dimensions evolved within the case studies conducted in the Australian and Indian construction contexts. Table 6.23 below presents the comparison of the various teamwork processes across the six case studies.

Table 6.23 Cross case analysis

T m w k / C	C LIARD	C ATROUS	C KHAKI	C SA ROON	C WHITE	C GREEN
Crew leadership	• Regular crew meetings conducted • Feedback and incentive systems were present • Training of leading hands was present	• Regular crew meetings conducted • Feedback and incentive systems were present • Training of leading hands was present	• Regular crew meetings conducted and systematic training of leading hands & senior crew members conducted with extensive involvement of Foreman • Feedback and incentive systems were present & extensively used	• Crew-level meetings were not observed; only site-level meetings observed between engineers • Feedback and incentive systems were absent • Training of leading hands was not apparent	• Crew-level meetings were not observed; only site-level meetings observed between engineers • Feedback and incentive systems were absent • Training of leading hands was not apparent	• Crew-level meetings were not observed; only site-level meetings observed between engineers • Feedback and incentive systems were absent • Training of leading hands was not apparent
Mutual performance monitoring & backup behaviour	• Small talks were present • Backup behaviour observed • Caring for each other observed for work-related things • Buddy system was not observed	• Small talks were present • Backup behaviour observed • Caring for each other observed for work-related things • Buddy system was not observed	• Small talks were present • Backup behaviour observed • Caring for each other observed for work-related things • Buddy system was observed	• Small talks were not apparent • Backup behaviour, caring for each other and buddy system were observed for both work-related and personal things	• Small talks were not apparent • Backup behaviour, caring for each other and buddy system were observed for both work-related and personal things	• Small talks were not apparent • Backup behaviour, caring for each other and buddy system were observed for both work-related and personal things

Continued in the next page

Adaptability	• Flexibility on change in work roles and tasks observed with greater situational awareness	• Flexibility on change in work roles and tasks observed with greater situational awareness	• Flexibility on change in work roles and tasks observed with greater situational awareness	• Flexibility on change in work roles and tasks observed with greater situational awareness • Accommodated change in work roles and task demands on personal basis	• Flexibility on change in work roles and tasks observed with greater situational awareness • Accommodated change in work roles and task demands on personal basis	• Flexibility on change in work roles and tasks observed with greater situational awareness • Accommodated change in work roles and task demands on personal basis
Crew orientation	• Systematic orientation of crew members • Orientation on technological devices observed	• Systematic orientation of crew members • Orientation on technological devices observed	• Systematic orientation of crew members • Orientation on technological devices observed	• Informal orientation of crew members • Absences of technological orientation	• Informal orientation of crew members • Absences of technological orientation	• Informal orientation of crew members • Absences of technological orientation
Communication	• Language barrier was present; Intervention of Foreman observed • Use of technology to aid communication was lesser	• Language barrier was present • Use of technology to aid communication was lesser	• Language barrier was relatively less compared to other sites; Intervention of Foreman observed • Use of technology to aid communication was relatively better; Involvement of leading hand	• Language barrier was present • Use of technology to aid communication was lesser	• Language barrier was present • Use of technology to aid communication was lesser	• Language barrier was present • Use of technology to aid communication was lesser

Table 6.23 highlight a few instances where there is an apparent difference in which the identified teamwork processes are observed and evolved within the six case studies. For instance, with regards to crew leadership, while observation of formal and regular crew meetings and training of leading hand was noted in all three Australian cases, extensive involvement of crew foreman was noted for these activities in Case KHAHI.

6.7 GROUNDING THE CONCEPTUAL FRAMEWORK

Utilising Salas's big five teamwork model, the developed conceptual framework (as provided in Figure 5.9 in Chapter 5) identified teamwork processes as mediators and coordinating mechanisms. The developed conceptual framework identified crew leadership, mutual performance monitoring, backup behaviour, adaptability, and crew orientation as mediators teamwork processes. Shared mental models, communication, and mutual trust were identified as coordinating mechanisms teamwork processes. The present chapter utilised the identified processes in the conceptual framework as guiding tenets to ground the collected data from the Australian and Indian cases. However, on grounding the conceptual framework, it was observed that in the context of onsite construction trade crews, all the processes and coordinating mechanisms have emerged as mediators teamwork processes. The coordinating mechanisms not only ensure that the mediators are consistently updated with the relevant information throughout the team but also act as wider teamwork processes that independently facilitate the way crews work as teams. Accordingly, the modified teamwork processes include crew leadership, mutual performance monitoring and backup behaviour, adaptability, crew orientation, communication, and mutual respect and trust as emerged *teamwork processes*. A set of dimensions are also identified for all the emerged teamwork processes.

In the process of identifying the set of emerged teamwork processes, there was a merging of certain teamwork processes as dimensions within other teamwork processes. For instance, as discussed before, shared mental model is considered one of the coordinating teamwork mechanisms as per the proposed conceptual framework. However, during the analysis of the collected data, it emerged as a dimension within crew orientation, i.e., shared mental model act as a means of facilitating crew orientation within the studied crews. Accordingly, shared mental models is placed as one of the dimensions that facilitate crew orientation instead as a broader coordinating teamwork mechanism. Similar to shared mental models, the merging of other teamwork processes was discussed in the respective sections. By including the emerged teamwork processes, Figure 5.9 in Chapter 5, the developed conceptual framework is modified as Figure 6.19.

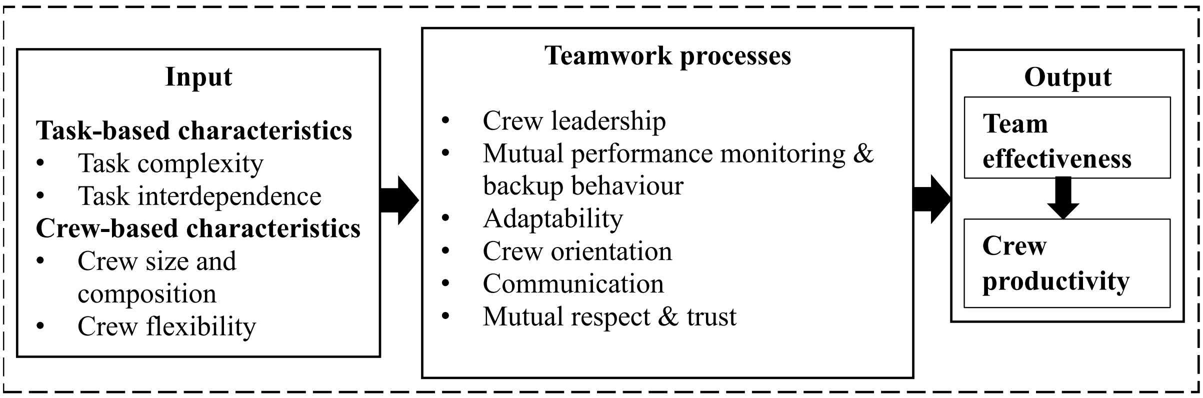


Figure 6.19 Teamwork processes of onsite construction trade crews – grounded framework

Figure 6.19 provides the grounded framework of teamwork processes and practices of onsite construction trade crews. As mentioned, the framework is grounded with the empirical data collected from Australian and Indian cases. In the context of synthesising the teamwork processes, a broader framework developed by Marks et al. (2001) was utilised by the present research. Marks et al. (2001) provide transition, action, and interpersonal processes as three broad categories of team processes. The framework developed by Marks et al. (2001) has widespread applicability to many team types within the mainstream organisational literature, and it is relevant in the age of digital/virtual teams as well (O'Neill et al. 2022; Larson and DeChurch 2020; Raghuram et al. 2019; Rosen et al. 2018). The present research further refined the broader framework provided by Marks et al. (2001) to suit the context of onsite construction trade crews. It was observed that the broader framework developed by Marks et al. (2001) is suited for production teams such as construction trade crews. Accordingly, the first two categories, transition and action processes, are task-focused that addresses behavioural activities and interactions aimed at planning and orchestrating team efforts towards task accomplishment (Grossman et al. 2017; Courtright et al. 2015). Interpersonal processes reflect relationship-focused behavioural activities aimed at managing interpersonal dynamics (Courtright et al. 2015; Madrid et al. 2018). In other words, transition and action processes can be termed as task-focused team processes that focus on how team members think and feel about their tasks, and interpersonal processes can be termed as relationship-focused team processes that focus on how team members think and feel about their fellow team members (Madrid et al. 2018; Chen and Kanfer 2006).

By utilising the above refined broad categories of team processes, crew leadership, crew orientation, and adaptability are classified under task-focused team processes. The reason for positioning crew leadership, crew orientation and adaptability under task-focused processes is that the dimensions of these processes are predominantly task-focused. For instance, the dimensions such as organising crew meetings, maintaining workloads and work timings of the crews, making site visits and providing feedback, developing shared mental models, exhibiting flexibility and promoting situation awareness are largely task-focused processes. Communication, mutual performance monitoring and backup behaviour, mutual respect and trust are classified under relationship-focused team processes. The reason for positioning communication, mutual performance monitoring and backup behaviour, and mutual respect and trust under relationship-focused processes is that the dimensions of these processes are predominantly relationship-focused. For instance, overcoming language barriers, overcoming issues related to using foul and derogatory language, establishing dominant and bullying behaviours, enabling experience sharing among crew members, recognising crew members' best practices, and establishing an environment of caring for each other among crew members and buddy system are relationship-focused processes. Therefore, the identified teamwork processes are then categorised as *task-focused* and *relationship-focused* teamwork processes. Figure 6.20 represents the developed framework indicating the task-focused and relationship-focused teamwork processes.

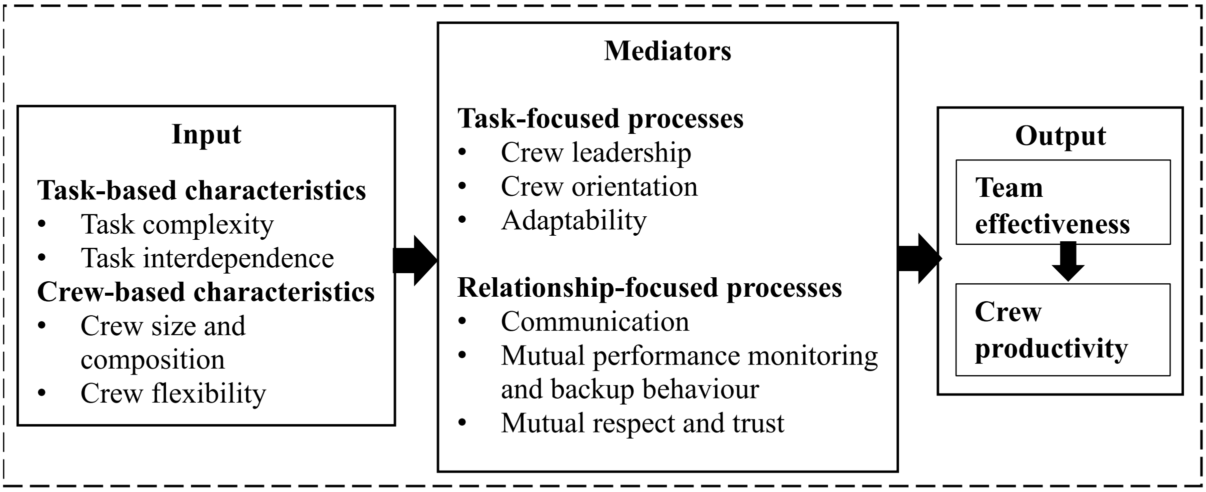


Figure 6.20 Teamwork processes of onsite construction trade crews

The developed framework establishes the teamwork processes of onsite construction trade crews. In further explaining the framework, Table 6.23 presents the teamwork processes and how it differs in exhibiting team effectiveness in the Australian and Indian context. In the case of crew leadership, while crew leadership enabled better team performance in Australian cases, it controlled the performance of teams in Indian cases. For instance, crew leaders in the

Australian cases devised a more organised work environment by practising structured work timings, conducting formal site meetings, and devised formal and transparent incentive mechanisms. There were formal feedback mechanisms and sharing of best practices. This enabled better team performance, and therefore the crew leaders largely exhibited coaching and supportive behaviour with their crew members rather than only monitoring and controlling their performance. In the Indian cases, crew leaders largely exhibited directive behaviour where monitoring and controlling crew members' activities were predominantly observed. Also, the absence of setting up an organised work environment by crew leaders with the absence of formal and transparent incentive mechanisms limited team effectiveness in Indian cases.

In the case of mutual performance monitoring and backup behaviour, while a sense of caring for each other was observed both in the Australian and Indian cases, a structured work approach facilitated the exhibition of formal work assistance (such as the buddy system) in Australian cases. However, in Indian cases, a more relational and informal caring environment was observed. Nevertheless, mutual performance monitoring and backup behaviour contributed positively to team effectiveness in both contexts. While organisations have started to address issues regarding work-life balance and mental health in the Australian context, there is limited discussion about this in the Indian context. Organisations in both contexts should aim to address issues regarding work-life balance and mental health as it directly contributes to improved team effectiveness.

In the case of adaptability, crews demonstrated flexibility in roles and tasks with greater situational awareness in the Australian context. Crew members in the Australian context enabled group discussions during challenging situations, and they sought help from each other with/without foremen facilitating it. Greater situational awareness and exhibiting flexibility at work contributed positively to team effectiveness. Re-distributing tasks during difficult conditions and heavy workloads, on-the-job training and role flexibility, contributed positively to team effectiveness in the Indian context. However, in Indian cases, these were primarily facilitated by the foremen and the leading hands. Being adaptable as a crew/team would enable greater team effectiveness (Rico et al. 2019; Maynard et al. 2015). Studies in organisational research also highlighted that adjustment in team roles, team structure or team coordination strategies influence team adaptation (Rico et al. 2019).

Table 6.24 Teamwork processes in the Australian and Indian context

Teamwork processes	Australian cases	Indian cases
Crew leadership	Crew leadership was largely enabling better team performance	Crew leadership was predominantly controlling the performance of teams
Mutual performance monitoring & backup behaviour	A structured work approach facilitated the exhibition of formal work assistance, such as the buddy system	A more relational and informal caring environment was observed
Adaptability	Crews demonstrated flexibility in roles & tasks with greater situational awareness	Crews demonstrated flexibility & situation awareness based on the demands of the job
Crew orientation	Orienting crews through regular meetings, technological devices, and incentives enabled better team performance	Informal meetings, limited technology & lack of incentives limited team performance
Communication	Regular formal meetings, the presence of a common language and the use of technology resulted in effective communication	Limited formal meetings, absence of shared language and limited use of technology resulted in communication issues
Mutual trust & respect	Formal recognition of best practices enhanced trust & respect. Training and awareness programs were initiated to overcome issues related to the use of good language and workplace behaviour	An encouraging culture of sharing best practices is not prevalent. Awareness is required regarding the use of appropriate language & appropriate workplace behaviour

Regarding team orientation, organisational researchers have highlighted that team orientation is critical to interdependent and task-oriented teams (Driskell et al. 2018; Driskell et al. 2010). Team orientation is likely to be salient in teams where members are highly interdependent; important task information is distributed across team members and teams whose tasks are marked by high levels of uncertainty or unpredictability (Driskell et al. 2010). In the context of the present study, i.e., in the context of onsite construction trade crews, crew orientation is discussed under the dimensions of conducting regular crew meetings, making frequent site visits, providing feedback to orient crews, developing shared mental models and orienting crew members with a positive attitude towards work. In this regard, in the context of Australian cases, crew orientation considerably influenced team effectiveness. Crew leaders and leading hands utilised meetings, site visits and feedback as a means to orient their crew members. Development of shared mental models, use of technology/digital devices, and sharing of best practices further enabled better orientation in Australian cases. In the Indian cases, crew leaders were observed to be largely instructive rather than collective in terms of orienting the crews. There is limited evidence in the Indian context with regard to crew leaders organising formal meetings, providing feedback, devising incentives, leveraging technology/digital devices, and sharing best practices to attain better crew orientation. Crew orientation was found to have positively influenced team effectiveness more in the Australian context than in the Indian context.

Communication directly influences team effectiveness. Complete and effective communication among crew members positively influences team effectiveness. Incomplete and ineffective communication negatively impacts team effectiveness. In the context of the present research, communication is discussed under the dimensions of conducting crew meetings, language barrier and use of technology for effective communication. In the Australian cases, systematic conduct of formal daily pre-start (DPS) and toolbox meetings (TBMs), the presence of a common language (English) and the use of gadgets/similar digital devices enabled effective communication, thereby improving team effectiveness. However, in the Indian cases, informal meetings, the absence of a shared language (due to the migrant workforce) and limited use of gadgets/similar digital devices (due to varied education and skill level of the workforce) resulted in communication-related issues. This limited team effectiveness in Indian cases.

Mutual respect and trust are discussed under the dimensions of using foul and derogatory language, establishing dominant and bullying behaviours in the workplace, disclosing opinions and sharing experiences, and recognising crew members. The use of foul and derogatory language and the establishment of dominant and bullying behaviour in the workplace were observed in the Australian and Indian cases. These negatively influenced team effectiveness. When crew members do not feel respectful and trustworthy, they do not maintain any positive relationships, which negatively impacts team effectiveness (Morrissette and Kisamore 2020; De Jong et al. 2016). However, when crew members maintain respect and trust, they perform well as a team (Morrissette and Kisamore 2020; De Jong et al. 2016). While sharing experiences and formal recognition of crews are observed to have positively influenced team effectiveness in Australian cases, the absence of such practices limited team effectiveness in Indian cases.

Overall, the above discussions summarised how the various teamwork processes and their dimensions positively and negatively influenced team effectiveness in the context of Australian and Indian cases. It can be noted that there are differences in the emergence and exhibition of teamwork processes and their dimensions in the context of

Australian and Indian cases. While the specific causes for the difference in teamwork processes and their impact on team effectiveness were elaborated in the above sections and subsections, there are wider contextual differences between these contexts. While the Australian construction industry is formally organised and representative of a developed economy, the Indian construction industry is largely informal and represents a developing economy. The next section describes these differences in the context of the present research.

6.8 COMPARING THE BROADER AUSTRALIAN AND INDIAN CONTEXT

Analysing and comparing the dimensions of teamwork processes in the Australian and the Indian contexts (as discussed in sections 6.6 and 6.7 of this chapter and as outlined in Table 6.23 in section 6.7), it can be argued that construction trade crews in Australia relatively displayed better teamwork performance than the Indian construction trade crews. The differences in team-based work practices in the Australian and Indian contexts can be analysed through the differences in the socio-economic and cultural conditions and the technological advancements in both contexts.

As mentioned before, the construction workforce in India consists of a significant portion of migrant workers. The engagement of construction workers in Indian projects can broadly be divided into three segments – the Naka/mandi segment, the institutional segment, and the intermediaries (labour sub-contractor) segment. The Naka segment refers to the marketplace that provides workers to small builders and petty contractors who employ casual labour for daily work. The Naka workers are usually paid on a daily basis. The workers who are directly employed by the construction organisations are referred to as an institutional segment of workers. Generally, large construction contracting organisations have this segment of workers. Organisations provide them with formal training and maintain them as a core group of workers who will be pipelined to their future projects. The institutional segment and the Naka segment are relatively small in size when compared to the intermediaries' segment.

Labour sub-contractors are usually referred to as intermediaries' segments, typically non-registered individuals or groups of individuals. Labour sub-contractors recruit workers (skilled, semi-skilled, and unskilled) from villages and towns. These workers who are predominantly migrant workers, come from different parts of the country to work on large construction projects in urban areas. Some of the crews consist of crew members who are their family members/extended family members, their community members who share the same religion/caste, and neighbours/friends. In most cases, the crew members are from the same village/town. The workers are informally recruited and engaged in the construction project sites. Construction organisations largely recruit workers through labour sub-contractors, and they are not provided with any formal training. They are informally managed by the labour sub-contractors.

The labour sub-contractors find difficulty in recruiting educated, skilled and experienced workers. Most of the workers are young, and the labour sub-contractors put them directly on project sites without any formal training and enable them to get trained by skilled workers. Most of the workers do not have adequate knowledge acquired about the construction work processes and practices. It is noted that there are significant challenges in managing the diverse workforce, which differ significantly in social and cultural aspects. The difference in education, experience, and skill level of workers contribute to how they organise themselves at work – which in turn results in how they display team-based work processes and practices among them.

On the other hand, construction workers in Australia largely consists of a skilled workforce. Workers go through formal training/certification before they join the industry. Construction organisations in Australia formally recruit and engage construction workers in job sites. There are skill training institutes that train workers in formal settings and provide them with certifications. This helps and supports workers to display better working practices on the job sites. Formal training and recruitment of the workforce, therefore, would make a considerable difference in the performance of workers in projects and organisations.

Formal construction training in Australia contributes to skill development, upgradation, and gain access to formal employment for trade workers. However, there is a lack of such formal training for the construction workforce in India. For instance, TAFE NSW (Technical and Further Education in New South Wales) is one of the largest vocational education and training providers in Australia. TAFE NSW provides an extensive range of construction trades courses for school leavers and career changers. Within building and construction trades, TAFE NSW has an extensive number of certification courses in areas such as stone masonry, formwork, steelfixing, flooring technology, plumbing, painting and decorating, and gas fitting, to name a few. The courses are structured at different skill levels, and career pathways are drawn accordingly. For example, Certificate I in Construction is a certification course for construction labourers and industry apprenticeships. Upon completing this course, an individual can join as a construction labourer who can assist a skilled worker/crew. Further, the individual can take up next-level courses and choose to be a part of a particular trade such as formwork, steelfixing etc. Such formal training provides individuals with the necessary technical and business education to take up jobs as they join a construction project site/organisation. Experienced construction workers also take up training to upgrade and upskill themselves with newer construction methods and technologies. Formal certifications would also help them gain recognition and work promotion in their organisation. In most cases, organisations also mandate workers to get certified in their trades as they take up jobs. As mentioned, such formal training and recruitment of the workforce make a considerable difference in the performance of workers in projects and organisations.

In the Indian context, as mentioned before, very limited formal training programs are provided to the workers. At the industry-level, there is National Skill Development Council (NSDC) and the Construction Skill Development Council of India (CSDC) by the Govt. of India. While the NSDC and CSDC develop and maintain national occupational standards, build training capacity, and provide certifications to the trained manpower as per NOS, the reach of these initiatives is very limited. While there are industry-level initiatives such as NSDC and CSDC, there are also organisation-specific institutes by a few of the large construction contracting organisations that formally recruit migrant workers and train and pipeline them for their projects. However, given the construction workforce's larger population in India, skill training initiatives are very limited, as discussed above. And similar to the Australian context, the training provided to the workers in India should encompass the work's technical, managerial, and technological aspects.

In line with the formal training and recruitment process, technological advancements in Australia are observed to be higher compared to the Indian context. The amount of mechanisation and automation in the Australian context is relatively higher than in the Indian context. Workers in Australia are equipped with accessible tools and devices that help them carry out work in an effective manner. There is access to and usage of digital devices in the construction job sites, which results in better communication and coordination of site-related processes. Such technological advancements facilitate effective team-based working in job sites. The absence of such technological and digital advancements is a limitation in Indian job sites. The differences in recruitment, training, and technological advancements in the Australian and Indian contexts, when looked through the socio-economic and cultural aspects of workers, help explain why teamwork processes and practices are relatively better in the Australian context.

While the present research is conducted in the context of Australia and India, it can be extrapolated to other contexts as these provide two different ends of the spectrum. For instance, while countries such as the United Kingdom (UK), the United States of America (USA), and other European countries represent developed economies, countries in the Asian and African continents represent developing economies. Therefore, the findings of the present study can be correlated and empirically verified in these contexts as well.

6.9 CONCLUSION

The present chapter grounded the conceptual framework with empirical data collected from the Australian and Indian cases. The grounded framework identified task-focused and relationship-focused teamwork processes that impact team effectiveness in the context of onsite construction trade crews. The identified task-focused teamwork processes include crew leadership, crew orientation, and adaptability. The identified relationship-focused teamwork processes include communication, mutual performance monitoring and backup behaviour, and mutual respect and trust. The following chapter concludes the research work. Chapter 7 summarises the research work, presents the key findings and establishes the theoretical, methodological, and practical contributions of the present research. It also discusses the key limitations and provides the future research directions from the work.

CHAPTER 7.

SUMMARY AND CONCLUSION

The present chapter summarises the research work and highlights the contributions and recommendations made based on the work. Section 7.1 summarises the work by highlighting the research gaps that were bridged by the study and how the study addressed the various research objectives stated in chapter 1. Section 7.2 presents the theoretical contributions from the study. Section 7.3 discusses the practical contributions of the study. Section 7.4 discusses the limitations with recommendations for future work.

7.1 ADDRESSING THE RESEARCH OBJECTIVES AND RESEARCH SUMMARY

The present research aims to provide a framework for analysing the influence of teamwork processes and practices of onsite construction trade crews on productivity. The following are the research gaps that were bridged by the study:

1. Though construction productivity is one of the most widely researched topics within construction management literature, the wealth of research on the influence of broader construction management practices on productivity, (Gurmu and Aibinu 2017; Bernold and AbouRizk 2010) contrasts the relative paucity of attention given to this aspect of trade crew work practices (Memarian and Mitropolous 2014; Mitropolous and Cupido 2009). In the first instance, the present study aims to unveil the influence of trade crew work practices on onsite construction productivity.

2. While a considerable amount of research has been conducted on construction project management teams, less attention has been paid to these onsite physical construction teams. Existing research in the construction labour productivity (CLP) area pays little attention to the importance of crews and teamwork in achieving improved productivity outcomes. There is subsequently a need to understand the mechanisms of teamwork, underlying the functioning of trade crews in physical onsite construction activities. The study aims to address this gap in knowledge.

3. The study aims to introduce concepts from the mainstream organisational psychology and management literature about crew related teamwork as a behavioural phenomenon. By so doing, it aims to develop a framework by merging the concepts of teamwork and productivity, in the context of onsite construction trade crews.

The present study aims to address the above-mentioned research gaps. Before summarising the research work, it is pertinent to present the specific research objectives that the present research investigated:

1. To identify and understand the work practices of onsite construction trade crews and their influence on productivity.

2. To develop a framework for team-based skills and behaviours for onsite construction trade crews by synthesising (a) construction labour productivity literature, (b) teamwork literature from the mainstream organisational and management literature, and (c) the identified construction work practices (*based on objective-1*).

3. To examine the team-based skills and behaviours influencing the productivity performance of onsite construction trade crews based on the developed framework.

The scope of the present study is limited to building construction activities. Given the labour-intensive nature of building construction activities, it provides a reasonably broad scope to study crew-based work practices, particularly examining the team-based skills and behaviours of onsite construction trade crews. The study is set in the Australian and Indian context as they cover the construction practices in developed and developing economies.

The present study follows the *qualitative paradigm* as the phenomenon of interest that the study aims to address is in the early stages of theoretical advancement. It is so relevant as with theoretical underpinning in the mainstream organisational and management literature, the present study aims to extend and refine theory in the construction context. Within the gamut of qualitative approach, *case study methodology* is chosen as an appropriate research methodology as it provides an in-depth understanding of the nature and complexity of the phenomenon under study in real-time settings. The present study uses a *multiple case study approach*. Within the multiple case study approach, a mixed-method approach to data collection and analysis strategy was adopted.

To address the first research objective, i.e., to identify and understand the work practices of onsite construction trade crews and their influence on productivity, an exploratory case study was conducted. The exploratory case study on a residential project compared a high-performing with an average-performing crew, in unveiling the influence of crew work practices on productivity. The former exhibited 44% higher productivity than the latter. It was found that work practices considerably influenced the productivity of each crew, as most other project and activity specific variables were relatively controlled by the virtue of the chosen research method. The high-performing crew was found to have adopted better work practices compared to the average-performing crew. The study identified five broad themes of work practices influencing this difference including: work preparation and execution strategy; group formation and stability; avoiding duplication of non-value adding tasks; crew social cohesion, and internal and external leadership.

Building on this, the mainstream organisational psychology and management literature was used as a vehicle to develop a framework for conceptualising the way that teams dynamically work together, in achieving productivity outcomes. This began with the identification of themes in the CLP literature that were categorised through the lens of crew teamwork. Along with the identified crew work practices (from research objective-1), the organisational psychology and management literature were then used to elaborate the teamwork processes – as captured in the developed conceptual framework. This addressed research objective-2.

To address the research objective-3, the developed conceptual framework is grounded in empirical data collected from the multiple case studies conducted in the Australian and Indian construction contexts. Three longitudinal case studies both in the Australian and Indian contexts were conducted. The findings from the case study were discussed and the developed conceptual framework in the previous stage (research objective-2) was modified accordingly. The grounded framework brings out the task-focused and relationship-focused teamwork processes that include crew leadership, crew orientation, adaptability, communication, mutual performance monitoring and backup behaviour, and mutual respect and trust.

7.2 THEORETICAL CONTRIBUTIONS

Existing research in the CLP area pays little attention to the importance of crews and teamwork in achieving improved productivity outcomes. By conceptualising crews in the context of team effectiveness, productivity performance can be more readily tested and understood. The major contributions of the study include the following:

1. The present literature on CLP identifies long list of isolated factors affecting CLP (Jarkas and Bitar 2012; Hasan et al. 2018; Hamza et al. 2022). The contribution from the present research is the identification of a synthesised set of work practices that considerably influenced the productivity of onsite construction trade crews. In stage1, the study identified five broad themes of crew work practices that influence productivity. These include work preparation and execution strategy; group formation and stability; avoiding duplication of non-value adding tasks; crew social cohesion and internal and external leadership. The identified work practices suggest that crews – as distinct from individual workers – can be seen as important when evaluating CLP.
2. The existing literature on CLP has not completely addressed the crew aspect of productivity management onsite. Productivity models developed so far have lacked explanatory power at a detailed level, in knowing how and where to improve performance. Existing literature on CLP has also paid little attention to the complexity of social construction, interactions, and interdependencies of crews, in explaining productivity (Dolage and Chan 2013; Chan and Ejohwomu 2018). In stage 2, by *conceptualising crews as teams*, their team-based work processes and practices were analysed. The mainstream organisational psychology

and management literature was used as a vehicle to develop a framework for conceptualising the way that teams dynamically work together, in achieving productivity outcomes.

3. Further in stage 2, the developed framework was empirically grounded to prove its contextual validity. The focus was therefore to capture the dynamics and context of construction crew teamwork, while concurrently testing the validity of the developed framework.

Teamwork, until now, has reminded as an under-utilised construct for explaining and rationalising the copious variables that impact CLP. For instance, in the construction management literature, there are so many individual variables (the present study alone identified 44 separate variables – as discussed in chapter 4) impacting CLP. This number of uncoordinated variables lacks parsimony and cohesion to the point of making them almost unmanageable in practice. For instance, it is difficult and impractical to individually manipulate each one, to improve CLP. This is especially the case because much of the work is subcontracted out, thus reducing the head contractor's ability to control/manage each individual group of workers. The main argument in this thesis is that this situation can be both simplified and therefore improved, by viewing teamwork as a mediating construct that captures and acts as a proxy for many of these variables identified in the existing CLP literature. By doing so, it offers a more parsimonious way that CLP can be realistically managed/manipulated in the field. Therefore, a key benefit of the developed framework is that crew teamwork can be used as a means of mediating what were previously many separate CLP variables.

Using the theoretical underpinning in the mainstream organisational and management literature, the present study aimed at extending and refining theory in the construction management context. By doing so, the study provided an alternate explanation for analysing onsite construction activities by suggesting modifications to established conceptualisations of construction trade crews. By conceptualising crews as teams, the heterogeneity of team-based skills and behaviours of crew members and their impact on productivity performance can be more readily understood. The developed framework views teamwork in the context of construction trade crews and onsite processes, and not the more common mindset of viewing teamwork as a professional or managerially focused phenomenon. Table 7.1 provides the summary of theoretical contributions.

Table 7.1 Summary of theoretical contributions

Research questions	Status of research issue in the extant literature	Contribution of research
1. What work practices do trade crews follow while executing their work? 2. Why and how do those practices emerge?	• Existing studies have largely focused on measuring productivity; less attention is paid to managing productivity. • Existing literature has inadequately addressed the 'crew' aspect of CLP. • Limited reference was made to the role of trade crews, their work practices & its impact on productivity – in productivity models.	**An addition** • The present study identified five broad themes of crew work practices that influence productivity • The study provided an alternate insight for analysing onsite construction activities by suggesting modifications to established conceptualisations of construction trade crews
3. Can we develop a framework to analyse the influence of crew work practices on onsite productivity?	• Lack of conceptual development on studying the crew work practices, specifically team-based work processes and practices	**An addition** • The present study conceptualised crews as teams • A framework was developed to analyse team-based skills & behaviours influencing the productivity performance of onsite construction trade crews • Contextualising Salas et al. (2005) Big five framework in construction • The developed framework was empirically grounded to prove its contextual validity

7.3 PRACTICAL CONTRIBUTIONS

The present study identifies specific work practices of onsite construction trade crews and their influence on productivity. While broader construction management practices were identified and utilised in practice, little attention was provided to practices at the trade crew level. The study identified a set of trade crew work practices that influence the productivity of construction trade crews. As mentioned, these work practices include work preparation and execution strategy; group formation and stability; avoiding duplication of non-value adding tasks; crew social cohesion; and internal and external leadership. While numerous studies in the past have identified extensive list of factors affecting construction productivity (Jarkas and Bitar 2012; Hasan et al. 2018; Hamza et al. 2022), the present study highlights the five broad theme of work practices that significantly influence trade crew productivity. These identified practices suggest that crews - as distinct from individual workers - can be seen as important when evaluating CLP. Also, it makes conceptual and practical sense to focus on work crew practices as a central and mediating variable, instead of a long list of isolated and disaggregated factors impacting productivity. It also offers a practical 'one-stop' means of implementing productivity improvement in a way that is inclusive of these factors but is also inclusive of a closer real-world understanding of people management onsite.

The identified work practices highlight the importance of devising work preparation and execution strategy at the trade crew level. While maintaining construction schedules for specific activities exists and is critical at project sites, the present study highlights the need for devising crew-specific planning and execution strategies for improving productivity. The findings also indicate the practical difficulties in developing purposeful sub-crews and allocating work for specific crew members with an intention to enhance their skills while taking care of current project priorities. The identified practices also highlight the need for developing a socially cohesive crew with clear managerial and leadership responsibilities allocated for crew members to manage inter- and intra-crew management activities.

The study also identified and compared specific teamwork processes and practices for the Australian and Indian construction contexts. The identified teamwork processes include crew leadership, mutual performance monitoring and backup behaviour, adaptability, crew orientation, communication and mutual respect and trust. The study practically highlights the need for crew leaders/foremen to enable team's performance rather than control team's performance. The practices emphasise that developing a more relational and informal caring environment and flexibility in assigning roles and tasks to crew members enabled greater performance. The study also highlighted the need for a formal work assistance system, such as the buddy system, to orient new crew members. The need to orient crew members through regular structured meetings and formal and informal site visits also helped improve crew performance. The identified teamwork processes and practices also help engineers and managers to systematically develop cohesive and high-performing crews.

The approach of viewing crews as teams also makes it more possible to divest teamwork responsibilities to subcontractors who can report to the head contractor, rather than trying to make the head contractor micromanage crew-level teamwork across the entire project. The study also highlights the importance of training construction trade crews. While social and behavioural training of construction professionals is prevalent in the industry, it is equally important to train construction trade crews on these aspects. Construction crew foremen and supervisors play a major role in enabling effective teamwork among construction trade crews. Therefore, it is important to training them on social and behavioural aspects. Foremen and engineers can develop team-based performance assessment and team-based reward and incentive systems for the crews. Training of construction trade crews in team-based work processes and practices is also equally important as training them on technical, technological, and engineering skills. Training of construction trade crews on these aspects would help improve the overall human resource management practices of the industry.

7.4 LIMITATIONS AND FUTURE WORK

The study was primarily conducted on building construction trade crews which included rebar placement, façade, and brickwork crews. The chosen study activities, the case study approach and the specific case study locations would pose inherent challenges in generalizing the findings. Also, as the study was conducted in the Indian and Australian contexts, steps were taken to carefully identify similar kinds of case studies and implement research in a similar fashion in both contexts. While English is the common language followed in Australia, translation of data collection templates into local Indian languages was carried out to gather data in Indian project sites. Hence, systematic exploration of this little-researched and less understood but evidently critical area using this carefully developed methodology helps provide direction for broader-based research and targeted testing in other trade activities and locations. Furthermore, findings from this study also point to new avenues for future research in construction crew teamwork theory and practice and the broader construction productivity literature. On this basis, the developed framework should be viewed as a basis for posing exploratory propositions to direct investigation into the dynamics of onsite construction crew teamwork and their influence on performance.

A potential direction of future research is to understand the role of larger organisational project contexts, within which teams operate. Research indicates that the organisational context in which a team operates plays a crucial role in its effectiveness and performance (Bell et al. 2018). For instance, at the project production level, construction work involves multiple and concurrent tasks that can create conflicting goals, constraints, and priorities (Memarian 2012). In larger organisational contexts, the role of human resource management systems (which includes performance assessment, rewards, and training), and the greater organisational design and culture play a direct and indirect role in the effectiveness of teams (Bell et al. 2018). Therefore, it is necessary to seek empirical evidence to understand the role of project and organisational contexts, on construction crew teamwork behaviour.

Another potential area of future research can aim to understand the temporal dynamic interaction and emergence of teamwork processes. As noted by mainstream researchers, team-level processes and outcomes are multilevel phenomena that emerge, bottom-up from the interactions among team members over time, under the shifting demands of a work context (Kozlowski 2015; Mathieu et al. 2018). Thus, the theoretical development that appropriately conceptualises the multiple levels, process dynamics, and emergence of team phenomena over time, is essential to advance understanding (Bell et al. 2018). Hence, to advance our understanding of teams as complex multilevel dynamic systems, future research should focus on understanding the interaction and emergence of how team processes occur over time.

The final recommended potential direction of future research is to understand and analyse the socio-economic and cultural conditions of the Indian construction workforce and its dynamic relationship to team-based working and productivity. Based on the present study, it is recognised that crews in the Australian context displayed relatively better teamwork practices when compared to the crews in the Indian context. The differences when looked through the lens of socio-economic and cultural aspects of workers help gather an explanation around why teamwork processes and practices are relatively better in the Australian context. In this context, future work can also focus on communicating best practices from Australian to Indian context.

REFERENCES

Abankwa, D. A., S. Rowlinson, and E. Adinyira. 2019. "Conceptualizing team adaptability and project complexity: A literature review." *International Journal of Innovation, Management and Technology*. 10 (1): 1-7.

Abdel-Wahab, M., and B. Vogl. 2011. "Trends of productivity growth in the construction industry across Europe, US and Japan." *Construction Management and Economics*. *29* (6): 635-644.

Abudayyeh, O., A. Dibert-DeYoung, and E. Jaselskis. 2004. "Analysis of trends in construction research: 1985–2002." *Journal of Construction Engineering and Management*. 130 (3): 433-439.

Adinyira, E., P. Manu, K. Agyekum, A. M. Mahamadu, and P. O. Olomolaiye. 2020. "Violent behaviour on construction sites: structural equation modelling of its impact on unsafe behaviour using partial least squares." *Engineering, Construction and Architectural Management*. 27 (10): 3363-3393.

Adrian, J. J., and L. T. Boyer. 1976. "Modeling method-productivity." *Journal of the Construction Division*. 102 (1): 157-168.

Adrian, J. J., and D. J. Adrian. 1995. Total productivity and quality management for construction. Stipes Publications Llc.

AI Group Economic Research. 2015. AI Group Economic Research - Australia's Construction Industry: Profile and Outlook. Accessed December 20, 2017. https://cdn.aigroup.com.au/Economic_Indicators/Construction_Survey/2015/Construction_industry_profile_and_Outlook.pdf

Ak y, C., S. A , . S y , E. M ı. 2018. "Estimating OHS costs of building construction projects based on mathematical methods." *Safety Science*. 109: 361-367.

Albon, R., and T. Jewels. 2014. "Mutual performance monitoring: Elaborating the development of a team learning theory." *Group Decision and Negotiation*. 23 (1): 149-164.

Alexander, M. J. 1974. *Information systems analysis*. Tennessee, USA: Science Research Associates.

Arashpour, M., R. Wakefield, B. Abbasi, M. Arashpour, and R. Hosseini. 2018. "Optimal process integration architectures in off-site construction: Theorizing the use of multi-skilled resources." *Architectural Engineering and Design Management*. 14 (1-2): 46-59.

Arditi, D., P. Gluch, and M. Holmdahl. 2013. "Managerial competencies of female and male managers in the Swedish construction industry." *Construction Management and Economics*,.31 (9): 979-990.

Australian Bureau of Statistics. 2022. "Australian Bureau of Statistics – Industry – Building and Construction." Accessed December 20, 2022. https://www.abs.gov.au/statistics/industry/building-and-construction

Ballard, G., and G. Howell. 1997. *Implementing lean construction: improving downstream performance.* In *Lean construction*. 111-125, edited by Luis Alarcon. Rotterdam, Netherlands: A. A. Balkema Publishers.

Baumeister, R.F. and Leary, M.R., 1997. "Writing narrative literature reviews." *Review of General Psychology*. 1 (3): 311-320.

Bazeley, P. 2013. Qualitative data analysis: Practical strategies. Thousand Oaks, CA: Sage publications.

Bell, S. T., S. G. Brown, A. Colaneri, and N. Outland. 2018. "Team composition and the ABCs of teamwork." *American Psychologist*, 73 (4): 349.

Bernold, L. E., and S. M. AbouRizk. 2010. "*Managing performance in construction*." Canada, UK: John Wiley & Sons.

Bigley, G. A., and K. H. Roberts. 2001. "The incident command system: High-reliability organizing for complex and volatile task environments." *Academy of Management Journal*. 44 (6): 1281-1299.

Bolstad, C.A., and M. R. Endsley. 1999. "Shared mental models and shared displays: An empirical evaluation of team performance." In Vol. 43 of *Proc., The Human Factors and Ergonomics Society Annual Meeting.,* 213-217. Los Angeles: Sage CA.

Borrego, M., J. Karlin, L. D. McNair, and K. Beddoes. 2013. "Team effectiveness theory from industrial and organizational psychology applied to engineering student project teams: A research review." *Journal of Engineering Education*. 102 (4): 472-512.

Boyatzis, R. E. 1998. Transforming qualitative information: Thematic analysis and code development. Thousand Oaks, CA: Sage publications.

Braun, V., and Clarke, V. 2006. Using thematic analysis in psychology. *Qualitative research in psychology*. *3* (2), 77-101.

Bryman, A., and Burgess, R.G. 1994. *Analyzing qualitative data,* Vol. 11. London: Routledge: Taylor and Francis

Burke, C. S., K. C. Stagl, E. Salas, L. Pierce. D. Kendall, and C. Darwin. 2006. "Understanding team adaptation : A conceptual analysis and model." *Journal of Applied Psychology*. 91 (6): 1189–1207.

Bush, J.T., J. A. LePine, and D. W. Newton. 2018. "Teams in transition: An integrative review and synthesis of research on team task transitions and propositions for future research." *Human Resource Management Review*. *28* (4): 423-433.

Business Roundtable Report. (1983). *More construction for the money: Summary report of the construction industry cost effectiveness project*. New York: Business Roundtable.

Caldas, C. H., J. Y. Kim, C. T. Haas, P. M. Goodrum, and D Zhang. 2015. "Method to assess the level of implementation of productivity practices on industrial projects." *Journal of construction engineering and management*. 141 (1): 04014061.

Campbell, D.T., and J. C. Stanley. 2015. "*Experimental and quasi-experimental designs for research*," Evanston, IL: Ravenio books.

Campion, M.A., M. J. Gina, and C. A. Higgs. 1993. "Relations between work group characteristics and effectiveness: Implications for designing effective work groups.". *Personnel Psychology*. 46 (4): 823-847.

Cannon-Bowers, J. A., E. Salas, and S. Converse. 1993. Shared mental models in expert team decision making, 221-246. Hillsdale, NJ: Lawrence Erlbaum.

Ceri- m , M., P. L. C ş , L. A. O m . 2017. **"**Task and person-focused leadership behaviors and team performance: A meta-analysis." *Human Resource Management Review*. 27 (1): 178-192.

Chalker, M., and M. Loosemore. 2016. "Trust and productivity in Australian construction projects: a subcontractor perspective." *Engineering, Construction and Architectural Management*. 23 (6): 192–210.

Chan, P. W., and O. Ejohwomu. 2018. "*How Does Project Management Relate to Productivity?: A Systematic Review of Published Evidence*." Association for Project Management. Manchester, UK.

Chan, P. and A. Kaka. 2004. "Construction productivity measurement: a comparison of two case studies." In: *Proceedings of 20th Annual ARCOM Conference*, Association of Researchers in Construction Management, Vol. 1, 3-12.

Chen, G., and R. Kanfer. 2006. "Toward a systems theory of motivated behavior in work teams." *Research in organizational behavior*. 27: 223-267.

Chiang, Y. H. 2009. Subcontracting and its ramifications: A survey of the building industry in Hong Kong. *International Journal of Project Management*. *27*(1), 80-88.

Choi, B., Ahn, S. and Lee, S. 2017. Role of social norms and social identifications in safety behavior of construction workers. I: Theoretical model of safety behavior under social influence. *Journal of Construction Engineering and Management*, *143* (5): 04016124.

Christian, J.S., M. S. Christian, M. J. Pearsall, and E. C. Long. 2017. "Team adaptation in context: An integrated conceptual model and meta-analytic review." *Organizational Behavior and Human Decision Processes*, 140: 62-89.

Cooper, T.N., 2016. "Enhanced mutual performance monitoring to improve backup behaviors and team performance." Doctoral dissertation, Clemson University, SC.

Costa, A.C., C. A. Fulmer, and N. R. Anderson. 2018. "Trust in work teams: An integrative review, multilevel model, and future directions." *Journal of Organizational Behavior*, 39 (2): 169-184.

Courtright, S.H., G. R. Thurgood, G. L. Stewart, and A. J. Pierotti. 2015. "Structural interdependence in teams: An integrative framework and meta-analysis." *Journal of Applied Psychology*, 100 (6): 1825.

Crawford, P., and B. Vogl. 2006. "Measuring productivity in the construction industry." *Building Research & Information*, 34(3): 208-219.

Creswell, J. W., and J. D. Creswell. 2017. Research design: Qualitative, quantitative, and mixed methods approaches. Newbury, Park: Sage publications.

Crotty, M. J. 1998. "The foundations of social research: Meaning and perspective in the research process." *The foundations of social research*. London: Sage Publications.

Dai, J., P. M. Goodrum, and W. F. Maloney. 2009. "Construction craft workers' perceptions of the factors affecting their productivity." *Journal of Construction Engineering and Management*, 135 (3): 217-226.

Dai, J., P. M. Goodrum, and W. F. Maloney. 2007. "Analysis of craft workers' and foremen's perceptions of the factors affecting construction labour productivity." *Construction Management and Economics*. 25 (11): 1137–1150.

De Jong., K. T. Dirks, and N. Gillespie. 2016. "Trust and Team Performance: A Meta-Analysis of Main Effects, Moderators, and Covariates." *Journal of Applied Psychology*. 101 (8): 1134–1150.

Department of Education, Skills, and Employment. 2022. *Department of Education, Skills, and Employment - Construction.* Accessed January 12, 2022, from https://www.dese.gov.au/employment

Devine, D. J. 2002. **"**A review and integration of classification systems relevant to teams in organizations*." Group Dynamics: Theory, Research, and Practice.* 6 (4): 291–310.

Dolage, D. A. R., and P. Chan. 2013. "Productivity in construction-A critical review of research." *Engineer - Journal of the institution of engineers Sri Lanka*. 46 (4): 31-42.

Drewin, F. J. 1982. Construction productivity, New York: Elsevier Science.

Driskell, J. E., E. Salas, and S. Hughes. 2010. "Collective orientation and team performance: Development of an individual differences measure*." Human factors*. 52 (2): 316-328.

Driskell, J. E., E. Salas, and T. Driskell. 2018. "Foundations of teamwork and collaboration." *American Psychologist*, 73 (4): 334.

Egan, J. 1998. **"***The Egan report-rethinking construction. Report of the construction industry task force to the deputy prime minister*." London.

Einarsen, S., Hoel, H. and Cooper, C. 2002. "*Bullying and emotional abuse in the workplace: International perspectives in research and practice*." London: Taylor and Francis.

Eisenhardt, K. M. 1989. Building theories from case study research. *Academy of management review*, 14(4), 532-550.

El-Gohary, K. M., and R. F. Aziz. 2014. “Factors influencing construction labor productivity in Egypt.” *Journal of Management in Engineering*. 30 (1): 1-9.

Endsley, M.R. 2017. “Toward a theory of situation awareness in dynamic systems.” In *Situational Awareness*, 9 - 42 edited by S. Eduardo, and S. D. Aaron. Routledge.

Enshassi, A., S. Mohamed, Z. A. Mustafa, and P. E. Mayer. 2007. “Factors affecting labour productivity in building projects in the Gaza Strip.” *Journal of Civil Engineering and Management*. 13 (4): 245-254.

Eriksson, P. E., and H. Szentes. 2017. “Managing the tensions between exploration and exploitation in large construction projects.” *Construction Innovation*. 17 (4): 492-510.

Fang, D., C. Wu, and H. Wu. 2015. “Impact of the supervisor on worker safety behavior in construction projects.” *Journal of Management in Engineering*. 31 (6): 1–12.

Fini, A. A. F., T. H. Rashidi, A. Akbarnezhad, and S. T. Waller, S.T. 2016. “Incorporating multiskilling and learning in the optimization of crew composition.” *Journal of Construction Engineering and Management*. 142 (5): 1–14.

Flick, U. W. E. 2009. An introduction to qualitative research, London: Sage Publications.

Flin, R., P. O. Connor, K. Mearns, P. O. Connor, and K. Mearns. 2002. “Crew resource management : improving team work in high reliability industries. *Team Performance Management: An International Journal.* 8 (3/4): 68–78.

Flyvbjerg, B., N. Bruzelius, and W. Rothengatter. 2003. Megaprojects and risk: An anatomy of ambition. Cambridge university press.

Fong, P.S. and B. W. Lung. 2007. “Interorganizational teamwork in the construction industry.” *Journal of Construction Engineering and Management*. 133 (2): 157-168.

Forsythe, P. 2018. “Extending and operationalizing construction productivity measurement on building projects.” *Construction Management and Economics*. 36 (12): 683-699.

Forsythe, P. J. 2014. “The productivity of steel reinforcement placement in australian construction.” In *World Congress on Cost Engineering, Project Management and Quantity Surveying, AACE American Association of Cost Engineers*. Australia: Federation of Scientific and Technical Associations.

Gafni, R. and N. Geri. 2010. "The value of collaborative e-learning: compulsory versus optional online forum assignments." *Interdisciplinary Journal of E-Learning and Learning Objects*. 6 (1): 335-343.

Gibbs, J. L., A. Sivunen, and M. Boyraz. 2017. "Investigating the impacts of team type and design on virtual team processes." *Human Resource Management Review*. 27 (4): 590-603.

Gibson, W. and Brown, A. 2009. Working with qualitative data. London: Sage Publications.

Glaser, B.G., and A. L. Strauss. 2017. The discovery of grounded theory: Strategies for qualitative research. USA: Routledge.

Goodrum, P. M., C. T. Haas, C. Caldas, D. Zhai, J. Yeiser, and D. Homm. 2011. "Model to predict the impact of a technology on construction productivity." *Journal of Construction Engineering and Management*. 137 (9): 678-688.

Grant, M. J., and A. Booth. 2009. "A typology of reviews: an analysis of 14 review types and associated methodologies." *Health Information and Libraries* Journal. 26 (2): 91-108.

Gravetter, F. J., and L. A. B. Forzano. 2003. "Research methods for the behavioral sciences," Boston, MA: Cengage Learning

Greene, J. C., and V. J. Caracelli. 1997. "Advances in mixed-method evaluation: The challenges and benefits of integrating diverse paradigms." San Francisco: Jossey-Bass

Grossman, R., S. B. Friedman, and S. Kalra. 2017. "Teamwork processes and emergent states" in *The Wiley Blackwell handbook of the psychology of team working and collaborative processes*, edited by P. Jonathan. 243-269. USA: Wiley

Guba, E. G., and Y. S. Lincoln. 1994. "Competing paradigms in qualitative research." in *Handbook of qualitative research*. 163-194. London: Sage Publications.

Gurmu, A. T., and A. A. Aibinu. 2017. "Construction equipment management practices for improving labor productivity in multistory building construction projects." *Journal of Construction Engineering and Management*. 143 (10): 04017081.

Hajikazemi, S., B. Andersen, and J. A. Langlo. 2017. "Analyzing electrical installation labor productivity through work sampling." *International Journal of Productivity and Performance Management*. 66 (4): 539-553.

Hamid, W., and D. Tutt. 2019. "“Thrown away like a banana leaf”: precarity of labour and precarity of place for Tamil migrant construction workers in Singapore." *Construction management and economics*. 37 (9): 513-536.

Hammersley, M., and P. Atkinson. 1995. Ethnography: principles in practice*,* 2nd edition, London: Tavistock

Hamza, M., S. Shahid, M. R. Bin Hainin, and M. S. Nashwan. 2022. "Construction labour productivity: review of factors identified." *International Journal of Construction Management*, 22 (3): 413-425.

Harmon, K. M., and B. Cole. 2006. "Loss of productivity studies–Current uses and misuses." *Constr. Briefings*. 8 (1): 1-19.

Harvey, J. F., K. J. Johnson, K. S. Roloff, and A. C. Edmondson. 2019. "From orientation to behavior: The interplay between learning orientation, open-mindedness, and psychological safety in team learning." *Human Relations*. *72* (11): 1726-1751.

Hasan, A., B. Baroudi, A. Elmualim, and R. Rameezdeen. 2018. "Factors affecting construction productivity : A 30 year systematic review." *Engineering, Construction and Architectural Management*. 25 (7): 916–937.

Hersey, P., and K. H. Blanchard. 1974. "So you want to know your leadership style?." *Training & Development Journal. 28* (2): 22–37.

Hewage, K.N., A. Gannoruwa, A, J. Y. Ruwanpura. 2011. "Current status of factors leading to team performance of on-site construction professionals in Alberta building construction projects." *Canadian Journal of Civil Engineering*. 38 (6): 679–689.

Hinze, J. 1981. "Human aspects of construction safety." *Journal of the Construction Division*. 107 (1): 61-72.

Hong, J., G. Q. Shen, Z. Li, B. Zhang, and W. Zhang. 2018. "Barriers to promoting prefabricated construction in China: A cost–benefit analysis." *Journal of Cleaner Production*. *172*: 649-660.

Honts, C., M. Prewett, J. Rahael, and M. Grossenbacher. 2012. **"**The importance of team processes for different team types." *Team Performance Management: An International Journal.* 18 (5/6): 312-327.

Hosseini, M.R., I. Martek, N. Chileshe, E. K. Zavadskas, and M. Arashpour. 2018. "Assessing the Influence of Virtuality on the Effectiveness of Engineering Project Networks: "Big Five Theory" Perspective." *Journal of Construction Engineering and Management.* 144 (7): 04018059.

Howell, G., and G. Ballard. 1994. Lean production theory: Moving beyond 'can-do'. In *Proc., 2nd Annual Conference of the Int'l. Group for Lean Construction*, 17-24. Chile.

Huckman, R. S., B. R. Staats, and D. M. Upton. 2009. "Team familiarity, role experience, and performance: Evidence from indian software services." *IEEE Engineering Management Review*. 40 (1), 99–118.

Hughes, R., and D. Thorpe. 2014. "A review of enabling factors in construction industry productivity in an Australian environment." *Construction Innovation*. 14 (2): 210-228.

Ilgen, D. J., J. R. Hollenbeck, M. Johnson, and D. Jundt. 2005. "Teams in organizations: From input-process-output models to IMOI models." *Annu. Rev. Psychol.*, 56, pp.517-543.

Invest India. (2022). *Invest India Construction*. Accessed January 12, 2022. https://www.investindia.gov.in/sector/construction

Jackson, K., and P. Bazeley. 2019. Qualitative data analysis with NVIVO. London: Sage Publications.

Jackson, S. E., K. E. May, and K. Whitney. 1995. "Understanding the dynamics of diversity in decision-making teams." *Team Effectiveness and Decision Making in Organizations*, 204–261. Jossey Bass

Jarkas, A. M. 2010. "Critical investigation into the applicability of the learning curve theory to rebar fixing labor productivity." *Journal of Construction Engineering and Management*, 136 (12): 1279-1288.

Jarkas, A. M., and C. G. Bitar. 2012. "Factors affecting construction labor productivity in Kuwait." *Journal of construction engineering and management*, 138 (7): 811-820.

Jin, R., J. Zuo, and J. Hong. 2019. "Scientometric review of articles published in ASCE's journal of construction engineering and management from 2000 to 2018." *Journal of Construction Engineering and Management*. 145 (8): 06019001.

John, A. O., and D. E. Itodo. 2013. "Professionals' views of material wastage on construction sites and cost overruns." *Organization, Technology and Management in Construction: An International Journal*. *5*(1): 747-757.

Kalisch, B. J., S. J. Weaver, and E. Salas. 2009. "What does nursing teamwork look like? A qualitative study." *Journal of nursing care quality*, 24 (4), pp. 298-307.

Kalisch, B. J., H. Lee, and E. Salas. 2010. "The development and testing of the nursing teamwork survey." *Nursing research*. 59 (1): 42-50.

Kartam, S., G. Ballard, and C. W. Ibbs. 1997. "Construction models: A new integrated approach." *Lean Construction*. 379-389.

Koskela, L. 1992. Centre for Integrated Facility Engineering. "*Application of the new production philosophy to construction*". 72. Stanford: Stanford university.

Koskela, L. 2000. *An exploration towards a production theory and its application to construction*. Finland: VTT Technical Research Centre of Finland.

Kozlowski, S. W. J., and B. S. Bell. 2003. "Work groups and teams in organizations." *In Handbook of Psychology*, *Vol. 12*. *Industrial and organizational psychology, edited by* W. C. Borman., D. R. Ilgen, and R. J. Klimoski. Washington, DC: John Wiley and Sons.

Kozlowski, S. W., S. M. Gully, E. R. Nason, and E. M. Smith. 1999. "Developing adaptive teams: A theory of compilation and performance across levels and time." In *The changing nature of work performance: Implications for staffing, personnel actions, and development, Vol 240 edited by Pulakos.*San Francisco, CA: Jossey- Bass.

Kozlowski, S. W. J. and D. R. Ilgen. 2006. "Enhancing the effectiveness of work groups and teams." *Psychological Science in the Public Interest*. 7 (3): 77–125.

Kozlowski, S. W. J. 2015. "Advancing research on team process dynamics: Theoretical, methodological, and measurement considerations." *Organizational Psychology Review.* 5 (4): 270–299.

Kuoribo, E., P. Amoah, E. Kissi, D. J. Edwards, J. A. Gyampo, and W. D. Thwala. 2022. "Analysing the effect of multicultural workforce/teams on construction productivity." *Journal of Engineering, Design and Technology*.

Larson, L. and L. A. DeChurch. 2020. "Leading teams in the digital age: Four perspectives on technology and what they mean for leading teams." *The Leadership Quarterly*, *31* (1),101377.Evanston, IL

Latham, M., 1994. Constructing the Team: The Latham Report. "*Final Report of the Government/Industry Review of Procurement and Contractual Arrangements in the UK Construction Industry."* London: HMSO.

Leonard-Barton, D. 1990. "A dual methodology for case studies: Synergistic use of a longitudinal single site with replicated multiple sites." *Organization science*. 1 (3): 248-266.

LePine, J.A., 2005. "Adaptation of teams in response to unforeseen change: effects of goal difficulty and team composition in terms of cognitive ability and goal orientation." *Journal of Applied Psychology*. 90 (6): 1153.

Lewins, A. and C. Silver. 2007. "Qualitative coding in software: principles and processes." In the book *Using Software in Qualitative Research.* London: Sage Publications.

Li, J. and J. M. Gevers. 2018. "Dynamics between member replacement and team performance: The role of members' relative attributes." *Applied Psychology*. 67 (1): 61-90.

Liang, H. and S. Zhang. 2019. "Impact of supervisors' safety violations on an individual worker within a construction crew." *Safety Science*. *120*: 679-691.

Lim, E. C., and J. Alum. 1995. "Construction productivity: issues encountered by contractors in Singapore." *International Journal of Project Management*. 13 (1): 51-58.

Lincoln, Y. S., S. A. Lynham, and E. G. Guba. 2011. "Paradigmatic controversies, contradictions, and emerging confluences, revisited." in *The Sage handbook of qualitative research*, 4 (2), 97-128. London: Sage Publications.

Lindsjørn, Y., D. I. Sjøberg, T. Dingsøyr, G. R. Bergersen, and T. Dybå. 2016. "Teamwork quality and project success in software development: A survey of agile development teams." *Journal of Systems and Software*. 122: 274-286.

Lingard, L., G. Regehr, B. Orser, R. Reznick, G. R. Baker, D. Doran, S. Espin, J. Bohnen, J, and S. Whyte. 2008. "Evaluation of a preoperative checklist and team briefing among surgeons, nurses, and anesthesiologists to reduce failures in communication." *Archives of Surgery*. 143 (1): 12-17.

Liu, M., and G. Ballard. 2009. "Factors affecting work flow reliability—A case study." In *Proc., 17th Annual Conf. of the Int. Group for Lean Construction*. Taipei, Taiwan.

Loganathan, S., and S. N. Kalidindi. 2016. "Absenteeism and turnover of migrant construction workers in Indian projects—A survey-based study." In *Construction Research Congress.* 1793-1802.

Loganathan, S., C. S. Bahinipati, K. S. Ram, and S. N. Kalidindi. 2021. "Policies and Priorities for Developing Capacity to Build High-Quality Infrastructure." In the Book *Frontiers in High-Speed Rail Development*, edited by Yoshitsugu, H., R. Werner, and K. E. Seetha Ram. Tokyo, Japan.

Loganathan, S., P. Forsythe, and S. N. Kalidindi. 2018. "Work practices of onsite construction crews and their influence on productivity." *Construction Economics and Building*. 18 (3): 18–39.

Love, P. E., P. Teo, and J. Morrison, J. 2018. "Revisiting quality failure costs in construction." *Journal of Construction Engineering and Management*. 144 (2).

Lurey, J. S., and M. S. Raisinghani. 2001. "An empirical study of best practices in virtual teams." *Information & Management*. 38 (8): 523-544.

Madrid, H.P., P. Totterdell, K. Niven, and C. A. Vasquez. 2018. "Investigating a process model for leader affective presence, interpersonal emotion regulation, and interpersonal behaviour in teams." *European Journal of Work and Organizational Psychology*. 27 (5): 642-656.

M k I . (2022). "Make in India Construction." Accessed January 12, 2022, https://www.makeinindia.com/sector/construction

Marks, M. A., J. Mathieu, and S. J. Zaccaro. 2001. "A temporally based framework and taxonomy of team processes." *The Academy of Management Review.* 26 (3): 356–376.

Marks, M. A., and F. J. Panzer. 2004. "The influence of team monitoring on team processes and performance." *Human Performance*, 17 (1): 25-41.

Martinez, A.R., 2015. "The role of shared mental models in team coordination crew resource management skills of mutual performance monitoring and backup behaviors." Doctoral Dissertaion, University of Southern Mississippi, Hattiesburg, Mississippi.

Mathieu, J., M. T. Maynard, T. Rapp, and L. Gilson. 2008. "Team effectiveness 1997-2007: A review of recent advancements and a glimpse into the future." *Journal of Management*. 34 (3): 410–476.

Mathieu, J. E., M. A. Wolfson, and S. Park. 2018. "The evolution of work team research since Hawthorne." *American Psychologist*. 73 (4): 308.

Maynard, M. T., D. M. Kennedy, and S. A. Sommer. 2015. "Team adaptation: A fifteen-year synthesis (1998–2013) and framework for how this literature needs to "adapt" going forward." *European Journal of Work and Organizational Psychology*. *24* (5): 652-677.

McComb, S.A. 2017. "Shared Mental Models and Their Convergence." In *Macrocognition in teams*, 34-50. CRC Press.

McGrath, J.E. 1964. "Social psychology: A brief introduction." London: Holt, Rinehart and Winston.

McKinsey Global Institute. 2017. "Reinventing construction through productivity revolution." Accessed January 3, 2022. https://www.mckinsey.com/business-functions/operations/our-insights/reinventing-construction-through-a-productivity-revolution

Memarian, B., 2012. "Development of high reliability construction work systems: Lessons from production practices of high performance work crews." Doctoral Dissertaion, Arizona State University, USA.

Memarian, B., and P. Mitropoulos. 2014. "Production system design for speed and reliability: A case study in concrete construction." *International Journal of Construction Education and Research*. 10 (3): 181-200.

Menches, C. L., and J. Chen. 2014. "Diary study of disruption experiences of crew members on a jobsite." *Journal of Management in Engineering*. 30 (1): 60-68.

Merriam, S. B., and E. J. Tisdell. 2015. "Qualitative research: A guide to design and implementation." San Francisco: John Wiley and Sons.

Mertens, D. M. 2010. "Transformative mixed methods research." *Qualitative Inquiry*. 16 (6): 469-474.

Meyer, C. B. 2001. "A Case in Case Study Methodology." *Field Methods*. 13 (4): 329-352.

Miles, M. B., and A. M. Huberman. 1994. Qualitative data analysis: A methods sourcebook. Thousand Oaks, CA: Sage Publications.

Ministry of Housing and Urban Affairs. 2019. "Ministry of Housing and Urban Affairs – Schemes and programmes." Accessed December 30, 2019. https://mohua.gov.in/cms/schemes-or-programmes.php

Ministry of Labour. 2002. Report of the National Commission on Labour, Govt. of India.

Mirivel, J.C. and R. Fuller. 2017. “Relational talk at work”. *In The Routledge handbook of language in the workplace*, 216-227. New York: Routledge.

Mitropoulos, P., and G. Cupido. 2009. “Safety as an emergent property: Investigation into the work practices of high-reliability framing crews.” *Journal of Construction Engineering and Management*. 135 (5): 407-415.

Mitropoulos, P., G. Cupido, and M. Namboodiri. 2009. “Cognitive approach to construction safety: Task demand-capability model.” *Journal of Construction Engineering and Management*, 135 (9): 881-889.

Mohammed, S., L. Ferzandi, and K. Hamilton. 2010. “Metaphor no more: A 15-year review of the team mental model construct.” *Journal of Management*. 36 (4): 876-910.

Morgeson, F.P., D. S. DeRue, and E. P. Karam. 2010. “Leadership in teams: A functional approach to understanding leadership structures and processes.” *Journal of Management*. 36 (1): 5-39.

Morrissette, A.M., and J. L. Kisamore. 2020. “Trust and performance in business teams: a meta-analysis.” *Team Performance Management*. 26 (5/6): 287-300.

Mossman, A. and S. Ramalingam. 2022. “Capacity Building: Learning From Corporate Successes Outside Construction.” In *Proceedings of the 30th Annual Conference of the International Group for Lean Construction (IGLC30)*, 996–1007. doi.org/10.24928/2022/0209.

Mustafa, G., R. Glavee-Geo, and P. M. Rice. 2017. “Teamwork orientation and personal learning: The role of individual cultural values and value congruence.” *SA Journal of Industrial Psychology*. 43 (1): 1-13.

Naoum, S. G. 2016. “Factors influencing labor productivity on construction sites: A state-of-the-art literature review and a survey.” *International Journal of Productivity and Performance Management*. 65 (3): 401-421.

Narayanan, S., A. M. Kure, and S. Palaniappan. 2019. “Study on time and cost overruns in mega infrastructure projects in India.” *Journal of The Institution of Engineers (India): Series A*. 100 (1): 139-145.

Nerwal, N. 2012. Construction crew design: a lean approach. *Construction Management*, Michigan State University.

Neuman, S. B., and S. McCormick. 1995. Single-subject experimental research: Applications for literacy. Newark, DE: International Reading Association

Neuman, W.L. 2009. Social Research Methods: Qualitative and Quantitative Approaches, 7th edition, Chandler: Pearson Education.

Ng, S. T., and Z. Tang. 2010. “Labour-intensive construction sub-contractors: Their critical success factors.” *International Journal of Project Management*. 28 (7): 732-740.

Nickdoost, N., J. Choi, Y. AbdelRazig, and J. Sobanjo. 2022. “A Project Life-Cycle Approach to Managing Procrastination in Construction Projects: State-of-the-Art Review.” *Journal of Construction Engineering and Management*. 148 (5): 03122001.

O’N , T., N. M N , A. , . S b . 2022. “Human–autonomy teaming: A review and analysis of the empirical literature.” *Human factors*. 64 (5): 904-938.

Oglesby, C.H., H. W. Parker, and G. A. Howell. 1989. “Productivity Improvement in Construction.” New York: McGraw-Hill

Ogungbamila, B., A. Ogungbamila, and G. A. Adetula. 2010. “Effects of team size and work team perception on workplace commitment: Evidence from 23 production teams.” *Small Group Research*. 41 (6): 725–745.

Onwuegbuzie, A. J., and R. Frels. 2016. Seven steps to a comprehensive literature review: A multimodal and cultural approach. London: Sage Publications.

Planning Commission. 2013. *Twelfth Five Year Plan (2012-2017)* Economic Sectors, Planning Commission, Govt. of India.

Poirier, E.A., S. Staub-French, and D. Forgues. 2015. “Measuring the impact of BIM on labor productivity in a small specialty contracting enterprise through action-research.” *Automation in Construction*. 58: 74-84.

Porter, C. O. 2005. “Goal orientation: effects on backing up behavior, performance, efficacy, and commitment in teams.” *Journal of Applied Psychology*. 90 (4): 811.

Porter, C. O., C. Itir Gogus, and R. C. F. Yu. 2011. “Does Backing Up Behavior Explain the Efficacy—Performance Relationship in Teams?.” *Small Group Research*. 42 (4): 458-474.

Raghuram, S., N. S. Hill, J. L. Gibbs, and L. M. Maruping. 2019. “Virtual work: Bridging research clusters.” *Academy of Management Annals*. 13 (1): 308-341.

Rahman, U. U., C. A. Rehman, M. K. Imran, and U. Aslam. 2017. "Does team orientation matter? Linking work engagement and relational psychological contract with performance." *Journal of Management Development*. 36 (9): 1102-1113.

Ramalingam, S., and A. Mahalingam, A. 2018. "Knowledge coordination in transnational engineering projects: a practice-based study." *Construction Management and Economics*. 36 (12): 700-715.

Raoufi, M., and A. R. Fayek. 2018. "Key Moderators of the Relationship between Construction Crew Motivation and Performance." *Journal of Construction Engineering and Management*. 144 (6): 04018047-1-04018047-13.

Rico, R., C. B. Gibson, M. Sánchez-Manzanares, and M. A. Clark. 2019. "Building team effectiveness through adaptation: Team knowledge and implicit and explicit coordination." *Organizational Psychology Review*, 9 (2-3): 71-98.

Roberts, K. H. 1993. "Cultural characteristics of reliability enhancing organizations." *Journal of Managerial Issues*. 165-181.

Rocco, T. S., and M. S. Plakhotnik. 2009. "Literature reviews, conceptual frameworks, and theoretical frameworks: Terms, functions, and distinctions." *Human Resource Development Review*. 8 (1): 120-130.

Rosen, M. A., D. DiazGranados, A. S. Dietz, L. E. Benishek, D. Thompson, P. J. Pronovost, and S. J. Weaver. 2018. "Teamwork in healthcare: Key discoveries enabling safer, high-quality care." *American Psychologist*. 73 (4): 433.

Rosnow, R., and R. Rosenthal. 1997. "People studying people: Artifacts and ethics in behavioral research." New York: W. H. Freeman & Company

Rousseau, V., C. Aubé, C, and S. Andre. 2006. "Teamwork behaviors: A review and an integration of frameworks." *Small Group Research*. 37 (5): 540–570.

Rowlinson, S., and Y. A. Jia. 2015. "Construction accident causality: an institutional analysis of heat illness incidents on site." *Safety science*. *78*: 179-189.

Rubin, H. J., and I. S. Rubin. 2001. Qualitative interviewing: The art of hearing data. Thousand Oaks, CA: Sage Publications.

Runeson, G., and Skitmore, M. 1999. "Tendering theory revisited." *Construction Management & Economics*. 17 (3): 285-296.

Saghafian, M., and D. K. O. Neill. 2018. "A phenomenological study of teamwork in online and face-to-face student teams." *Higher Education*. 75 (1): 57–73.

Salas, E., 1992. "Toward an understanding of team performance and training." *In Teams: Their training and performance*, 3-29 edited by Swezey RW. Nonvood, NJ: Ablex.

Salas, E., N. J. Cooke, and M. A. Rosen. 2008. "On teams, teamwork, and team performance: Discoveries and developments." *Human factors*. 50 (3): 540-547.

Salas, E., D. E. Sims, and C. S. Burke. 2005. "Is there a 'Big Five' in teamwork." *Small Group Research*. 36 (5): 555–599.

Samanta, S., and J. Gochhayat. 2021. "Critique on occupational safety and health in construction sector: An Indian perspective." In *Proceedings Materials Today.* https://doi.org/10.1016/j.matpr.2021.05.707

Santoso, D. S., 2009. "The construction site as a multicultural workplace: A perspective of minority migrant workers in Brunei." *Construction Management and Economics*. 27 (6): 529–537.

Sanvido, V. E. 1984. "Designing productivity management and control systems for construction projects." Doctoral dissertation, Stanford University, Stanford, California.

Sanvido, V. E. 1988. "Conceptual construction process model." *Journal of Construction Engineering and Management*. 114 (2): 294-310.

Schober, R. W. 2008. "Optimal maintenance crew composition and enhancement of crew productivity." M.S. Thesis, Clemson University, South Carolina, USA.

Schreyer, P. 2001. "The OECD productivity manual: a guide to the measurement of industry-level and aggregate productivity." *International Productivity Monitor*. 2 (2): 37-51.

Sezer, A. A., and J. Bröchner. 2014. "The construction productivity debate and the measurement of service qualities." *Construction Management and Economics*. 32 (6): 565-574.

Shemla, M., B. Meyer, L. Greer, and K. A. Jehn. 2016. "A review of perceived diversity in teams: Does how members perceive their team's composition affect team processes and outcomes?." *Journal of Organizational Behavior*. 37: 89-S106.

Shohet, I. M., and A. Laufer. 1991. "What does the construction foreman do?." *Construction Management and Economics*. 9 (6): 565-576.

Silverman, D. 2015. Interpreting qualitative data. London: Sage Publications.

Sivasubramaniam, N., Liebowitz, S.J. and Lackman, C.L., 2012. Determinants of new product development team performance: A meta-analytic review. Journal of Product Innovation Management, 29(5), pp.803-820.

Sonnentag, S., and J. Volmer. 2009. "Individual-level predictors of task-related teamwork processes: The role of expertise and self-efficacy in team meetings." *Group and Organization Management*. 34 (1): 37-66.

Stake, R. E. 1995. The art of case study research. Thousand Oaks, CA: Sage Publications.

Strauss, A., and J. Corbin. (1990). Basics of qualitative research. Thousand Oaks, CA: Sage Publications.

Sundstrom, E., M. McIntyre, T. Halfhill, and H. Richards. 2000. "Work groups: From the Hawthorne studies to work teams of the 1990s and beyond." *Group Dynamics: Theory, Research, and Practice*. 4 (1): 44.

Sveikauskas, L., S. Rowe, J. Mildenberger, J. Price, and A. Young. 2016. "Productivity growth in construction." *Journal of Construction Engineering and Management*. 142 (10): 04016045.

Tasheva, S. N., and A. Hillman. 2018. "Integrating diversity at different levels: multi-level human capital, social capital, and demographic diversity and their implications for team effectiveness. *Academy of Management Review*. 44 (4): 746-765

Thomas, A. V., and J. Sudhakumar. 2014. "Factors influencing construction labour productivity: An Indian case study." *Journal of Construction in Developing Countries*. 19 (1): 53.

Thomas, H. R., and J. Daily. 1983. "Crew performance measurement via activity sampling." *Journal of Construction Engineering and Management*. 109 (3): 309-320.

T m , H. R., M. J. H m , U. E. L. S z I. Z v šk . 2004. "Closure to "Reducing Variability to Improve Performance as a Lean Construction Principle" by H. Randolph Thomas, Michael J. Horman, Ubiraci Espinelli Lemes de Souza, and Ivica Zavřski." *Journal of Construction Engineering and Management*. 130 (2): 300-301.

T m , H. R., M. J. H m , U. E. L. D S z , I. Z vř k . 2002. "Reducing variability to improve performance as a lean construction principle." *Journal of Construction Engineering and Management*. 128 (2): 144-154.

Thomas, H. R., M. J. Horman, R. E. Minchin Jr, and D.Chen. 2003. "Improving labor flow reliability for better productivity as lean construction principle." *Journal of Construction Engineering and Management*. 129 (3): 251-261.

Thomas, H. R., W. F. Maloney, R. M. W. Horner, G. R. Smith, V. K. Handa, and S. R. Sanders. 1990. "Modeling construction labor productivity." *Journal of Construction Engineering and Management*. 116 (4): 705-726.

Thomas, H.R., M. J. Horman, U. Espinelli, and L. Souza De, 2004. "Symbiotic crew relationships and labor flow." *Journal of Construction Engineering and Management.* 130 (65): 908–917.

Thompson, J. D. 1967. Organizations in Action. New York, NY: McGraw-Hill

Tulacz, G., and T. Armistead. 2007. "Large corporations are attempting to meet the industry halfway on issues of staff shortages and risk." *Engineering News Record*. *26*.

Vaggi, G. (1987). The Economics of Francois Quesnay. Duke University Press.

Voss, C., N. Tsikriktsis, and M. Frohlich. 2002. "Case research in operations management." *International Journal of Operations & Production Management*. 22 (2): 195-219.

Wageman, R. 1995. "Interdependence and group effectiveness." *Administrative Science Quarterly*. 40 (1): 145–180.

Wahyuni, D. 2012. "The research design maze: Understanding paradigms, cases, methods and methodologies." *Journal of Applied Management Accounting Research*. 10 (1): 69-80.

Walker, A. 1985. Project management in construction. UK: John Wiley and Sons.

Wang, X., Y. Chen, B. Liu, Y. Shen, and H. Sun. 2013. "A total factor productivity measure for the construction industry and analysis of its spatial difference: A case study in China." *Construction Management and Economics*. 31 (10): 1059-1071.

Watkins, M., A. Mukherjee, N. Onder, and K. Mattila. 2009. "Using agent-based modeling to study construction labor productivity as an emergent property of individual and crew interactions." *Journal of Construction Engineering and Management*. 135 (7): 657-667.

Webber, S. S. 2002. "Leadership and trust facilitating cross-functional team success." *Journal of Management Development*. 21 (3): 201–214.

Weick, K. E., and K. M. Sutcliffe. 2001. "Managing the unexpected: What business can learn from high reliability organizations." *Managing the unexpected: Assuring high pe1jormance in an age of complexity*. 1-4.

Wildman, J. L., A. L. Thayer, M. A. Rosen, E. Salas, J. E. Mathieu, S. R. and Rayne. 2012. "Task types and team-level attributes: Synthesis of team classification literature." *Human Resource Development Review.* 11 (1): 97-129.

Wing, C. K. 1997. "The ranking of construction management journals." *Construction Management and Economics*. 15 (4): 387-398.

Yap, J. B. H., W. J. Leong, and M. Skitmore. 2020. "Capitalising teamwork for enhancing project delivery and management in construction: Empirical study in Malaysia." *Engineering, Construction and Architectural Management*. 27 (7): 1479-1503.

Yi, W., and A. P. Chan. 2014. "Critical review of labor productivity research in construction journals." *Journal of Management in Engineering*. 30 (2): 214-225.

Yin, R. K. 2009. Case study research: Design and methods. Thousand Oaks, CA: Sage Publications.

Zandin, K. B. 2001. Maynard's Industrial Engineering Handbook. New York: McGraw-Hill Education.

APPENDIX – A

CONSTRUCTION CREW TEAMWORK SURVEY

UTS HREC ref no. ETH17-1710

This research seeks to understand how the nature of teamwork affects the output of onsite construction work crews. In compliance with ethics requirements by the University's ethics committee (approval no: ETH17-1710), confidentiality on participants' and company's information is guaranteed. The data to be collected when used, will not identify the details of the participants and company.

1. **Name of the trade** you work on: ________________________________

2. **Age (please tick one):**

Under 25 years old	25-34 years	35-44 years	45-54 years	55-64 years	Over 65 years

3. **Highest education level (please tick one):**

Grade school	High School	Associate degree graduate	Bachelor's degree	Post-Graduate

4. **Experience in your role (please tick one):**

6 months	>6 months to 2 years	Greater than 2 to 5 years	Greater than 5 to 10 years	Greater than 10 years

5. **Job Title/Role (please tick one):**

Foreman/Supervisor	Leading hand	Tradesman	Apprentice	Labourer

6. In the last week, how many hours of **overtime** did you work? **(please tick one)**

None	1-4 hours	4-8 hours	8-12 hours	More than 12 hours

7. How often do you feel **the crew sizing is sufficient (please tick one)?**

100% of the time	75% of the time	50% of the time	25% of the time	0% of the time

8. How **satisfied** are you in your **current position**? **(1 – very low; 5 – very high)**

1	2	3	4	5

9. Independent of your current job, how **satisfied** are you with **being a foreman/leading hand/tradesman/apprentice/ labourer? (1 – very low; 5 – very high)**

1	2	3	4	5

10. **Rate the level of 'teamwork' in your crew? (1 – very low; 5 – very high)**

1	2	3	4	5

Please fill in all the following items (***please tick one in each item***) regarding **YOUR CREW/TEAM**. Crew/Team is defined as the group of people working on the same trade including **head foreman, foreman, leading hand, tradesman, journeyman, apprentice and labourers**. It does **NOT** refer to individuals **who coordinate with your trade.**

*Crew head - The crew head may be the head foreman/foreman of the crew who manages and leads all the members of the crew and coordinates with other trade activities

ITEM	**Rarely**	**25%** of the time	**50%** of the time	**75%** of the time	**Always**
1) All crew members understand what their responsibilities are throughout the shift.					
2) The crew head* monitor the progress of the members throughout the shift.					
3) Crew members frequently know when another member needs assistance before that person asks for it.					
4) Crew members communicate clearly what their expectations are of others.					
5) Crew members ignore many mistakes and annoying behavior of teammates rather than discussing these with them.					
6) When changes in the workload occur during the shift, a plan is made to deal with these changes.					
7) Crew members know that other crew members follow through on their commitment.					
8) The crew head* balance workload within the crew.					
9) My crew believes that to do a quality job, all of the members need to work together.					
10) Some crew members spend extra time on breaks.					
11) Crew members respect one another.					
12) When a crew member points out to another team member an area for improvement, the response is often defensive.					
13) Crew members are aware of the strengths and weaknesses of other members they work with most often.					
14) Crew members with strong personalities dominate the decisions of the crew.					
15) Most crew members tend to avoid conflict rather than dealing with it.					
16) Apprentices/labourers and skilled workers do not work well together as a team.					
17) The crew head is available and willing to assist crew members throughout the shift.					

ITEM	Rarely	25% of the time	50% of the time	75% of the time	Always
18) Crew members notice when a member is falling behind in their work.					
19) When the workload becomes extremely heavy, crew members pitch in and work together to get the work done.					
20) Feedback from crew members is often judgmental rather than helpful.					
21) My crew readily engages in changes in order to make improvements and new methods of practice.					
22) Crew members readily share ideas and information with each other.					
23) Crew members clarify with one another what was said to be sure that what was heard is the same as the intended message.					
24) Crew members are more focused on their own work than working together to achieve the total work of the team.					
25) The crew head give clear and relevant directions as to what needs to be done and how to do it.					
26) Within our crew, members are able to keep an eye out for each other without falling behind in our own individual work.					
27) Crew members understand the role and responsibilities of each other.					
28) Crew members willingly to help others when they are overloaded.					
29) Crew members value, seek and give each other constructive feedback.					
30) When someone leaves the project, we reallocate responsibilities fairly among the remaining crew members.					
31) Crew members trust each other.					

THANK YOU FOR YOUR PARTICIPATION!!

APPENDIX – B

CONSENT FORM AND PARTICIPANT INFORMATION SHEET

CONSENT FORM

Role of teamwork processes and practices of construction work crews on productivity; UTS ethics approval number: ETH17-1710

I ____________________ *[participant's name]* agree to participate in the research project Role of teamwork processes and practices of construction work crews on productivity *(UTS HREC approval reference number ETH17-1710)* being conducted by Santhosh Loganathan, PhD Student, University of Technology Sydney, Santhosh.Loganathan@student.uts.edu.au; +61[redacted] – supervised by Prof. Perry Forsythe, University of Technology Sydney, Perry.Forsythe@uts.edu.au for his degree Doctor of Philosophy. I understand that funding for this research has been provided by the University of Technology Sydney.

I have read the Participant Information Sheet or someone has read it to me in a language that I understand.

I understand the purposes, procedures and risks of the research as described in the Participant Information Sheet.

I have had an opportunity to ask questions and I am satisfied with the answers I have received.

I freely agree to participate in this research project as described and understand that I am free to withdraw at any time without affecting my relationship with the researchers or the University of Technology Sydney.

I understand that I will be given a signed copy of this document to keep.

I agree to be:
☐ Audio recorded
☐ Video recorded

I agree that the research data gathered from this project may be published in a form that:
☐ Does not identify me in any way

I am aware that I can contact Santhosh Loganathan or his Supervisor Prof. Perry Forsythe if I have any concerns about the research.

____ ____/____/____
Name and Signature [participant] Date

____ ____/____/____
Name and Signature [researcher or delegate] Date

NOTE:
This study has been approved by the University of Technology Sydney Human Research Ethics Committee [UTS HREC]. If you have any concerns or complaints about any aspect of the conduct of this research, please contact the Ethics Secretariat on ph.: +61 2 9514 2478 or email: Research.Ethics@uts.edu.au, and quote the UTS HREC reference number. Any matter raised will be treated confidentially, investigated and you will be informed of the outcome.

PARTICIPANT INFORMATION SHEET
Role of teamwork processes and practices of construction work crews on productivity (UTS HREC Approval number ETH17-1710)

WHO IS DOING THE RESEARCH?

My name is Santhosh Loganathan (Santhosh.Loganathan@student.uts.edu.au; +61) and I am a PhD Student at UTS. My supervisor is Prof. Perry Forsythe (Perry.Forsythe@uts.edu.au).

WHAT IS THIS RESEARCH ABOUT?

This research aims to understand the role of teamwork processes and practices of construction work crews on productivity. It specifically aims to understand what processes and how these process mechanisms are generated to enable teamwork in work crews and how these mechanisms, in turn, influence the productivity of work crews.

FUNDING

Funding for this project has been received from the University of Technology Sydney.

WHY HAVE I BEEN ASKED?

You have been invited to participate in this study because you are directly involved in on-site construction processes and are a crew member. You are able to provide your perception of teamwork within your crew and how this has influenced the productivity of your crew.

IF I SAY YES, WHAT WILL IT INVOLVE?

If you decide to participate, I will invite you to

- answer a questionnaire that will take approximately 15 minutes to complete
- participate in a 30 to 45 minutes semi-structured interview that will be audio recorded and transcribed
- periodic onsite time-lapse video of construction activities

ARE THERE ANY RISKS/INCONVENIENCE?

Yes, there are some risks/inconvenience, however, the research has been carefully designed and all collected data will be unidentified. Yet, there is a possibly that it will cause some inconvenience such as your time.

DO I HAVE TO SAY YES?

You don't have to say yes.

WHAT WILL HAPPEN IF I SAY NO?

If you decide not to participate, it will not affect your relationship with the researchers or the University of Technology Sydney. If you wish to withdraw from the study once it has started, you can do so at any time without having to give a reason, by contacting Santhosh Loganathan (Santhosh.Loganathan@student.uts.edu.au; +61) or Prof. Perry Forsythe (Perry.Forsythe@uts.edu.au).

If you withdraw from the study, the data you have provided will be destroyed. However, it may not be possible to withdraw your data from the study results if these have already had your identifying details removed.

CONFIDENTIALITY

By signing the consent form you consent to the research team collecting and using personal information about you for the research project. All this information will be treated confidentially. All participants will be given an ID code and the code for which will only be known to the researchers. The data collected will be protected and unmodified. All the interviews will be coded and abbreviated to de-identify participants for analysis reasons. The coding system will be saved on the UTS networked secured personal computer, and another backup copy will be stored on the USB stick/ UTS cloud stor, both are password protected and encrypted. The data will not be published in any identifiable way. The data that will be used in publications will be anonymous to ensure privacy and confidentially. This includes not revealing the project name, location, and participants' names. The case studies will be also be coded as case A, B. Your information will only be used for the purpose of this research project it will only be disclosed with your permission, except as required by law.

We plan to publish the results in the form of Journal articles, conference articles, and thesis. In any publication, information will be provided in such a way that you cannot be identified. We will give you an option to review the publication material before we finalise it.

WHAT IF I HAVE CONCERNS OR A COMPLAINT?

If you have concerns about the research that you think I or my supervisor can help you with, please feel free to contact me on Santhosh Loganathan (Santhosh.Loganathan@student.uts.edu.au; +61 [redacted]) or supervisor Prof. Perry Forsythe (Perry.Forsythe@uts.edu.au).

NOTE:

This study has been approved by the University of Technology Sydney Human Research Ethics Committee [UTS HREC]. If you have any concerns or complaints about any aspect of the conduct of this research, please contact the Ethics Secretariat on ph.: +61 2 9514 2478 or email: Research.Ethics@uts.edu.au], and quote the UTS HREC reference number. Any matter raised will be treated confidentially, investigated and you will be informed of the outcome.

APPENDIX – C

UTS
UNIVERSITY OF TECHNOLOGY SYDNEY

Graduate Research School

Research Integrity for Students

Certificate of Completion

This is to certify that

Santhosh Loganathan

has successfully completed

Module 1: Research Integrity and Code of Conduct

Production Note:
Signature removed
prior to publication.

Professor Lori Lockyer,
Dean, Graduate Research School

University of Technology Sydney

Date: 20/06/2017

UTS
UNIVERSITY OF TECHNOLOGY SYDNEY

Graduate Research School

Research Integrity for Students

Certificate of Completion

This is to certify that

Santhosh Loganathan

has successfully completed

Module 2: Plagiarism and Misconduct
Module 3: Risk Assessment
Module 4: Risk Management and Health & Safety
Module 5: Project Management

Production Note:
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prior to publication.

Professor Lori Lockyer,
Dean, Graduate Research School

University of Technology Sydney

Date: 20/06/2017

Statement of National WHS General Construction Induction Training SOT 2818584

NSW GOVERNMENT | WorkCover

WorkCover NSW

Statement of National WHS General Construction Induction Training

This is to certify that:

Santhosh Loganathan
(full name of participant)

has completed

National WHS General Construction Induction Training

On 24/02/2018
(date of training)

This certificate is valid for 60 days from the course date.

Registered training organisation name TCP Training

WorkCover NSW approval number

Trainer name GUS FAITH

Trainer identification number

Trainer signature Production Note: Signature removed prior to publication.

Note: Please ensure you present this certificate to your employer as proof of completion of training.

WORK SAFE HOME SAFE

National WHS General Construction Induction Training

This Statement of Training provides evidence that the recipient has been assessed against, and found competent in, the course learning outcomes for the specified national unit of competency for General Construction Induction Training.

Form No. WC05429 0214

This is to certify that

Santhosh Loganathan

Favetti Bricklaying Pty Ltd

Successfully completed

Orientation - Part A - Building

On 21 February 2018

Modules Completed

Orientation – Part A – Building

LIST OF PAPERS BASED ON THIS THESIS

Journal papers

1. Loganathan, S., and P. Forsythe. 2020. "Unravelling the influence of teamwork on trade crew productivity: a review and a proposed framework." *Construction Management and Economics*. 38 (11): 1040-1060. https://doi.org/10.1080/01446193.2020.1795900

2. Loganathan, S., P. Forsythe, and S. N. Kalidindi. 2018. "Work practices of onsite construction crews and their influence on productivity." *Construction Economics and Building*, 18 (3): 18-39. https://doi.org/10.5130/AJCEB.v18i3.5973

Book Chapters

1. Loganathan, S., C. S. Bahinipati, K. S. Ram, and S. N. Kalidindi. 2021. "Policies and Priorities for Developing Capacity to Build High-Quality Infrastructure." *Frontiers in High-Speed Rail Development*, 510-525. Asian Development Bank Institute. https://www.adb.org/publications/frontiers-high-speed-rail-development

Conference papers

1. Loganathan, S., and S. N. Kalidindi. 2017. "Labor sub-contracting issues in the Indian construction industry", In *Proc., PMI Research and Academic Conference*, 2-4 March 2017, IIT Delhi, Delhi, India, pp. 145-152. (***Won Best Jury award paper at the conference***).

2. Loganathan, S., and S. N. Kalidindi. 2016. "Absenteeism and Turnover of Migrant Construction Workers in Indian Projects—A Survey-Based Study", In *Proc., of Construction Research Congress*, 31 May-2 June 2016, Pureto Rico, USA, pp. 1793-1802. https://doi.org/10.1061/9780784479827.179

3. Loganathan, S., and S. N. Kalidindi. 2015, "Masonry labor productivity variation: An Indian case study", In *Proc., of Indian Lean Construction Conference*, 6-7 February 2015, Mumbai, India, pp. 175-185.

CURRICULUM VITAE

1. **Name:** Santhosh Loganathan

2. **Educational Qualifications**

2010 Bachelor of Engineering (B.E)

- Institution: St. Peter's Engineering College (Anna University, Tamil Nadu)
- Specialization: Civil Engineering

2013 Master of Engineering (M.E)

- Institution: Anna University, Chennai, Tamil Nadu
- Specialization: Construction Engineering and Management

2022 Doctor of Philosophy (Ph.D.)

- Institution: Jointly by Indian Institute of Technology Madras (IITM) and University of Technology Sydney (UTS)
- Specialization: Construction Project Management

3. **Academic Awards**

2010 Bachelor of Engineering (B.E)
- University Rank Holder, 25th Rank, Anna University, Tamil Nadu

2013 Master of Engineering (M.E)
- University Rank Holder, 2nd Rank, Anna University, Tamil Nadu

DOCTORAL COMMITTEE

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	Prof. Koshy Varghese Professor Department of Civil Engineering, IIT Madras
	Prof. Shankar Sankaran Professor School of Built Environment, Faculty of Design Architecture and Building, University of Technology Sydney Australia
	Prof. Perry Forsythe Professor School of Built Environment, Faculty of Design Architecture and Building, University of Technology Sydney Australia
MEMBERS:	Prof. K Ananthanarayanan Professor Department of Civil Engineering, IIT Madras
	Prof. Ashwin Mahalingam Professor Department of Civil Engineering, IIT Madras
	Prof. R K Amit Professor Department of Management Studies, IIT Madras