Uncovering How Team Improvisation Occurs in Organisations: Microprocesses, Influences and Outcomes

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Abstract

The extant literature has reported with regards to individual and organisational level improvisation when improvisation is more likely to occur and how to make it more effective. However, there is limited evidence to explain the microprocesses of improvisation at the team level, and why improvisation occurs. An understanding of these processes is important because it would help complete and deepen improvisation theory, and offer specific guidance for practitioners with regard to solving problems in uncertain circumstances. The thesis research therefore set out to empirically identify the different types of microprocesses underlying team improvisation episodes and explore how cognitive, social and structural factors influenced these microprocesses. The other aim was to investigate how outcomes of team improvisation differed over time and at different levels. Two qualitative studies were therefore conducted in one manufacturing organisation in the People's Republic of China. One study was interview-based (n =20) with the second being observational in nature, following team meetings (n = 17) over three months. Using thematic analysis to analyse the data, 45 distinct team improvisation microprocesses were identified and these were categorised into four higher-level themes. Based on an input-process-output model, the Team Improvisation of Microprocess Framework (TIMF) was created, which highlighted the relationship between microprocesses, the influences and the outcomes of team improvisation. The key findings highlighted that teams improvised by undertaking different sets of microprocesses related to creating physical devices, interpreting rules, asking for help, and creating new plans with simultaneous verification. Influences on these improvisation microprocesses were found from a range of cognitive (e.g. feelings of time pressure), social (e.g. power) and structural (e.g. location) sources. There were also findings emphasised that team members improvised: a) to suppress anxiety and relieve boredom, b) to obtain positive

emotions, c) to produce positive outcomes. Interestingly, the findings highlighted potential contradictory tensions between positive and negative outcomes at the individual, team and organisational levels. The thesis therefore adds much-needed empirical detail on the nature of team improvisation microprocesses and contributes to a better theoretical understanding regarding the interplay between team improvisation and its influences and outcomes. From a practical perspective, the thesis discusses how the research can help organisations teach employees to improvise more effectively using the TIMF as an action guide.

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Chapter One Introduction

To begin with, this chapter highlights the importance of studying improvisation in organisations, the major shortcomings and research gaps in the extant literature, and how this thesis aims to address them. It then presents the overall aim and objectives of the thesis research and explains its significance. Finally, the chapter explicates the structure of the thesis.

Improvisation, the intentional deviation from established procedures to cope with unexpected events, is pervasive in organisations (Cunha et al., 2017; Miner et al., 2024). As a widespread phenomenon, improvisation has been found across industries such as in new product development (NPD) and innovation (Vera et al., 2016), emergency management (Roud, 2021), service management (Oh & Jang, 2023) and finance (Leybourne, 2009). Scholars have found that improvisation can increase creativity (Sawyer, 2000; Nisula & Kianto, 2018) and job performance (Banin et al., 2016), as well as facilitate organisational learning (Miner et al., 2001; Macpherson et al., 2022) and innovation (Xiang et al., 2020), or when it comes to coping with emergencies (Berglund et al., 2024). However, a number of scholars have also pinpointed negative associations with regard to improvisation (Vendelø, 2009) such as low product quality (Flach, 2014), property damage, and danger in terms of personal safety (Giustiniano et al., 2016). Nevertheless, it is important to pay attention to improvisation as it can lead to impactful change in organisations and to organisational members (Miner et al., 2024). Moreover, scholars recognise that improvisation is highly contingent (Crossan & Sorrenti, 1997; Arshad, 2011) and negative outcomes might occur when organisations try to repeat an effective improvisation even though it does not fit into another circumstance (Miner & O'Toole, 2024). The complexity that occurs when it comes to mixing positive and negative outcomes has been understudied (Ciuchta et al., 2021; Daood &

Giustiniano, 2024; Vera et al., 2024) and therefore researchers need to obtain a deeper, theoretical understanding of what goes on during improvisation episodes in terms of how such improvisation occurs, what elements influence improvisation and how do they do so, and what outcomes result from improvisation.

The focus of this thesis is on team improvisation for a number of reasons. A team is often defined as a group of people with interdependent tasks and skills aiming to work towards achieving a shared objective – a common feature of organisational life (West & Lyubovnikova, 2012). According to one survey published by the Harvard Business School, 89% of corporate employees serve on at least one team (Molinsky & Hahn, 2024). Consequently, focusing on teams is worthwhile due their prevalence. However, very little is known about how teams improvise in an organisational setting because the majority of studies have been conducted at the individual level (Hadida et al., 2015). Therefore, it is important to explore processes that surround decisions about when to improvise (e.g., Mendonca, 2007; Suarez & Montes, 2019) and reveal what conditions can allow organisations permit effective improvisation (e.g., Kamoche & Cunha, 2001; Vera et al., 2016; Aage & Meisiek, 2024). Others (e.g., Vera & Crossan, 2004; Marotto et al., 2007) have tended to infer from how musicians or stage performers improvise to how a group of employees improvise, without paying much attention to the domain differences (Mirvis, 1998; Fisher & Barrett, 2019). Therefore, focusing on team level improvisation in organisations can help clarify the processes that shape team decisions when it comes to improvisation. Recent scholars such as Ciuchta et al., (2021) have therefore called for more studies to explore microprocesses – ways in which that improvisation can unfold differently. Vera et al. (2024) believe that microprocess studies on improvisation can 'advance core theory on OI [organisational improvisation] processes because they describe ways that OI can

unfold differently given a specific context' (p. 491). As a result, this research sets out to identify and explore the different microprocesses involved in team improvisation.

Although researchers have not yet agreed on a clear definition of team improvisation, the improvisation literature has provided empirical evidence to suggest a common ground for its meaning (see 2.2), defining it as '*one (on behalf of a team) or more team members deviating from written procedures to compose and quickly execute a new solution in order to achieve a shared team goal*' (Miner et al., 2001; Vera & Crossan, 2005). Thus, one feature of team improvisation can be identified: improvisation occurs as a result of interaction between members or one member improvising on behalf of the team. Similarly, although the term 'microprocesses' is used extensively in the improvisation field, it has not been defined in relation to team improvisation. By searching for commonalities among those studies recognised as microprocesses research, this thesis offers a definition of the microprocesses of team improvisation as a theoretical contribution to the improvisation literature: '*action patterns undertaken/demonstrated by one (on behalf of the team) or two team members when deviating from written procedures to compose and quickly execute a new solution in order to achieve a shared team goal*' (see 2.3). Additionally, it is important to note that the 'written procedures' referenced in this research primarily serve as a basis for comparison with the actions of team members to identify instances of improvisation. The written materials encompass detailed technical guidelines such as process flows, machine operations, and tooling standards. They also include directives for factory management and organisational protocols.

Moreover, in order to understand team processes, Hackman and Morris (1975) suggests an Input-Process-Output (IPO) model as a general paradigm for analysing the role of team processes in the relationship between inputs and outputs as they apply to a team. Inputs are referred to as stable, structural characteristics of the team; team processes are referred to

as how the team works together (e.g., interaction processes); outputs are referred to as what teams produce (e.g., numbers of new products) (Hackman & Morris, 1975). For example, relying on the IPO model, Sacramento et al. (2024) explore the team's cognitive processes (*Process*) in relation to the personality of its members, such as their openness (*Inputs*) and creativity (*Outputs*). Similarly, improvisation researchers (e.g., Leybourne, 2024; Cunha & Berti, 2024) have suggested the need to further probe how microprocesses might be affected by looking into the influences and the outcomes, so that it is possible to know when, how and why team improvisation occurs.

With regard to the influences relating to improvisation, many researchers have explored when to improvise. Researchers such as Kamoche & Cunha (2001) and Aage & Meisiek (2024) aim to identify what conditions might enable improvisation to occur, then examine how these conditions can make improvisation more effective. A lot of enabling conditions such as a smaller number of routines (Weick, 1998), empowering leadership (Magni & Maruping, 2013) and team cohesion (Magni et al., 2009) have been found and tested as being positively associated with successful improvisation. Scholars such as Vera et al. (2024) argue that more nuanced conditions can be found by looking into microprocesses with regard to specific contexts. On the other hand, some studies such as that of Miner & O'Toole (2024) probe why people improvise by investigating how improvisation can be shaped. Learning (Miner et al., 1996; Weick, 1998), flexibility (Barrett, 1998), and emotions such as a feeling of transcendence (Eisenberg, 2020), are found to be the main reasons people improvise. Scholars such as Ciuchta et al. (2021) and Hadjimichael (2024) suggest that future researchers should investigate how microprocesses are influenced in order to generate insights into why people improvise, in order to advance improvisation theory. Practically, this is important because employees may be less overwhelmed or anxious when they have a clear understanding of why they improvise, and how they can find ways to improve, and managers

may be better able to predict employees' behaviours in order to support or curtail improvisation. Therefore, it is necessary to further probe how team improvisation microprocesses can be influenced.

With regard to the outcomes of improvisation, similar to how the IPO model highlights the outputs of processes (Hackman & Morris, 1975), improvisational scholars (e.g., Cunha et al., 1999; Cunha & Berti, 2024) have highlighted the importance of examining the outcomes of improvisation. They have done so because practitioners can learn from the outcomes, whether positive or negative. Certainly, a mix of positive and negative outcomes resulting from improvisation have been found. Positive outcomes include innovation (Wiedner et al., 2020), team adaption (Abrantes et al., 2018), improved performance (Vera & Crossan, 2005) and increased creativity (Nisula & Kianto, 2018). Negative outcomes of improvisation such as company property damage and injury (Flach, 2014) and emotional exhaustion (Oh & Jang, 2023) are relatively little mentioned in the literature. Much of the research on improvisational outcomes has focused on finding how to create positive outcomes, without paying much attention to how to avoid negative ones (Trotter et al., 2013).

Moreover, the outcomes of improvisation can be more complicated. Ciuchta et al. (2021) suggest that researchers should apply a timeframe when considering the outcomes of improvisation, i.e., immediate, short-term, and long-term. Vendelø (2009) shows how short-term positive outcome might have a long-term negative impact, because an improvisation was likely to be highly contingent on the context in which it occurred. In addition, scholars such as Magni et al. (2009) and Hadida et al. (2015) point out that different levels – such as individual, team and organisational levels – should be taken into account when investigating improvisation activities, since the influences and consequences of improvisation can cross levels. Therefore, it is important to apply multiple perspectives to examine the outcomes of one particular improvisation event.

At a practical level, by clarifying the different outcomes of the microprocesses of team improvisation, organisational members can understand what specific actions might lead to positive/negative outcomes. From a theoretical development perspective, understanding the consequences of improvisation may help answer the question of why improvisation continue to occur (Miner & O'Toole, 2024). This question is important because organisational actors may continue to engage in improvisation that has a positive effect on performance in the short-term but is harmful to the organisation in the longer term (Vendelø, 2009). Miner and O'Toole (2024) call on researchers to help practitioners avoid the downward spirals of over-improvisation by focusing on the results of improvisation to offer insights into the question of why improvisation continues/stops. Taken together, it is important to distinguish the outcomes of the microprocesses of team improvisation in order to generate practical recommendations and advance improvisation theory.

This section introduced the importance of studying the microprocesses of team improvisation, their influences and outcomes. Four research questions were therefore proposed:

- *RQ1: What are the key microprocesses of team improvisation?*
- *RQ2: What are the key influences on team improvisation?*
- *RQ3: How do the key influences shape the microprocesses of team improvisation?*
- *RQ4: What are the outcomes of team improvisation?*

The next section will introduce the main reasons for choosing the research context under consideration in this research – manufacturing companies in China during COVID – and the general background information.

1.1 Background of a manufacturing company in China during COVID

To investigate the research questions, this research was carried out in a manufacturing company. The reason for choosing this research context is that employees in a manufacturing company have clear written procedures (both technical and organisational) for them to follow, making identification of team improvisation easy because team actions can be compared with these written procedures to identify any differences. Many studies (Miner et al., 2001; Cunha et al., 2003; O'Toole et al., 2020) have chosen manufacturing companies as research contexts because actions can be compared with written procedural documents to identify improvisation. Moreover, this research was carried out in China during COVID. The COVID pandemic and the ever-changing Zero-COVID policy enacted in China engendered a high degree of unpredictability for all Chinese businesses, especially manufacturing companies because they had to cope with the random lockdowns, travel restrictions and social distancing policy while ensuring that a sufficient number of workers would show up to work in order to keep production going. Under these circumstances, improvisation activities might be easier to capture as scholars (e.g., Brown & Eisenhardt 1997; Baker & Nelson, 2005) have reported substantial evidence of a positive association between improvisation and environmental turbulence. Therefore, the researcher felt that a particular manufacturing company in China during COVID would provide a suitable sample given the unpredictable environment in which it was operating.

1.2 Research aims

The overall aim of this research was to develop a deeper understanding of the way in which teams improvise by exploring the microprocesses which underpin decisions about improvisation. A review of the literature reveals that exploring different ways of improvisation unfolding at the team level can be a fruitful route for developing improvisation

theory in that it offers insights into what team improvisation means, when/how team improvisation occurs, and why team members improvise.

Due to the measurement scales with regard to improvisation proposed by Miner et al. (1998a) and Vera and Crossan (2005) being ineffective for identifying microprocesses, recent scholars (e.g., Ciuchta et al., 2021; Vera et al., 2024) have called for more qualitative, inductive research to identify microprocesses. The use of semi-structured interviews to capture team improvisation is common in the improvisation field. However, details of improvisation can be difficult for participants to remember because it often occurs under time pressure, and self-reported data can be biased as the participants might provide answers to interview questions that cast them in a favourable light. Therefore, in this research the researcher conducted two studies. Study 1 used semi-structured interviews to create a framework with regard to team improvisation microprocesses, and to identify influences and to highlight improvisation outcomes at different levels. Study 2 then used team meeting observations to test the validity of the Study 1 findings, and examine whether additional insights could be made.

1.3 Significance of the research

This research is significant in several ways. Chiefly, as the extant literature focused on studying how to make improvisation effective by exploring various organisational conditions and testing different organisational variables, the microprocesses associated with team improvisation remain an understudied area (Vera et al., 2024; Hadjimichael, 2024). This research therefore helps to advance core theory regarding the improvisation process by a) offering a new categorisation of team improvisation microprocesses which helps understand how teams improvise, b) identifying structural, social and cognitive influences over the decision to improvise (e.g., location, power source, time pressure, emotion, and team

climate), and c) applying the perspectives of time (i.e., immediate-, short-, and long-term) and levels (individual, team, and organisational levels) as proposed by Ciuchta et al. (2021) to the outcomes. The aim of this was to enrich the discussion of the outcomes of improvisation, as the literature has traditionally only focused on improvisation leading to positive outcomes (Vendelø, 2009; Trotter et al., 2013; Miner & O'Toole, 2024). In addition, this research is significant because it reveals a number of reasons regarding why people improvise, thereby answering calls for further insights into this phenomenon (Ciuchta et al., 2021).

1.4 Thesis structure

This thesis comprises six chapters, of which this is the first, offering a preview of the thesis. Chapter Two provides an overview of the literature relating to improvisation, providing a definition of team improvisation and the microprocesses involved, and then critically reviewing the literature on the influences and outcomes of improvisation as the basis on which to formulate the research aim and specific research questions. Chapter Three details the general methodology employed, elucidating the philosophical assumptions that shape this qualitative research. It includes several aspects that readers can use to judge the quality of the research, together with a description and justification of the general research design, including methodological considerations. This is followed by an explanation of the process of selecting an organisation and information about the research context – a Chinese manufacturing company during the COVID pandemic. Chapter Four and Five provide details of Study 1 – semi-structured interview, and Study 2 – team observation respectively. Both chapters comprise details of participant sampling, method design, data collection and analysis, findings, discussion and limitations. Chapter Six is the concluding chapter, summarising the theoretical contributions across Study 1 and Study 2, offering practical

recommendations and suggestions for future research, and addressing the limitations of this research.

Chapter Two Literature Review

The aim of this chapter is to provide an overview of the literature relating to improvisation, provide definitions of team improvisation and microprocesses, and then present an argument for the need to study such microprocesses, and the influences which can shape them.

It is necessary to detail how relevant articles were identified for this literature review. Given the situation that a multiplicity of meanings are involved in explaining the term ‘improvisation’ and considering that researchers might employ this term in various ways in different disciplines, in order to maximise the inclusion of all relevant studies, a broad selection requirement was adopted for the initial search. As a result, keywords: ‘team improvisation’, ‘improvisation’, ‘improvi’, ‘organisation’, were used to refine the electronic search, while multiple search engines were used – Starplus, JSTOR, Google Scholar, and ScienceDirect. To be included in this research, the articles needed to either explain or use improvisation in a significant way. Then, based on the identified articles, a snowballing method was used to identify some additional articles to be included in the review.

2.1 Similarities/differences between improvisation and related constructs in organisational behaviour literature

Before exploring the literature on improvisation, it is important to briefly examine the relationship between improvisation and related constructs in order to provide a clearer theoretical understanding of improvisation within the broader organisational behaviour literature. Based on previous studies that have undertaken such comparisons (Cunha et al., 1999; Silva et al., 2024), a number of concepts are selected in the form of bricolage, creativity, innovation, adaptation, and proactivity.

Improvisation and bricolage. Improvisation and bricolage are closely connected, both emphasising creativity and resourcefulness in terms of addressing constraints. They share a reliance on transforming available resources into novel solutions, particularly in environments characterised by resource scarcity, such as time or materials (Cunha et al., 1999; Baker & Nelson, 2005). Both constructs highlight the importance of adaptability when faced with unanticipated challenges, reflecting their shared foundation in innovative problem-solving (Weick, 1993; Cunha et al., 2014; Silva et al., 2024).

Although some researchers view bricolage as a subset of improvisation, particularly in situations where resource constraints necessitate its use as part of a broader improvisational effort (Leybourne & Sadler-Smith, 2006; Di Domenico et al., 2010), the two concepts differ with regard to their temporal focus and application. Improvisation is featured by immediacy, blending thought and action in real time, involving the concurrent planning and execution of actions in response to immediate demands (Moorman & Miner, 1998; Cunha et al., 2014). In contrast, bricolage focuses on creatively recombining existing resources, such a process typically occurring without the pressing time constraints associated with improvisation (Baker & Nelson, 2005; Silva et al., 2024).

Improvisation and creativity. Improvisation and creativity are both processes that involve the generation of novel ideas or solutions (Cunha et al., 1999). Improvisation also aligns with Sternberg's concept of practical creativity, as it emphasises problem-solving in real-time contexts (Sternberg, 2006). However, a key distinction lies in their temporal orientation. Creativity can often be planned and nurtured over time, whereas improvisation requires individuals to think and act simultaneously in the moment (Cunha et al., 1999). The immediacy of improvisation means it is typically constrained by the available resources and the urgency of the situation, whereas creativity benefits from extended periods of reflection and the ability to access optimal resources (Amabile, 1998). Another key difference is that,

with creativity, the focus is on generating new and potentially useful ideas, without necessarily focusing on whether they are put into practice; however, improvisation does include putting things into practice (Fisher & Barrett, 2019).

Improvisation and innovation. Innovation can be conceptualised as the implementation of any device, system, process, programme, product, or service that is novel to the organisation (Dougherty, 1998). Innovation thus shares its focus on novelty with improvisation, but innovation usually unfolds as a structured and deliberate process, involving careful planning, testing, and implementation (Dougherty, 1996; Cunha et al., 1999). In contrast, improvisation blends planning and execution into immediate/short-term processes to address unforeseen challenges (Cunha et al., 2014). While improvisation may act as a precursor to innovation in resource-constrained or high-pressure contexts, it often carries greater uncertainty and risk due to its extemporaneous nature (Miner et al., 2001; Brown & Eisenhardt, 1998).

Improvisation and adaptation. Both constructs involve responding to changing conditions, sharing the focus on changing a course of action (Cunha et al., 1999). Adaptation typically involves deliberate and systematic efforts to adjust to external circumstances, allowing time for strategic planning and resource mobilisation (Campbell, 1989; Cunha et al., 1999). In contrast, improvisation arises in situations that demand immediate responses, often in the absence of pre-existing plans or adequate preparation (Ciuchta et al., 2021).

Improvisation and proactivity. Both improvisation and proactivity involve individuals taking an active role in shaping their environment rather than passively reacting to circumstances (Grant & Ashford, 2008; Cunha et al., 1999). However, proactivity is future-focused, involving planning, anticipation, and actions designed to prevent problems or seize opportunities by deliberate preparation, while improvisation is inherently present-focused, featuring by real-time actions without prior planning (Grant & Ashford, 2008; Miner

et al., 2001). Moreover, while both proactivity and improvisation seek to mitigate uncertainty, they differ significantly in their approaches and temporal orientation. Proactivity is characterised as 'self-starting, change oriented, and future focused' (Parker, Bindl & Strauss, 2010, p. 828). For example, a manufacturing team might anticipate potential machinery breakdowns and might therefore implement a preventive maintenance schedule rather than waiting for the equipment to fail. By contrast, improvisation emphasises the generation of immediate, creative solutions to emergent challenges, and making use of available resources in the moment (Cunha et al., 1999). For example, when a production team experiences an unexpected machine breakdown, the team improvises by using tools and materials at hand, and devises an on-the-spot solution to temporarily fix the issue and resume production.

To summarise, improvisation frequently intersects with constructs such as creativity and innovation in its emphasis on generating shared novelty, as well as with adaptation and bricolage in its focus on emergence and practical application. However, what distinguishes improvisation is its unique temporal orientation which prioritises responding to the immediate present by swiftly generating and implementing novel ideas. This orientation enables improvisation to facilitate efficiency in real-time decision-making and action. In contrast, related concepts such as proactivity are predominantly rooted in planning and deliberate execution, aiming to foster variety and achieve longer-term effectiveness rather than immediate responsiveness.

2.2 The overview of improvisation literature

In order to offer an overview of the improvisation literature, it is necessary to review where the improvisation literature comes from and how it has developed to date, to see how it can be further improved. These include a consideration of the origins of improvisation and

the introduction of the key papers which have had an influential impact on the development of improvisation theory.

2.2.1 The emergence and development of improvisation research

Improvisation, whether as an action or a process, has long been discussed in the art worlds, particularly in terms of theatre performance and music. In the 1940s, Viola Spolin created directorial techniques to help actors to be focused on the present moment; he then wrote a book *Improvisation for the Theatre* which was published in 1977 to teach actors how to make choices improvisationally. In the field of music, Franz Liszt (active in the mid-19th century) was considered to be the first pianist to play improvisational music, because he often played variations based on traditional music. In general, improvisation in the arts world is marked by spontaneous reactions in the moment.

In the 1990s, when organisational scholars such as Meyer et al. (1998) began to use improvisation in the arts as a metaphor for organising, the first task for them was to conceptualise a definition of improvisation. The worlds of organisation and jazz music started to be linked by people who have walked in both. Berliner (2009) claims improvisation occurs when musicians do not know where the notes led them. Weick (1993b) pinpoints that the key to understanding improvisation is an understanding of the inseparability of composing and performing.

Meanwhile, another stream of scholars used the metaphor of theatrical performance, and the work of Vera and Crossan (2004, 2005) has been cited. Drawing from theatre improvisation, Vera and Crossan (2005) outline two elements with regard to stage improvisation – 'letting go' and 'making do' – and explain them in terms of 'spontaneity' and 'creativity' respectively (p. 205). 'Letting go' refers to a state in which improvisers follow their instincts on stage (Crossan & Sorrenti 1997). Weick (1998) describes this state as

'thinking on your feet' (p. 522), so 'letting go' is interpreted by Vera and Crossan (2005) as the spontaneous dimension of improvisation, pointing out that improvisation has a time orientation, whereby the actors have to react on the spur of the moment. 'Making do' refers to the attempts on the part of improvisers to come up with create useful creative responses (Drazin et al., 1999), Vera and Crossan (2005) therefore interpret creativity as a dimension of improvisation, pointing out that improvisation is a conscious creative process, although the result is not always creative. Scholars following Vera and Crossan (2005) were committed to using artistic improvisation to theorise improvisation in organisations because they believe that the elements of artistic improvisation are universal and highly transferable. For example, in theatrical improvisation, the elements from which stage actors improvise are the same ones used by organisational members in their daily work, such as words, postures, facial expressions, and tone of voice (Vera & Crossan, 2005).

As these metaphors were useful when it comes to understanding the definition of improvisation. In an attempt to explain 'what is improvisation?', scholars such as Frank Barrett, Karl Weick, and Bill Pasmore found that concepts from jazz improvisation such as minimal structure could be further used to understand how improvisation might occur (Barrett, 1998; Bastien & Hostager, 1992). In jazz improvisation, minimal structure refers to jazz musicians improvising in a condition with minimal commonalities, so they improvise by elaborating simple structures (e.g., a rhythm with only a few musical notes) in different and complex ways (Eisenberg, 2020; Barrett & Peplowski, 1998). In the organisational context, minimal structure was understood as a type of indirect control associated with corporate culture or ideology which allowed organisational actors to be creative and spontaneous as improvisation could be fostered (Kamoche & Cunha, 2001). As empirical evidence, Vera et al. (2016) tested the moderating effect of the notion of minimal structure by conceptualising it as autonomy combined with goal clarity; they found that minimal structure was a positive

element, enabling improvisation during knowledge-based processes. Scholars such as Abrantes et al. (2018) thus continued to translate useful concepts from the arts into organisational language, as well as finding evidence to support those translated concepts in order to develop improvisation theory.

Moreover, Vera and Crossan (2004) translated the principles of improvisational theatre performance into conditions that would likely enable occurrences of improvisation in organisations. For example, the only unbreakable rule in improvisational theatre was agreement, i.e., one performer has to agree with another to keep the performance going; this rule is also understood as 'yes-and' (Crossan, 1998). Vera and Crossan (2004) argue that organisations can develop a type of corporate culture by adding the notion of agreement as a value, so organisational members can feel safe and are be encouraged to take risks as they know their actions will be supported by others; the authors named such corporate culture as 'experimental culture' (p. 740). However, another group of scholars including Hadida et al. (2015) and Hadjimichael (2024) argued that artistic contexts and metaphors might not fully capture what is going in corporate contexts in terms of improvisation. For example, improvisation in jazz or theatre is often about experimenting to create a new piece of work (Berliner, 2009). However, in organisational contexts, improvisation is often a response to when an unexpected problem occurs that needs solving quickly (Cunha et al., 2003). Tsoukas (1991) thus highlighted that the key limitation of the use of artistic translation was the difference between the domains of arts and organisation since 'metaphors are inherently partial [as they] must emphasise certain features at the expense of others' (p. 571).

Apart from relying on artistic metaphors to develop improvisation theory in organisations, scholars in the 1990s investigated improvisation in organisations by looking into extreme contexts where people were likely to act in the moment, such as in a firefighting and rescuing situation.

Weick's (1993a) 'Mann Gulch' paper was considered by many scholars (e.g., Miner et al., 2024) as the first paper to introduce the construct of improvisation in the organisational field as a distinct and foundational process. Weick (1993a) investigated the deaths of 13 firefighters in the infamous Mann Gulch fire disaster by carefully unpacking the actions of the firefighters, sorting out as much information about the event as possible, and digging into the firefighters' backgrounds such as their level of firefighting skills and length of service. Weick (1993a) showed the effect of improvisational actions on the part of an individual firefighter named Dodge. When other firefighters tried to outrun the fire by moving toward the ridge they were tragically engulfed in flames, whereas Dodge survived by facing the blaze and creating an escape fire: lighting a fire to create an area where people could escape (Weick, 1993a). Based on Dodge's improvisation, the author analysed the reasons for the improvisation, such as the fact that Dodge was the most experienced woodman, which allowed him to remain calm under pressure; a wealth of hands-on experience made him most likely to know that he should not turn his back on the fire, but face it directly, creating a backfire to reduce flammable materials (Weick, 1993a).

More importantly, Weick (1993a) presented a useful approach to the study of improvisation, which was called the microprocess method by later scholars (Cunha et al., 2017; Vera et al., 2024). The reason for using such a term was that Weick (1993a) clearly mapped out the detailed/micro actions of a firefighter in chronological order during the event of fighting wildfire (Vera et al., 2024). As a result, Weick (1993a) could study when the firefighter – Dodge – improvised, and to further probe why they improvised. A stream of scholars have adopted a similar microprocessing perspective, and applied a qualitative approach to study improvisation in high-stake events, such as the attacks on the World Trade Center (Mendonça, 2007) and the sinking of the Costa Concordia cruise ship (Giustiniano et al., 2016). As more scholars looked into the improvisation processes, they found

improvisation was more likely to occur when accidents happened (O'Toole & Miner, 2020), or employees wanted to seize opportunities (Cunha & Kamoche, 2003). However, it is necessary to point out that these scholars often arrived at conclusions from a few specific microprocesses in a single event without attempting to level them up to more transferable ones.

Qualitative scholars have extended the study of improvisation to various organisational settings such as the new product development (NPD) and research and development (R&D) fields (Moorman & Miner 1998a; 1998b), and to information technology implementation (Boudreau & Robey, 2005). However, some researchers highlighted the relative absence of quantitative theory testing research (Cunha et al., 1999). Since the efforts in the early stages of conceptualising improvisation in organisations allowed researchers to reach agreement on the definition of improvisation, so measurement scales with regard to improvisation were created to allow researchers to engage in quantitative research and to understand improvisation phenomena by testing causal mechanisms.

Two papers, one by Moorman and Miner (1998a), and another by Vera and Crossan (2005) played important roles in this respect as they provided scales to measure improvisation which were then widely adopted by other scholars (e.g., Vera et al., 2016). Table 1 shows the detailed scales.

Table 1. *The two most adopted measurement scales of improvisation*

Authors, year	Questionnaire items
Moorman and Miner (1998a)	1. Figured out action as we went along/Action followed a strict plan as it was taken. 2. Improvised in carrying out this action/Strictly followed out plan in carrying out this action. 3. Ad-libbed action/Not an ad-libbed action.
Vera and Crossan (2005)	1. The team deals with unanticipated events on the spot. 2. Team members think on their feet when carrying out actions. 3. The team responds in the moment to unexpected problems. 4. The team tries new approaches to problems.

	5. The team identifies opportunities for new work processes. 6. The team takes risks in terms of producing new ideas in doing its job. 7. The team demonstrates originality in its work.

The two scales helped the improvisation literature to expand as researchers connected improvisation to other organisational components. Moorman and Miner (1998a) argued that the best way to measure improvisation is by considering 'the length of time between the design and execution of an action' (p. 3). As a result, these authors created a seven-point semantic differential scale, allowing participants to rate three items. In their measurement scale, Vera and Crossan (2005) included circumstances in which team improvisation is likely to occur, such as when a team deals with unanticipated events on the spot, wants to seize opportunities, and tries new approaches to problems. By adding these specific scenarios, respondents were better able to judge whether or not they had improvised. As a result, by using these improvisation scales, the improvisation phenomenon has been studied in a variety of industries and contexts, allowing researchers to study triggers, necessary conditions, influencing components and major outcomes (Ciuchta et al. 2021). According to Ciuchta et al. (2021), such an expansion of the improvisation literature has been particularly beneficial for two areas. One was discovering the causal relationships between improvisation and organisational outcomes, such as improvement in effectiveness and efficiency (Kyriakopoulos, 2011) and team performance (Magni et al., 2013). The other was exploring more types of influences on improvisation by testing when improvisation would be more likely to occur. For example, scholars have found that processing information (Akgün et al., 2006), managerial expertise (Hodgkinson et al., 2016), and team cohesion (Magni et al., 2009) could all increase the possibility of the occurrence of improvisation. Researchers have been able to develop moderation/mediation models to further test what types of elements could reduce/increase the effect of improvisation. For example, Vera et al. (2016) tested the

moderating role of minimal structures in terms of the relationships between knowledge-based processes and interactions, and the improvisation capability of teams. The found that minimal structures have a positive effect on all the relationships. For example, Hmieleski et al. (2013) tested the joint moderating roles of entrepreneurs' optimism and environmental dynamism in the relationship between improvisation and firm performance; and discovered the joint moderators' positive effect.

However, it is necessary to highlight that the two scales were criticised as being too basic (Trotter et al., 2013) because they could not identify improvisation processes. Rather, they only measure the extent to which teams improvised but not *how* the improvisation happened. For example, the scale developed by Moorman and Miner (1998a) asked participants to rate their actions in terms of items such as 'figured out action as we went along/action followed a strict plan as it was taken' or 'improvised in carrying out this action/strictly followed out plan in carrying out this action' (p. 17), in order to test whether an action was improvisational by contrasting them with planned actions. Although there is value in keeping these features for the identification of improvisation, such items do not contain characteristics associated with improvisation processes, as they were designed to test the extent of an action's spontaneity/extemporaneity. As a result, recent scholars (e.g., Ciuchta et al., 2021) have encouraged researchers to conduct qualitative studies on action streams of improvisation in specific contexts, so that such work can be included in the basic scales of improvisation at more granular levels. For example, this study aims to identify the microprocesses of team improvisation in a manufacturing company; the microprocesses can then be used as for developing a measurement scale to identify specific improvisation processes at the team level in the manufacturing industry or in other contexts in order to test transferability.

In summary, the emergence and development of the improvisation literature benefited from efforts in three major directions which allowed scholars to critique them. First, the literature used the elements of artistic metaphors to allow researchers to the concept of improvisation and the conditions which might promote the occurrence and effectiveness of improvisation in organisations; however, such transformation can be limited due to the differences between the arts and the organisation domain. Second, the literature adopted a microprocesses approach (by sorting out the actions of improvisation) to explore how effective improvisation happens based on single events (often in extreme situations). However, the microprocesses were not transferable ones. Third, the literature focused on using quantitative methods to measure causal relationships between improvisation and other organisational variables to improve the robustness of improvisation theory. However, the improvisation processes received limited attention as the scales developed in this stage were not able to capture processes. Recent scholars (Vera et al., 2024) thus called for more qualitative studies to be conducted with regard to microprocesses.

In the next section, this thesis will explain the reasons for studying the microprocesses of team improvisation.

2.2.2 Reasons for studying the microprocesses of team improvisation

There are a number of theoretical and practical reasons for studying team improvisation microprocesses in detail. Theoretically, to the best of the writer's knowledge, the team processes associated with improvisation that underpin decisions about how to improvise have received limited attention in the extant literature. The reason for such a paucity might be because many scholars (e.g., Vera & Crossan, 2005; Kyriakopoulos, 2011; Vera et al., 2016) have used quantitative methods to explore the relationships between team improvisation and other organisational variables, dedicating to uncovering a) how much

improvisation went on during an improvisation episode, b) when an improvisation was likely to occur, c) what and how to make improvisation more effective; rather than on how the improvisation occurred. Besides, neither Moorman and Miner's (1998a) scale nor the scale created by Vera and Crossan (2005) are able to identify specific improvisation processes (see Table 1). The review paper by Ciuchta et al. (2021) also noted there has been little study of time-varying causal models of improvisation processes and intermediate variables due to the methodological limitation of being unable to identify such processes. Recent scholars (Vera et al., 2024; Hadjimichael, 2024) have therefore called for more qualitative studies on the microprocesses of improvisation in order to develop improvisation theory.

As for the limited number studies on improvisation processes using qualitative methods, researchers (e.g., Moorman & Miner, 1998a; Bingham & Eisenhardt, 2011; Baker & Nelson, 2005) have tended to focus on how individual/organisational variables contribute to effective improvisation, rather than on team improvisation processes (Vendelø, 2009; Trotter et al., 2013). For example, Bingham and his colleagues studied how organisations improvised in such a way as to facilitate entry into a foreign market, and found a number of conditions that might improve the effectiveness of organisational improvisation. These included the use of simple rules to allow actors to cultivate heuristics in an organisational structure in order to combine freedom and order (Bingham, 2009; Bingham & Eisenhardt, 2011; Bingham & Davis, 2012).

When researchers focus on the team level, they tend to view the team as a whole and explore the cognitive mechanisms behind the decision of when to improvise, rather than consider the microprocesses involved. For example, Suarez and Montes (2019) explored how a team of mountaineers made decisions to improvise while climbing Mount Everest. By analysing the conditions surrounding when to improvise, the authors proposed a cognitive mechanism for creating effective improvisation responses (Suarez & Montes, 2019).

Mendonça (2007) studied how teams of telecommunication experts restored power after the World Trade Center attack, such as by using street cables and portable generators to restore floor power when the basement power station was flooded. The author then analysed the contexts surrounding the decision about when to improvise to determine the cognitive conditions that enabled the improvisation to be effective (Mendonça, 2007). Another way of understanding team processes during improvisation was metaphorical. The concepts of synchronisation and yes-and were suggested as possible ways of improving the quality of team improvisation in an organisation (Crossan et al., 1996; Vera & Crossan, 2005). Synchronisation in a jazz band setting referred to how instruments entered a state of continuous rhythm, but noted that the criteria for judging whether or not a band showed synchronisation was subjective (Gilson et al., 2001) and difficult to apply in an organisational setting. Yes-and refers to how theatre performers always accepted others' creations in order to build on them (Vera & Crossan, 2004). However, it seems unlikely to be the same when employees improvise in an industrial setting, as evidence has only been found in jazz and comedy (Hadida et al., 2015). Given that the microprocesses of team improvisation have been ignored to a degree, scholars such as Hadjimichael (2024) argued that know-how knowledge remained a blackbox which made improvisation theory incomplete.

Practically, studying the microprocesses of team improvisation can be useful for employees when it comes to solving problems. For instance, when the driver of a vehicle stops it on hearing some abnormal sounds and suspects that there might be an engine problem, he normally pulls over and opens the bonnet in order to make a quick inspection and repair the car if possible. To do this it would be useful for the driver to have the necessary know-how (i.e., knowing how all the parts of the engine work together) if he/she is going to judge whether it is safe to continue driving and come up with a plan to fix the car.

From a personal point of view, as an undergraduate I felt happy and fulfilled when I played drums with friends improvisationally and felt my heart stirring when I accidentally played a rhythm that sounded beautiful. We would repeat that rhythm over and over again to make it a riff, even building a song on it. Such a positive personal feeling has been reported in the literature by many musicians (e.g., see Berliner, 2009; Mirvis, 1998). However, the literature shows that improvisation in organisations may be less enjoyable (Brown, 2018; Fisher & Barrett, 2019). Consequently, studying microprocesses can offer practitioners the know-how needed to improvise in such a way as to improve their wellbeing and job satisfaction.

In summary, the topic of improvisation has been studied using quantitative methods because many researchers have focused on how to promote effective improvisation. One limitation of using quantitative methods is that the process of team improvisation is not easily understood. Similarly, qualitative studies tend to focus on effective conditions or the cognitive mechanisms underpinning the improvisation surrounding when to improvise at individual or organisational level. Consequently, team processes have tended to be ignored to a degree. This is a problem because it leaves a gap in improvisation theory, and improvisation can be risky for organisations without understanding how it happens, as people often do not know the outcomes before improvising, and not knowing how to improvise can be stressful for all concerned. Therefore, this research aims to address the gap by exploring the microprocesses of team improvisation.

2.3 Defining team improvisation

By drawing on the ideas of ‘making do’ and ‘letting go’ associated with improvisational theatre, improvisation has been described as the spontaneous (‘letting go’) and creative (‘making do’) process of attempting to achieve an objective in a new way (Vera

& Crossan, 2004, p. 733). Vera and Crossan (2005) explained spontaneity as unplanned improvisation, and creativity as improvisers seeking to promote something practical and different from the normal procedures. Many researchers adopted a theatre-drawn definition of improvisation and viewed creativity as a dimension of improvisation. For example, Leybourne (2006) treated creativity as a facet of improvisation, and Magni et al. (2013) considered improvisation a creative and spontaneous process of handling an unanticipated situation.

The other metaphor researchers often drew on was jazz music. Barrett (1998) captured the nature of jazz improvisation during the performance, i.e., musicians did not know where the notes were leading them; he thus described improvisation as an action that discovered the future and 'creates as it unfolds' (p. 605). Researchers used the phrase 'novel attempt' rather than 'creative process' to describe improvisation (Weick, 1993b). A review paper by Cunha et al. (1999) pinpointed the relativity of novelty. For example, a practitioner could mirror other people's actions to cope with an unexpected situation; the mirrored actions were novel to the practitioner, but not something that had not been seen. Moorman and Miner (1998a) proposed to use the time interval between the improvised design and its execution to identify improvisation. Moorman and Miner (1998b) defined improvisation 'as the degree to which composition and execution converge in time … the more proximate the design and implementation of activity in time, the more that activity is improvisational' (p. 698). The narrowness of the time interval between design and execution is an effective improvisational referent (Moorman & Miner, 1998a). Furthermore, Miner et al. (2001) used Weick's (1993b) description of jazz improvisation, 'no split between composition and performance … no split between design and production' (p. 6), to define improvisation as 'the deliberate and substantive fusion of the design and execution of a novel production' (p. 314). Although researchers in the improvisation field have widely accepted Miner et al.'s (2001) definition of

improvisation (Ciuchta et al., 2021), a clear definition of team improvisation was needed to capture what happens in practice. For example, given that Miner et al. (2001) did not clarify the degree of novelty of the improvisation, it would be challenging to recognise such improvisation, since the improvisation literature recognised that novelty was relative (e.g., Cunha et al., 1999). Moreover, Miner et al. (2001) defined improvisation as '… substantive fusion of the design and execution …' (Miner et al., 2001, p. 314). However, scholars found such a description regarding the time interval between the design and execution unclear. For example, Macpherson et al. (2022) suggested that the expression of improvisation involved 'acting in the moment' (p. 863) should replace the term of substantive fusion to show that a new solution was something which was quickly executed. As a result, this thesis clarifies the term team improvisation in terms of four aspects – extemporaneity, novelty, intentionality, and team setting.

2.3.1 Extemporaneity

Although Miner et al. (2001) explained extemporaneity as substantive fusion of the design and execution, some empirical evidence has shown that a new solution needs time to proceed into execution – for example, organisational resources need time to be mobilised (e.g., Mendonça, 2007). When the telecom company decided to use temporary power supplies to restore electricity, it needed time for pumps and portable diesel generators to be gathered and transported to the World Trade Center (Mendonça, 2007). Therefore, a reasonable assumption about team improvisation is that the team members act quickly to execute the design due to time pressure caused by the context, such as implementing a quick solution to machinery breakdown to keep a manufacturing production line moving.

2.3.2 Novelty and intentionality

Novelty means deviating from written procedures. Researchers have thus preferred to use R&D (e.g., Moorman & Miner, 1998a), firefighters (e.g., Mamédio et al., 2024), and administrative employees (Vera & Crossan, 2005) as subjects for their research given that the procedures for actions exist (e.g., standard operations for firefighters), so researchers can use written procedures to identify deviated actions. As a result, such deviated actions not only represented the degree of novelty in the improvisation but also the degree of deliberateness. Therefore, the present research chose to compare team actions (i.e., what was engaged in by teams) and written procedures (what teams were supposed to do) to determine the novelty and intentionality of a particular improvisation. It should be noted that the written procedures examined in this study encompass a broad scope, including technical specifications for machine and tool operations, as well as guiding documents related to organisational practices and factory management regulations.

2.3.3 Team setting

It was essential to specify the differences between individual and team improvisation. According to Bantz and Smith (1977), individuals' behaviours depend on their interpretation of the circumstances they are facing. At the individual level of improvisation, a practitioner only needs to interpret the situation on his/her own in terms of whether they were improvising at a particular moment. The individual could follow the procedure every time, then neglect the improvised timing or figure it out as things went along (Moorman & Miner, 1998a). However, team improvisation involves interactions within the team. Miner et al. (2001) reported an example of team improvisation in which members suggested different ideas for quality control. 'One person proposed that they test each part as received; another suggested that the vendor perform testing in return for a sorting fee' (Miner et al., 2001, p.

312). Moreover, interaction outside the team could be considered as team actions contributing to improvisation. Miner et al. (2001) observed consistent communication between a client and a team member throughout a project to develop products. The communication by members regarded as being done on behalf of the team (Miner et al., 2001). Therefore, team improvisation is likely to engage with speech and behaviours to decide to deviate from procedures and compose a new solution. The interactions within the team and those conducted by a member on behalf of the team are the key differences between individual and team improvisation (Miner et al., 2001). As a result, the team actions identified in the collected data could be (1) interactive and (2) individual actions made by one member on behalf of the team.

To conclude, based on Miner et al. (2001), the definition of team improvisation used in this thesis is: *one (on behalf of a team) or more team members deviating from written procedures to compose and quickly execute a new solution in order to achieve a shared team goal*. This definition is different from individual level improvisation because it determines the actions experienced in an interactive process between team members or a result of such a process regardless of the actions carried out by one or more members (Hadida et al., 2015). In addition, this definition is different from organisational level improvisation because the actions are performed by team members and aimed to achieve a team goal, meaning teams can perform activities as independent operating units without the whole organisation joining in (Moorman & Miner, 1998a). The next section will define the term microprocess of team improvisation.

2.4 Defining the term microprocesses of team improvisation

Given that this literature review has defined the term team improvisation, it is important to define the concept of microprocesses, which in turn determines the meaning of the microprocesses of team improvisation.

In a general sense, a study of microprocesses should attend to the ways in which interaction is meaningfully situated in a context. As a result, a microprocess research relating to improvisation should engage in how action streams are situated in the facets of organisational contexts such as structures, norms, resources, as well as broader institutional and societal structures, processes, and logics (Ciuchta et al., 2021).

In the improvisation field, Weick's (1993a) work could be seen as a good example of a microprocess study, in that the author sorted out action streams that indicated that firefighters acted differently to respond to a wildfire, representing different types of improvisation microprocesses – ways in which improvisation unfolded (Vera et al., 2024). Weick (1993a) then analysed how the improvisation microprocesses interacted with facets of contexts such as the surrounding environment, the firefighting equipment and resources available, and standard operation procedures of firefighting, in order to generate insights into the triggers and enabling conditions for improvisation, or reasons for improvising. However, the term microprocesses of team improvisation has yet to be adequately defined in the improvisation field although it has been widely mentioned (Ciuchta et al., 2021). It is therefore necessary to critically review what microprocesses studies were about and how they were conducted to arrive at a definition of the term 'microprocesses of team improvisation'; non-improvisation research relating to microprocess should also be considered as a reference for defining the term.

With the exception of Weick (1993a), only a small number of researchers have engaged in microprocesses studies (Ciuchta et al., 2021), such as Yanow and Tsoukas (2009),

Mendonça (2007), and Bechky & Okhuysen (2011). In these studies, the authors tended to present a mixture of actions by individuals/groups, and provided necessary contextual information to make sense of the presented actions. For example, Yanow and Tsoukas (2009) illustrated the pervasiveness of improvisation conceptually with examples from real life. For example, when a driver is driving a vehicle, he/she might sense that the gearbox is not working as smoothly as it should. Consequently, the driver will improvise by operating the gear shift lever to try to get the gearbox to work properly (Yanow & Tsoukas, 2009). The authors then described how such an improvisation might be escalated: when the driver still feels that the gearbox problem has not been solved, he/she will stop the car, open the car bonnet, and look at the powertrain in order to improvise to get the car back on the road quickly (Yanow & Tsoukas, 2009). More clearly, Mendonça (2007) described how Telecom employees restored electrical power to a building, and a clear action stream was provided. When Telecom employees could not access central power in the basement due to firefighting activities, they checked that the cables were connected correctly and restored power to the building floor by floor (Mendonça, 2007). Based on a detailed description of the event response, Mendonça (2007) analysed the cognitive process of improvisation by interviewing the participants using a critical decision method – a method that tended to explore what knowledge and thinking processes were involved during decision-making. Similarly, another microprocesses study of improvisation by Bechky and Okhuysen (2011) recorded detailed actions of how a team of police officers changed an entering plan to a drug house when a couch was found to be in the team's path. The lead officer perceived the situation as dangerous, 'Someone could be on the other side (of the couch), just waiting for us'. Consequently, the decision was that the lead officer ran left to 'cover' the couch, while the original plan was to run to the right; the second officer, whose role was to run left, immediately ran to the right to cover the room; according to this description, the authors

entitled this microprocess as ‘role shifting’ (Bechky & Okhuysen, 2011, p. 246). The authors then interpreted how the redundancy in task knowledge might be the reason for adjusting to each other’s actions without explicit communication (Bechky & Okhuysen, 2011). As these microprocess studies in the improvisation field indicate, when using the term ‘microprocesses’, it should refer to action sequences or a description of action streams if only one event was focused on; and when speaking of microprocesses research, such research should not only contain actions, but also should other purposes such as examining the contextual information to demonstrate how the actions were embedded in the context to explore the enabling condition of improvisation or why such actions occurred. Or having a purpose of proposing types of improvisation, for example, by observing the actions of project development employees in two different companies, Miner et al. (2001) categorised the observed action sequences into behavioural, artifactual, and interpretive improvisation.

Empirical evidence from the non-improvisation field also suggests the microprocesses term is about actions. Lehmann-Willenbrock et al. (2017) examined how team microprocesses affect the likelihood of positivity occurring within dynamic team interactions; they described microprocess as the sequence of speaking actions at a given time. Biswas et al. (2023) presented a microprocess associated with product innovation, and they used an action-based description to show how people from outside the company provided insights into product innovation.

Although action streams were appropriate for consideration as a commonality of the term microprocesses, on the researcher’s reading of the literature, there are three main criticisms to be made with regard to team microprocesses in the improvisation field. First, researchers tended to use the term ‘team’ to describe a group of people’s behaviours, in effect taking the term team for granted, without explaining how each team member interacts to achieve team consensus (e.g., resolving disagreements within the team) and coordinate

actions to act like a team. At this point in the research, how members interact during team improvisation remains in the metaphorical dimension. For example, a musical experiment by Bastien and Hostager (1992) to examine how musicians communicate in order to improvise, found a set of communicative signals which invoked changes in timing during the performance, such as 'active physically', 'watched each other closely', 'questioning look', 'nodded', 'making eye contact' or 'giving verbal instructions' (p. 98). Another metaphorical idea associated with team interaction is rotated/turn-taking leading conversations which is informed by the theatre improvisation metaphor as actors need to take turns to speak and act to keep the improvisational performance going (Vera & Crossan, 2004). However, team members might not be likely to interact in a similar way to musicians or stage actors when improvising. This may hinder researchers when it comes to answering the question 'what is team improvisation?' which is an important aspect of developing improvisation theory (Vendelø, 2009).

Second, researchers tend to use paragraph-to-paragraph descriptions to explain the action streams of a team, rather than using analytical approaches to explore the patterns of the team's action streams in a specific context. This might be because microprocess researchers usually only focus on one event. The advantage is that microprocesses can be described in great detail which is conducive to exploring the participants' psychological processes. However, the downside is that the microprocesses seem to be difficult to transfer into other contexts because they are so unique.

Third, when analysing the influences affecting microprocesses, researchers tend to focus less on the reasons for improvising, and more on the enabling conditions of improvisation, as the researchers have a great deal of contextual information (e.g., organisational resources, procedures, participants' skills and knowledge of job tasks) to offer insights into how improvisation might be enabled. According to scholars such as Cunha et al.

(1999), Hadjimichael (2024), and Vera et al. (2024), it is important to provide insights into the question of why improvisation happens, as a considerable way forward with regard to developing improvisation theory. Therefore, when studying team improvisation microprocesses, this research should a) pay attention to the interaction of team members to explore the microprocesses regarding occurrences of team improvisation, b) pursue the action patterns of microprocesses across team improvisation activities to improve transferability, c) pay attention to how microprocesses are influenced, particularly concerning explaining why improvisation happens. As a result, this research defined the term microprocesses of team improvisation as *action patterns undertaken/demonstrated by one (on behalf of the team) or more team members when deviating from written procedures to compose and quickly execute a new solution in order to achieve a shared team goal.*

This section critically reviews the microprocesses studies in the improvisation field to provide such a definition. The next section will review articles related to the influences on improvisation, as well as the studies relating to the outcomes because Cunha et al. (1999) highlighted the question of why improvisation occurs, the response to which was likely to be informed by also looking at the outcomes of improvisation.

2.5 Influences of improvisation

As the exploration of action streams often serve a purpose, the studies that focus on influences with regard to improvisation usually aim to examine the conditions that enable such improvisation (Cunha et al., 1999), which might also help to inform the reasons for improvisation (Cunha et al., 1999; Ciuchta et al., 2021). It is therefore necessary to review the studies focusing on the influences on improvisation, to see what has been done and what else could be done to offer more insight.

Among all types of enabling conditions relating to improvisation, three conditions were found to be the most common triggers or causes of improvisation, named triggers: they were problem/surprise, opportunity, and self-enrichment (Ciuchta et al., 2021). Problems or surprises were often seen as a classic trigger for improvisation, such as unexpected client requests (Lai et al., 2014), and equipment breakdowns (O'Toole et al., 2020). When practitioners decided to improvise because they wanted to seize an opportunity, that opportunity became a trigger (e.g., Miner et al., 2001; Suarez & Montes, 2019). For example, Miner et al. (2001) found that when practitioners found that the speed of a computer program was greatly increased after a bug had been eliminated, they saw this as an opportunity to interpret the unexpected speed increase as a new marketing feature. Self-enrichment can be a trigger; by interviewing practitioners who developed new products and services, Dougherty and Takacs (2004) found that team play could be seen as a boundary that enabled an improvised flow of innovative activities. Consequently, people might improvise in order to enjoy intrinsic experiences.

In the following three sections, the influences of improvisation are divided into structural, social, and cognitive perspectives as suggested by Ciuchta et al. (2021).

It is necessary to point out that some of the influences might be viewed from more than one perspective. For example, power could be considered as both social and structural influences although improvisation scholars (e.g., Silva, 2002) tend to view power as a social influence because it is found to affect social relationships.

Therefore, this research's classification of the influences was based on the previous improvisation studies.

2.5.1 Structural influences

Structural influences refer to enabling conditions for improvisation on the part of those who operate in a particular environment (Ciuchta et al., 2021), including the business environment, the physical environment, and particular organisational structures.

In the field of structural influences with regard to improvisation, the most eye-catching component is environmental turbulence (Ciuchta et al., 2021). A number of scholars believe that organisations improvise in such a way to adapt to the increasing competition caused by environmental turbulence (e.g., Brown & Eisenhardt 1997; Eisenhardt & Tabrizi 1995) because a rapidly changing environment can destroy the value of existing capabilities (Miner et al., 2024). In the opinion of Moorman and Miner (1998a), organisational actors would improvise rather than not act when faced with environmental turbulence. Based on such an assumption, Pavlou and Sawy (2010) took NPD teams in the IT industry as subjects, and found their improvisation activity increased as the level of environmental turbulence increased. The authors thus argued that improvisation was more valuable in turbulent environments because it required team members to adapt more quickly. However, it should be noted that Pavlou and Sawy's (2010) research focused on marketing and technology changes affected by environmental turbulence using a measurement scale developed by Jaworski and Kohli (1993). In this measurement scale, environmental turbulence was measured in terms of the participants' perceptions and attitudes towards changes in the market and with regard to technology. Specifically, the participants were asked to rate statements such as 'it takes us forever to decide how to respond to our competitors' price changes' (Jaworski & Kohli, 1993, p.66). Consequently, the level of turbulence could vary since respondents might have different perceptions with regard to the statement. This seems to imply that the environment might not be regarded as a completely objective component because the turbulence of the environment needs to be perceived to affect improvisation

(Baker & Nelson, 2005). Similarly, Ciuchta et al. (2021) pointed out that how organisational actors perceived the environment in which they were operating as sometimes particularly important in studying the relationship between structural influences and improvisation because it opened a door for the exploration of social cognition of improvisation. For example, Suarez and Montes (2019) explored how climbers on Mount Everest responded to the increasing levels of uncertainty in the environment by consideration of the observer's diaries, the climbers' diaries, and interviews with the climbers; they proposed that climbers make use of a cognitive search mechanism to determine whether to improvise when the environment changed. However, this literature review argues that we should not ignore objective differences regarding the degree of environmental turbulence. For example, Cunha et al. (2019) found that Angolan managers tended to make short-term decisions because they felt that the unpredictable business environment they operated in could not provide sustainable resources. Similarly, such improvisation in terms of management by deciding has been reported in many developing countries, such as those in Africa. Singh et al. (2022) have attributed such improvisation to the turbulence and complexity of the local business environment, meaning that practitioners therefore tend to manage issues by making on-the-spot decisions rather than planning for and anticipating future situations. Gomes et al. (2024) further confirmed the impact of volatile business environments and policies on improvisation, when they explored the characteristics of improvisation in local and foreign organisations operating in Africa.

Moreover, organisational structures such as levels of hierarchy are commonly regarded as a structural influence with regard to improvisation (Ciuchta et al., 2021). The concept of minimal structure has been widely mentioned. By relying on the idea of minimal hierarchy in jazz bands, Kamoche and Cunha (2001) proposed the concept of minimal structure, including social and technical structures. The former refers to norms for behaviour,

communication, leadership, and organisational culture that enable improvisation to occur; the latter refers to individual competence/knowledge that enables improvisation (Kamoche & Cunha, 2001). Vera et al. (2016) found that minimal structures (measured in terms of autonomy and goal clarity) positively moderated the relationship between an R&D team's ability to create a shared understanding of new knowledge and its improvisation capability, such that the relationship was stronger when minimal structures were in place.

Protocol was found to be a structural influence. By investigating how medical professionals improvised in an emergency room, Batista et al. (2016) found that they needed to improvise in reference to medical protocols because they found the situation was not always the same for every patient, and that protocols may not apply to unique examples. The authors found that protocols such as clinical notes and supplemental diagnostic tests were seen as a façade for improvisation, in order to protect against external scrutiny (Batista et al., 2016). As a result, experienced doctors could improvise based on intuition due to the uniqueness of each patient (Batista et al., 2016).

In another article, organisational rules were found to act as a structural influence when it came to improvisation when organisational actors improvised within the rules. Giustiniano et al. (2016) investigated that the sinking of the Costa Concordia, and found that the disaster came about as a result of the captain's improvisation in terms of an organisational standard, specifically, that the major priority should be the safety of the ship, the crew, and the passengers. When the ship was due to arrive at its intended location, the captain, in order to show off his superior seamanship, improvised by deactivating the navigation technology and switching the ship to manual navigation (although such an action was allowed under certain conditions such as excellent visibility, and when the situation met certain criteria); such improvisation eventually caused the ship to run aground and sink (Giustiniano et al., 2016). Technically, the captain did not disobey any formal rules as he was allowed to switch to

manual navigation, but by doing so, he disregarded the organisation's top priority – that of safety – in order to show off his skills, thereby displaying arrogance.

What was more, organisational roles were found to influence improvisation. Bechky and Okhuysen (2011) provided an example in the form of improvisation which happened in the case of a film production crew. When a camera operator failed to turn up for work, the executive producer and camera crew decided to promote a cinematographer on site to be the camera operator. Such an improvisation was based on the camera crew's overlapping task knowledge – the cinematographer knew how to operate the camera (Bechky & Okhuysen, 2011).

Furthermore, in terms of the physical environment, resource availability was recognised as a structural influence when it comes to improvisation, meaning the occurrence of improvisation depended on the accessible resources 'at hand' (Silva et al., 2024). A number of researchers (e.g., Baker et al., 2003; Muyinda & Mugisha, 2015; Rieder, 2017) have pointed out that the reality of a lack of physical resources could force the need for improvisation. For example, Muyinda and Mugisha (2015) found that affected by economic and war crises, doctors in Uganda chose to use septrin instead of amoxicillin, in addition to chloroquine and fansider, as first-line treatment for malaria, rather than using artemisinin-based combination therapies. Other improvisations included drugs used to treat adults being split into small doses and given to children. The authors acknowledged that the improvisation provided an alternative for patients in terms of access to medicines, but such improvisation led to medicine misuse and an increase in resistance to drugs, which further created medical and ethical dilemmas (Muyinda & Mugisha, 2015). This article indicated that improvisation could emerge as a substitute for a lack of physical resources. Muyinda and Mugisha (2015) thus recommended that local government and international funding bodies build social

services with health facilities and infrastructure to provide accessible medical resources during times of war.

In addition, Magni and Maruping (2024) found that geographical dispersion can influence how people improvise. By examining how teams improvise under different degree of dispersion (such as across countries), the authors proposed that teams presented different types of sensemaking processes with regard to improvisation (Magni & Maruping, 2024). For example, when team members are in a face-to-face meeting, they tend to develop a shared understanding of a problem and arrive at a shared solution; but when members are separated in different countries but are required to work together, they construct a situation individually to enact a solution (Magni & Maruping, 2024). The authors further suggest that future research should focus on the arrangement of team members across physical sites given that this may influence how people improvise as they might develop different working norms (Magni & Maruping, 2024).

2.5.2 Social influences

Social influences refer to the social resources in which practitioners are embedded as influences for improvisation (Ciuchta et al., 2021).

Power can be a social influence with regard to improvisation. Silva (2002) examined the process by which two public hospitals in Latin America outsourced their administrative information systems; the author found that people needed political power to intervene in order to improvise, and they needed to explain why the improvisation was legal in order to make others comply. Silva's (2002) study successfully introduced power as a dimension of improvisation theory. However, this paper did not focus on power in terms of position, rank or seniority, which seems to be more common in organisations. It might be because the author conducted their research in public hospitals where government authority played a

dominant role in deciding matters relating to hospital outsourcing. This literature review argues that power resulting from ranking and seniority also deserves a deeper exploration in terms of its relationship with improvisation.

Customer requests have been highlighted in the improvisation literature. Lai et al. (2014) explored how frontline employees in an international tourist apparel retailer improvised when interacting with customers. They found that unexpected customer requests often led to improvisation on the part of employees. This could be regarded as a service innovation, as such improvisation provided personal connection and engagement for customers (Lai et al., 2014). In addition, when Molnar et al. (2017) investigated the project experience of a software team developing an automated information system, the authors found that the requirements from the client (e.g., contract planning at the beginning of the project and the modification requirements during the project) could directly affect the development process. The clients' requirements forced team members to solve problems faster and more creatively (Molnar et al., 2017).

Social acceptance has been recognised as a type of social influence on improvisation (Ciuchta et al., 2021). Mendonça and Wallace (2007) proposed that improvisation was more likely to happen if it was socially accepted. For example, when investigating the experiences of a group of mountaineers climbing Mount Everest, Suarez and Montes (2019) found that one of the climbers improvised by pausing their descent in order to repair ropes damaged by sharp rocks. The improvisation was discussed and accepted within the group, and a new rule was established: 'if you see a damaged rope, fix it right away.'; this allowed for improvisation under certain circumstances (Suarez & Montes, 2019, p. 583).

In addition, team cohesion and behavioural integration were found by Magni et al. (2009) to act as social influences with regard to improvisation, given that team members' levels of improvisation increase as the team's level of cohesion and behavioural integration

increases. It might be that members of cohesive teams demonstrate a higher level of commitment to the team's tasks, indicating a stronger task desire to do whatever spontaneous activities are required (Mullen & Copper, 1994).

2.5.3 Cognitive influences

In general, cognitive influences refer to any information processing that the brain engages in, including attention, thinking, memory, and reasoning (Danili & Reid, 2006). However, the improvisation literature has focused predominately on the role of memory (O'Toole et al., 2020). However, the research relating to cognitive influences focuses on organisational memory itself, and how organisational actors draw on memory to improvise, a feature which was recognised as an intuitive and conscious process (Ciuchta et al., 2021).

The idea of memory as a cognitive influence of improvisation comes from a jazz metaphor, because jazz improvisers reported a cognitive process involving recalling memories while improvising to ensure an ongoing action flow (Berliner, 2009). Organisational memory has been explained as 'stored information from an organisation's history that can be brought to bear on present decisions' (Walsh & Ungson, 1991, p. 61.). Broadly speaking, Moorman and Miner (1998b) categorised memory as procedural memory and declarative memory. Procedural memory refers to 'skill or action knowledge' (Kyriakopoulos, 2011, p. 706), often represented as tacit knowledge which involves knowing the background (e.g., other people's expertise, knowledge, job task); in this sense, knowledge becomes more of a social influence. Declarative memory refers to 'fact knowledge' (Moorman & Miner, 1998b, p. 706) which consists of knowing about facts, events or propositions associated with explicit knowledge.

Moorman and Miner (1998b) asserted that a higher level of procedural memory could increase the possibility of coherent actions. This might lead to actions fitting the performance

context which might result in fast responses but which might decrease the likelihood of novel actions. Team members may be more likely to make fast responses because they may be more familiar with procedural memory (Crossan et al., 2005). For example, the organisation itself could provide skills training. Moorman and Miner (1998b) further argued that declarative memory could increase the possibility of novelty in improvisation, while organisational actors needed a bit more time to draw on such a memory. This was because knowledge about events, facts, and hypotheses enabled practitioners to better recognise and grasp an emerging pattern since they could draw on declarative memory to compare what was happening with past situations (Moorman & Miner,1998b).

Moreover, knowledge could be seen as a cognitive influence with regard to improvisation. Weick's (1993a) Mann Gulch paper was the first paper to introduce knowledge into the analysis regarding how improvisation might be influenced. Weick studied the unplanned actions of an experienced firefighter, Dodge, who created an escape fire while other firefighters chose to outrun the wildfire. Karl Weick argued that Dodge's improvisation was based on his extensive knowledge of forest firefighting, such as awareness of guidelines for dealing with fire emergencies, or on his basic knowledge with regard to creating a fire – oxygen, flammable material, and temperature above the point of ignition. Dodge was likely to be able to think of eliminating any one of these to prevent a fire, to create an escape path; or he might have read the story of creating a backfire from the novel The Prairie (Weick, 1993a). This background knowledge of firefighting may have been key to Dodge's ability to improvise an escape fire with existing flora and terrain (Weick, 1993a, Hadjimichael, 2017). Other scholars also agreed that existing explicit knowledge was the foundation for improvisation (e.g., Cunha et al., 2003), while, some researchers (King & Ranft, 2001; Moorman & Miner, 1998b) indicated that tacit knowledge may play an important role in facilitating the development and deployment of improvisation.

Furthermore, although the literature on improvisation has included a lot of research on memory as a cognitive influence on improvisation, recent scholars have called for more exploration of cognitive influences such as emotion, values, and beliefs (Hadjimichael, 2024) such as those relating to organisational culture, team climate, and psychological safety (Magni et al., 2017; Sacramento et al., 2024).

Human emotions/feelings can occur when organisational actors are eager to pursue/suppress a particular emotion (Hadjimichael & Tsoukas, 2023). However, proponents of the role of emotion have not paid much attention to its relationship with improvisation (Cunha et al., 2017), and current understanding remains in the metaphorical dimension. For example, Mirvis (1998) suggested that an optimum mixture of anxiety and confidence is required to lead to improvisation; he proposed the idea that a positive form of anxiety helps people to activate attention and forces them to search for alternatives. In an organisational context, Fisher and Barrett (2019) pointed out that people experience fear and excitement when undertaking improvisation due to its general discouragement in an organisational environment; workers tend to improvise as a last resort or hide its use. In the improvisation literature, researchers (e.g., Ciuchta et al., 2021; Hadjimichael, 2024) have called for more studies on the role of emotion as an influence on improvisation, because it could be a fruitful avenue, having shown its potential in other contexts.

Organisational culture, as a manifestation of a set of values and beliefs, is mentioned in the literature as an influence. For example, the concept of experimental culture has been transferred from the theatre metaphor, referring to values and beliefs that promote action and experimentation (Cunha et al., 1999). Vera and Crossan (2004) argue that organisations can develop a type of corporate culture by adding the notion of agreement as a value, such that organisational members can feel safe and be encouraged to take risks as they know their actions will be supported by others. Yao et al. (2017) further explore the dimensions of an

organisational culture to make effective improvisation: a) action promotion – organisations encourage employees to propose/think/act promptly to solve problems, b) error tolerance – employees accept mistakes and are willing to pay for losses, and c) trust and support – employees exhibit attempts and actions to encourage trust and support each other. Liao et al. (2023) then examined the relationship between each of the dimensions pinpointed above with regard to improvisation. They found organisational members were more spontaneous and responsive when they felt trusted and supported by their superiors; however, high autonomy and acceptance of mistakes did not necessarily lead to more novel improvisation (Liao et al., 2023).

Team climate can be a cognitive influence on improvisation when there is a shared belief that the behaviours and the norms within a team support the generation and execution of new ideas (Van Der Vegt et al., 2005; Magni et al., 2017). Similarly, scholars such as Gilson & Shalley (2004) and Yan & Zhang (2017) also propose that members can be encouraged to search for creative alternatives when they have a shared perception of innovation support when confronting emergent situations. Such a perception might be established by members' experiences of working in an innovative organisational climate. For example, members are more likely to perceive the organisational climate as being innovative when they often frequently discuss and challenge the status quo in a constructive way, and managers accept new ideas, encouraging them to be explored and implemented (Zheng et al., 2009). Based on a survey of more than 300 employees of services companies, Su et al. (2022) found a positive association between the role of innovative climate and improvisational behaviour. Another related concept is team exploration climate, defined as a team's shared perception of how much the environment encourages extensive searching, experimentation, and the adoption of new techniques and novel approaches when it comes to problem-solving (Lubatkin et al., 2006). As Sacramento et al. (2024) found, such a team climate had a positive

connection with team creativity. It is therefore reasonable to infer that team climate might cultivate improvisational behaviour when members are under time pressure (Magni et al., 2017).

Psychological safety represents another potential cognitive influence on improvisation (Su et al., 2022). It is defined as the belief that an organisation or team provides a safe space for interpersonal risk-taking (Edmondson, 1999). Scholars such as Bradley et al. (2012) and Hu et al. (2018) have highlighted the relationship between psychological safety and creativity-related behaviours, including creativity and innovation (Frazier et al., 2017; Peng et al., 2019), such as challenging established norms and suggesting novel approaches. Furthermore, Sacramento et al. (2024) found evidence to support the role of team psychological safety as a mediator between openness and creativity at the team level. Given that team improvisation is characterised by risk and uncertainty as it involves deviating from conventional approaches (Vera & Crossan, 2005), it is reasonable to assume that team psychological safety may influence how team members engage in improvisation.

This section has reviewed the literature relevant to the influences of improvisation from structural, social, and cognitive perspectives. These studies focused on how improvisation could be influenced. They informed us as to what conditions might enable improvisation, and how they might do so. As ways to advance improvisation theory, they further probed the reasons why people improvise. However, some underexplored dimensions with regard to improvisation have been mentioned above, such as the role of physical dispersion, time pressure, power from different sources, emotions, values and beliefs, as influences on improvisation. In order to explore these under-researched areas, recent publications (e.g., Hadjimichael, 2024) suggest that there is a need to change the commonly-used methodological approach which has tended to rely on metaphor perspectives. The reason for this is that transforming arts metaphors into organisational language tends to be

selective as only certain aspects of improvisation fit into the analogical transformation while leaving out aspects that do not (Tsoukas, 1991). Scholars strongly suggest the need to look into people's experience of improvisation in real life in order to seek novel findings (Cunha et al., 2017; Fisher & Barrett, 2019). Hadjimichael (2024) recommends the use of in-depth interviews involving the use of open-ended questions to let the participants talk about their own experiences. Video recording can also be included to capture tone, pitch of voice and facial expressions. Close observation is also encouraged (Hadjimichael, 2024). For example, the researcher could shadow participants in the workplace and combine this with 'think aloud' techniques so that the researcher can become aware of what is going through the participant's mind while performing a task (Lauterbach, 2018). As a result, methodologically, this research aims to explore practitioners' experiences of improvisation by using interviews and observation in order to understand the participants' worlds.

The next section will discuss the studies that focus on the outcomes of improvisation.

2.6 Outcomes of improvisation

Several studies have focused on how the impact of improvisation leads to both positive and negative outcomes at different time and levels (Ciuchta et al., 2021). A review paper by Cunha et al. (1999) summarised flexibility and learning as the two most frequently-mentioned outcomes of improvisation in the literature. First, some early-stage scholars (e.g., Barrett, 1998; Weick, 1993a) pinpoint flexibility as the most attractive outcome of improvisation in organisations because it allows organisational actors to adjust their actions in real-time to maintain the fit with the environment. A number of recent researchers (e.g., O'Toole et al., 2020) have also found that the main benefit of improvisation in the day-to-day operation of a company is to keep the team flexible and ready to deal with the unexpected such as in the case of machine breakdowns. As organisational members receive positive

outcomes from improvising (Brown & Eisenhardt, 1997; Cunha & Berti, 2024), improvisation earns a higher legitimacy as a standard practice (Cunha et al., 1999). However, improvisation can be over-legitimised and perceived as a better way of facing challenges. Consequently, organisations may become over-reliant on improvisation and not choose to follow procedures and form plans when they are sometimes a more efficient solution (Miner et al., 1996). Meanwhile, organisational members may feel anxious as they may feel the need to constantly improvise, which is not a light endeavour to do (Fisher & Barrett, 2019).

Second, learning is mentioned by some scholars (e.g., Brown & Eisenhardt, 1997; Macpherson et al., 2022) as a key outcome of improvisation, because organisational members tend to learn from their improvisation which will have a wider implication when learning outcomes accumulate over time. Three ways of learning have been found in the literature (Cunha et al., 1999). Firstly, employees learn how to improvise, so scholars consider improvisation as a skill in its own right (Weick, 1999) and has to be learnt by performing it. The implication is that organisations can develop training tasks for people to improve their improvisational capability (Vera et al., 2016). For example, Mannucci et al. (2021) suggested that managers provide collaboration training to improve employees' improvisation skills as the authors found that members tend to learn in a social environment through interactions. Second, employees can learn through formalising their improvisation because improvisation does not simply fade away after it has been performed (Miner et al., 1996; Cunha et al., 1999). An example by Macpherson et al. (2022) found that firefighting services formalised individual and team improvisation performed by firefighters into standard operation procedure, in order to enhance future performance. Third, practitioners learn more about the environment through improvisation (Weick, 1999). In this sense, improvisation becomes a way of learning, allowing mistakes and failures. Taken together, these outlined studies

present an argument that people learn through improvisation and these have a de facto transformational effect on organisations over time.

To be more systematic in reviewing studies related to outcomes of improvisation, Ciuchta et al. (2021) suggest researchers consider the time perspective, i.e., categorising the outcomes according to whether they appear in the immediate term, short-term, and long-term. Besides, as the literature always highlights that improvisation is not inherently good or bad (Vera & Crossan, 2004; Cunha et al., 2017), the outcomes of improvisation should be considered from a positive/negative perspective, and this will be useful when it comes to making practical recommendations for this thesis.

The following sections review articles categorising the outcomes of improvisation in the two ways outlined above.

2.6.1 Immediate, short-term, and long-term outcomes

First, the immediate outcomes of improvisation, as the name indicates, refer to those consequences that appear immediately after the practitioners improvise. Immediate outcomes are the most common consequences of improvisation, as practitioners tend to address immediate problems (O'Toole et al., 2020). Investigating an NPD team, Miner et al. (2001) found that the immediate outcomes can take the form of novel physical equipment that a team has improvised to solve an unexpected problems. Processes can also have immediate outcomes. For example, Miner et al. (2001) reported that because company policy mandated the use of external focus groups during the development process, the team created an internal focus group of employees to consult on an on-call basis, thus permitting frequent feedback. Interpretation can be another type of immediate outcome. For instance, Miner et al. (2001) found that a marketing team improvised in such a way to interpret the improvement in software running speed arising from a computer bug fix as a new selling point.

Second, short-term outcomes often take the form of performance and learning (Ciuchta et al., 2021). Research in the field of NPD places great emphasis on performance as an improvisational result; one major NPD research study assessed the conditional impact of improvisation on NPD performance (Ciuchta et al., 2021). The coordination of the organising of improvisation activities was a key theoretical concern. Research in this area has found evidence to support the hypothesis that organisational memory, real-time information flows, and past collective experience could often improve new solutions or facilitate the coordination of outcomes, such as improvement in the efficacy and efficiency of NPD teams (Kyriakopoulos, 2011; Moorman & Miner, 1998; Vera & Crossan, 2005). The positive outcomes of improvisation have been the most-researched field. For example, improvisation promotes team innovation when certain team characteristics such as expertise and a culture of experimentation are present (Vera & Crossan, 2005). This indicates that the relationship between improvisation and project performance is a complex one. Kyriakopoulos (2011) found that it was difficult to determine whether actors used declarative or procedural organisational memory, and whether performance or efficiency determines the outcome of NPD.

Moreover, scholars have investigated organisational learning as a short-term outcome (e.g. Akgün et al., 2003; Boudreau & Robey, 2005). Such learning was often detailed. For example, Macpherson et al. (2022) examined how firefighter teams made improvisations to organisational learning. One proposal addressed the fact that the firefighter team was supposed to assemble on the floor below the burning floor, as per standard operating procedure. However, the team sent one member upstairs to look at the fire (Macpherson et al., 2022). The reason was that the standard procedure was to extinguish a pan fire with a large amount of water, causing the whole floor to flood. However, the firefighters applied an alternative action, showing that the team had learnt from past mistakes, such as flooding the

whole floor unnecessarily (Macpherson et al., 2022). Because the alternative action by the firefighters was not reported by the supervisor as it went against procedure, the improvisation remained hidden and resulted in local learning (Macpherson et al., 2022).

Third, long-term outcomes resulting in a lasting impact on the organisation or broader context. At a broader level, long-term outcomes can include emergent changes in the organisation's entire institutional context over time (Smets et al., 2012). Examining the practice of lawyers in an international law firm, Smet et al. (2012) found that lawyers improvised by introducing a process of 'local law due diligence' (p. 885) to spot legal problems. This improvisation meant that lawyer teams adopted a pragmatic attitude towards resolving legal problems. This approach was codified into the firm's practice guidelines and disseminated globally to other solicitors as online tools. Scholars further found that such a long-term impact was often conditional. For example, Hmieleski and Corbett (2008) found that improvisation on the part of startup founders could lead to sales growth; however, such a positive connection was conditional, as it was moderated by the founders' self-efficacy.

2.6.2 Positive and negative outcomes

According to Ciuchta et al. (2021), most improvisation studies focus on positive outcomes, regardless of the qualitative or quantitative methods researchers employed.

Several studies mentioned in the previous section focused on positive outcomes (e.g. Miner et al., 2001; Smet et al., 2012). Negative outcomes might, therefore, need more attention as improvisation itself is not inherently good or bad (Fisher & Barrett, 2019; Vera & Crossan, 2004). Consequently, studying negative outcomes might lead to an exploration of some of the paradoxical situations that practitioners face, and hence further develop improvisation theory (Miner et al., 2024).

A few studies have identified negative learning outcomes in the longer term as being a result of improvisation, such as when organisations 'generalize a solution that makes no sense in circumstances other than those where it was first conceived' (Cunha et al., 1999, p. 330). Although some scholars (Flach, 2014; Leybourne et al., 2014; Giustiniano et al., 2016)) mentioned negative outcomes from improvisation such as product quality loss, chaos or inefficiency, little is known about the conditions causing such a negative outcome of improvisation. Therefore, given that relatively few studies have been conducted such negative outcomes, scholars such as Vendelø (2009) and Cunha et al. (2024) have called for more studies in this area, and for consideration to be given as to what and how particular conditions made the improvisation negative.

To summarise, categorising the outcomes of improvisation from a time-based perspective and in terms of positive/negative aspects, the current literature indicates that immediate/short-term outcomes might be the reasons for people improvising, whilst the long-term impact of improvisation could be difficult to predict. However, recent researchers (e.g., Giustiniano et al., 2016; Hadjimichael, 2024) indicate that the literature tends to focus on instances of improvisation that have positive outcomes in order to figure out how to make improvisation effective. However, a more holistic consideration of the outcomes of an improvisation activity at different times and levels is encouraged in order to understand the complexity of improvisation (Ciuchta et al., 2021; Vera et al, 2024).

Taken all previous sections together, this chapter described the importance of studying the microprocesses of team improvisation (see 2.1), definitions of team improvisation (see 2.2) and the actual microprocesses of team improvisation (see 2.3). This was done with the use of a critical review of the literature which showed how studies of influences and outcomes of improvisation (2.4 and 2.5 respectively) could advance

improvisation theory. An overall research aim can thus be proposed in order to further advance the improvisation literature:

Understand how different types of microprocesses are shaped during team improvisation

To achieve this research aim, four specific research questions are as follows:

1. *What are the key microprocesses of team improvisation?*
2. *What are the key influences on team improvisation?*
3. *How do the key influences shape microprocesses of team improvisation?*
4. *What are the outcomes of team improvisation?*

In the next chapter, a general methodology is presented, explaining how this research aim to answer the research questions, how the design of the research is shaped by the researcher's philosophical assumptions and how to judge the quality of this qualitative research.

Chapter Three: General Methodology

The purpose of this chapter is to reveal the assumptions that have been made when it comes to designing the qualitative studies that make up this thesis. The concepts of ontology and epistemology are explained, and the chapter includes how the philosophical assumptions have shaped the methodology used. Moreover, the components related to the quality of the qualitative research that existed in the literature are discussed to show that this research is of good quality. The general research design in terms of Study 1: Semi-structured interviews and Study 2: Team meeting observation, is included with justifications for their inclusion. The methodological considerations in terms of challenges and limitations are also introduced. This is followed by sections on the research context. Detailed information regarding method designs, and how the participants were sampled, selected, and recruited are presented with regard to each study (see Chapter Four for Study 1, and Chapter Five for Study 2).

3.1 Philosophical assumption

3.1.1 Ontology

Ontology refers to the nature of existence and the structure of reality as such (Crotty, 1998). The concept of ontology relates to the nature of the world and what we can know about it (Hennink et al., 2020).

There are two dominant ontological views. The first is positivism by which the social world is viewed as the independent existence of humans, and the knowledge is thus objective and should be obtained through the use of rigorous procedures (Robson & McCartan, 2016). Researchers in positivist studies tend to adopt a paradigm close to those of the natural sciences.

The other is interpretivism by which researchers view reality in terms of individuals' subjectivity and admit that there are multiple realities (Creswell, 2007). In other words, there is no reality beyond an individual's subjective view of the world.

Moreover, since this research aims to explore how team improvisation occurs, the data analysis was conducted from a process view of the social world (Langley, 1999). Two ontological perspectives exist in viewing process studies (Langley et al., 2013). The first is the social world, which is 'made of things in which processes represent change in things' (Langley et al., 2013, p. 4), meaning that entity's nature does not change, although its quality might change. The second views the social world as one of the processes, which indicates that an entity (e.g., a team) is a temporary instantiation of ongoing processes (Tsoukas & Chia, 2002). The research was designed in terms of social constructivism, consistent with the view that social worlds are processes (Tsoukas & Chia, 2002).

3.1.2 Epistemology

Epistemology refers to the study of how people obtain knowledge of the world (Hughes & Sharrock, 1997). Crotty (1998) pinpoints epistemology as a way of looking at and making sense of the world.

The mainstream types of epistemologies are objectivism and subjectivism. Objectivism is the 'notion that truth and meaning reside in their objects independently of any consciousness' (Crotty, 1998, p. 42). Objectivists, consistent with a theoretical view of reality, believe that an exact and specific reality awaits discovery, and thus the research goal is to find that reality (Alvesson & Sköldberg, 2017). However, subjectivists believe people can be shaped by perceptions, thus adding their interpretations to seeing and understanding the world (Gill & Johnson, 2010).

Concerning team improvisation, people's actions are inevitably influenced by their interpretations of the contexts around them; researchers thus can produce 'know-how' knowledge (Tsoukas & Chia, 2002). Assuming that the reality is socially constructed, a subjective epistemology has been adopted in terms of the research design as the researcher aims to understand participants' experiences about how team improvisation occurs (Bluhm et al., 2011).

3.1.3 Qualitative research

Following the discussion of philosophical assumptions, this section describes the methodology adopted since it influences how the researcher studied the phenomenon (Silverman, 2011).

Interpretivism

Associated with qualitative research, interpretivism focuses on the subjective meaning of social phenomena (Bluhm et al., 2011), which is appropriate for investigating issues such as how people improvise and how improvisations are shaped.

Unlike a positivist approach that emphasises generalisation (Gill & Johnson, 2010), the interpretivist approach usually involves inductive research, meaning that the findings are built from the data in a bottom-up way rather than constructing findings from theories, working top-down (Bryman, 2016; Bell, Bryman & Harley, 2019). Considering the socially-constructed nature of team improvisation (Leybourne, 2024), an interpretivist view has been adopted in this research. Such a view has been adopted by many scholars (e.g., Miner et al., 2001; Macpherson et al., 2022) when they designed qualitative research approaches to explore improvisation. For example, Miner et al. (2001) made sense of their data using open coding following the use of interviews and team meeting observations. By recursively

constructing the codes, they refined the definition of improvisation with the findings of different forms of improvisation (Miner et al., 2001).

Social constructionism

Social constructionism is a theoretical perspective that assumes people create realities via individual and collective actions (Charmaz, 2006). As a form of interpretivism, constructionists are encouraged to develop the subjective meaning of individuals' experiences and focus on the interaction process among individuals to seek how meaning is generated (Creswell, 2007). The basis of social constructionists' beliefs is that people are inevitably stamped by their social origin with regard to meaning and social characters (Crotty, 1998). Moreover, Fish (1990) emphasises that 'all objects are made and not found' and pinpoints 'they are made social and conventional' (p. 186). Ormston et al. (2014) argue that knowledge is produced through understanding the social world of the people being studied, focusing on meaning and interpretations socially-constructed by the social actor in a particular context.

Unlike the objectivist stance, which highlights that the researcher's job is to measure phenomena since they already exist, social constructionists tend to question the taken-for-granted concepts (Crotty, 1998). Felin et al. (2012) called for more attention to be paid to the micro level of social phenomena; fruitful nuances could be neglected when a collective construct is quantitatively measured. During this research project, the main research aim is to understand how people improvise within teams. The nature of team improvisation in the organisation is a social construction (Miner et al., 2024), so it is appropriate for the researcher to understand people's actions via the participants' eyes (Creswell, 2007). The ways in which the contexts affect the participants' actions will have been constructed between the researcher and the participants.

Furthermore, adopting a social constructionist perspective is consistent with this research's data analysis – thematic analysis (see 4.4). The social constructionist perspective

allows team improvisation to be explored from the participant's point of view. Through the experiences of team improvisation shared by the respondents (i.e., multiple socially-constructed realities), this research obtains details of the microprocesses of team improvisation by searching for patterns in similar social conditions. In addition, the social constructionist perspective allows the influences of team improvisation to be explored because the influencing components are the results of social construction between the participants and the researcher.

As many scholars have used a positivist approach involving the use of questionnaires (e.g., Vera & Crossan, 2005) and experiments (e.g., Audretsch et al., 2023) to study improvisation in order to measure and test the relationships between improvisation and various organisational elements, a good level of objective patterns has been documented. By investigating the situation from a social constructionist perspective, a subjective reality could be added to advance the theoretical debate in the improvisation field by producing a piece of research reflecting on participants' views of team improvisation regarding micro-level heterogeneity which underlies the concept of team improvisation (Charmaz, 2006; Felin et al., 2012).

3.2 How can readers judge the quality of qualitative research?

The quality of qualitative research must be discussed by researchers in terms of transferability, dependability, transparency, credibility, confirmability and reflexivity (Lincoln & Guba, 1985). As these notions relate to qualitative research's quality (Lincoln & Guba, 1994), researchers need to explain them in detail and expand on their connections with the research.

3.2.1 Transferability

Qualitative studies are often critiqued in terms of the findings lacking generalisability. Such critiques questions the quality of qualitative research. However, the aims of qualitative research are to present and embrace complexity and to explore the research topics in detail (Geetz, 1973) rather than seeking generalisability.

Unlike quantitative researchers, who seek the probability of findings in other datasets, qualitative researchers use the term 'transferability' to refer to the degree to which the results of qualitative research can be transferred to other contexts or settings conducted among other participants (Lincoln & Guba, 1985). To achieve transferability, qualitative researchers provide thick descriptions of findings and show how the specific contexts shape the findings (Geetz, 1973). Providing a thick description requires researchers to pay attention to social actors' actions and the nuances in contexts, affects, and the generation of multiple codes (Geetz, 1973). Denzin (1989) states that researchers can see the contexts of a particular action, trace the development of that action, and interpret the action with the use of thick descriptions.

By providing such thick descriptions, readers can understand how qualitative research offers insights into their area of interest in a various contexts (Yin, 2018).

3.2.2 Dependability and transparency

Dependability refers to the stability of findings over time (Bitsch, 2005). Bryman (2016) explains that dependability ensures that the qualitative research process can be repeated, and the findings can be compared with those of other research.

The nature of qualitative research may make it difficult for other researchers to produce the same findings because the findings are based on the researchers' interpretations. The difficulty of reproducing findings can be considered as a limitation when it comes to

conducting qualitative studies because such studies cannot be compared (Parker, 2004). However, if one researcher conducted a qualitative study using a similar approach and similar context to that of another researcher, the qualitative research could reveal any changes and differences between the studies, which could result in meaningful insights (Charmaz, 2006).

To achieve dependability, qualitative researchers highlight the procedures used (Flick, 2022). Data collection procedures, participant sampling, and data analysis methods should be presented in detail to make it possible for others to design a similar study in order to answer similar research questions (Bryman, 2016). By providing details of the research process, such as, 'What I did, how I did it, and why I did it' (Tuval-Mashiach, 2017), researchers can achieve a certain level of transparency. Transparency asks researchers to 'disclose all relevant research processes via an honest detailing of every aspect of the data collection process and the rules used to analyse data by presenting excerpts of the textual data' (Tuval-Mashiach, 2017, p. 128). In this research, details about the general research design can be found in 3.3 which shows how the two studies are justified for inclusion. In each method design (see 4.2, and 5.1), details about how each study is conducted (e.g., the data collection process in 4.3, and the data analysis process in 4.4), and reasons for the choices of data collection methods and data analysis strategy are shown. By doing so, a level of dependability can be achieved.

As the detailed presentation of the research process achieves a degree of transparency, Tuval-Mashiach (2017) argues that researchers should make data records available to other researchers and readers to allow them to recognise the patterns revealed by the research to allow them to compare with their own studies, coding schemes and the examples of team improvisation activities. This would thereby improve transparency.

3.2.3 Credibility, confirmability, and reflexivity

Credibility concerns strategies to ensure that a study can be trusted by its audience and other researchers and that its findings are valid (Tuval-Mashiach, 2021). Researchers must prove that their work is believable. Demonstrating philosophical assumptions, by presenting the details of techniques in data analysis and providing the contexts, contributes to establishing the credibility of the research (Tuval-Mashiach, 2017; Patton, 1999).

By following Patton's (1999) recommendations, several steps can be taken to improve the credibility of the research by (1) showing negative improvisation examples; (2) building findings from different data methods; and (3) reporting personal and professional information that may affect the research.

First, Patton (1999) suggests that testing rival explanations and presenting negative examples are helpful techniques for improving the integrity of the analysis. This means that qualitative researchers should search for alternative ways of organising data that may lead to different findings and report any examples which do not fit into the patterns (Patton, 1999). The data reported by the participants may mostly be actions that led to positive outcomes. Therefore, the researcher should pay attention to the ones with adverse consequences. Such a demonstration of non-fitted examples should not be seen as weakening the findings, but rather as an opportunity to allow the readers to understand the complexity of the phenomenon under consideration (Patton, 1999). As participants may have felt uncomfortable sharing negative experiences, the researcher conducted interviews bearing in mind the distress protocol (see Appendix 1) which was approved by the research ethics committee at the University of Sheffield.

Second, researchers are encouraged to construct findings from various data sources to improve confirmability (Patton, 1999). Improvisation researchers have observed team meetings to capture team activity (e.g., Miner et al., 2001). They relied on follow-up

conversations to check whether they understood the procedures to identify a deviated action (e.g., Vera et al., 2016). Documents relating to procedures are references that researchers can rely on to identify improvisation (e.g., Macpherson et al., 2022). In this research, the methods of semi-structured interviews (Study 1) and team meeting observations (Study 2) are used to collect data (see 4.3 and 5.2 for the detailed data collection processes). This research applied a deductive thematic analysis in Study 2 (see 5.3) to confirm the findings of Study 1 which used a different data collection method, as well as searching for new patterns of microprocesses and influences of team improvisation; as a result, the credibility of this research is improved.

Third, researchers must be reflexive throughout the research process to improve confirmability. Confirmability refers to the 'degree to which the findings of the study can be confirmed by other researchers' (Tuval-Mashiach, 2021, p. 369). Lincoln and Guba (1985) describe confirmability as the possible intrusion of researchers' beliefs and values. To ensure the interpretations of the findings are derived from and embedded in the data, researchers need to routinely reflect on their assumptions, expectations, choices, and actions to consider how the research has been shaped (Finlay & Gough, 2003; Tuval-Mashiach, 2021). Such practice is called 'reflexivity' and involves dynamic and continuing self-awareness (Lynch, 2000). Being reflexive means that researchers conduct a thoughtful, self-aware analysis of the intersubjectivity between researchers and the researched (Finlay & Gough, 2003). The reflexivity can be made via the use of reflexive journal. The topics covered in the journal used in this research ranges from approaching the research, collecting data, and conducting analysis to building findings (see 4.3.2, 4.4.1, 5.2.4, and 5.3.5 for considerations from the researcher's reflexivity journal).

In addition, Creswell and Miller (2000) propose member checking as a way of improving credibility. By participants viewing the raw data and providing feedback on its

accuracy, participants involvement can add credibility to the research (Creswell & Miller, 2000). In this research, the participants were asked to review the extent to which the field notes represented key information discussed in the team meetings, and the field notes were revised based on the participants' comments.

Summary

To produce qualified qualitative research, in-depth descriptions of team improvisation were presented in conjunction with local contextual information to understand how improvisation occurs in a team setting and how the microprocesses of team improvisation could be affected by the context. A transparent research process in terms of the designs of data collection methods and analysis strategies was presented (see 4.2, 4.3, and 4.4), which allows subsequent researchers to make a comparison with their own work. Besides, by offering a reflexivity report, readers can discern to what extent and in what aspects the researcher's presence has shaped the research, so that they can judge the quality of the research.

The next section describes how and why this thesis choses a particular type of company for the research context.

3.3 Research context

3.3.1 Organisation selection

This research requires empirical evidence to indicate where improvisation can be most-commonly found to ensure its capture. Consequently, this research can be benefitted from deliberately searching for participants most likely to improvise in team conditions. As a result, the methods used in previous empirical studies regarding team improvisation were examined, to summarise the shared characteristics of an appropriate research context. Seven

papers from top peer-reviewed journals such as *Organization Studies* (see Table 2) were flagged in terms of studying team improvisation.

Table 2. *Empirical studies' research context for selecting participants*

Scholars' name, year	Types of teams	Type of organisation	Features of selected research context
Miner et al. (2001)	Research and development (R&D) teams	A manufacturer in food products; a developer of electronic instruments	Teams that have formalised procedures.
Vera and Crossan (2005)	Training teams; work teams across departments	A large municipal setting	Teams deal with unexpected situations with limited resources or operate under time pressure.
Lynn and Reilly (2008)	R&D teams	High-tech industry	Teams have a structured NPD process
Baker, Miner and Eesley (2003)	Founding teams	Knowledge-based firms (e.g., faculty start-ups)	Firms are in the conditions of high uncertainty; Members have comparable skills and competencies.
Vera et al. (2016)	R&D teams	Computer technology innovation	Teams work in rapidly evolving fields; have clear goals and autonomy.
Magni, Proserpio, Hoegl, and Provera, (2009)	Information systems development teams	Technology company	Teams need to make rapid responses to emergent situations
Cunha, Kamoche, and Cunha (2003)	New mould developing R&D teams	Mould development company; computer technology company	Teams have a clear shared goal, with a straightforward process to follow.

Summarised from the studies outlined in Table 2, two criteria stood out when it comes to choosing participants who were likely to improvise and made them appropriate for this study to collect data from: (1) employees who have formalised procedures to follow, such as

R&D teams who are required to follow process manuals (Cunha et al., 2003). Consequently, any improvisation could be identified via a comparison between what they did and what they were supposed to do; (2) employees who are in ever-changing/unpredictable environment, because such an environment can generate many surprises for employees that can cause the need for improvisation. Such an unpredictable environment can be caused by the changing policies (Liu et al., 2022) or client relationships (Yan et al., 2020). As a result, this research's data was collected from project teams from a manufacturing company in China called Avatar Group (anonymised name). Because there were many written procedures about how things should be done (e.g., how a product should be developed and manufactured), it was deemed that improvisation would be relatively easy to identify. In addition, given that the COVID pandemic was raging and Zero-COVID policies were implemented in China during the period of data collection, a high degree of uncertainty was faced by the company.

In February 2021, in order to obtain organisational access, the researcher's father helped the researcher set up an online meeting with the organisational contact, Mr X. The family connection ensured ease of access. From February to August 2021, the researcher had several meetings to discuss the purpose of the research, its content, and possible outcomes. Mr X agreed that improvisation happened daily at work, and even under the strictest procedural management, people performed unauthorised actions without any preparation. Around August 2021, a human resource (HR) manager was invited to an online meeting to share background information about the Avatar Group. To determine if the Avatar Group was likely to provide rich data for the purpose of this research, the summarised criteria from the previous paragraph was compared with the features of the Avatar Group based on the information the researcher gathered during the online meetings with Mr. X and the HR manager. Figure 1 demonstrates why the organisation was a good fit for the improvisation research.

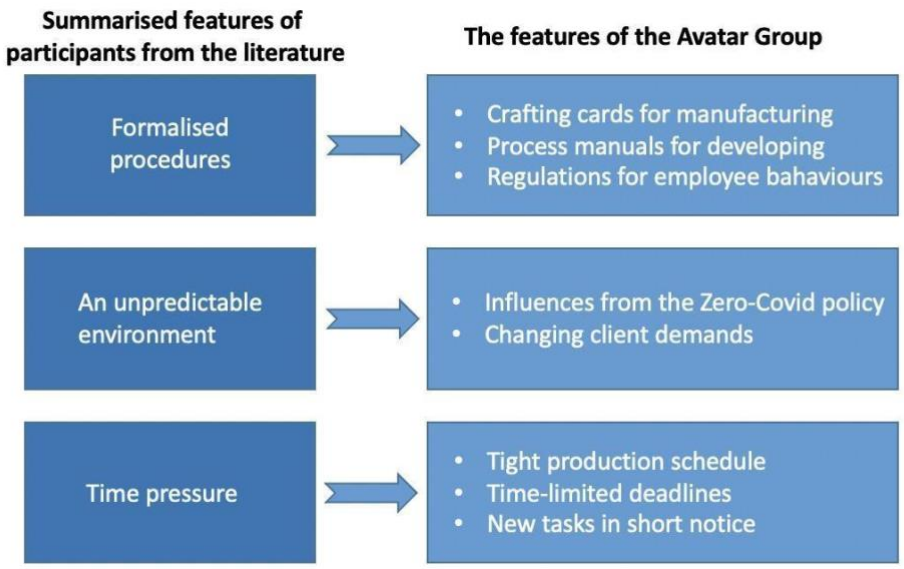


Figure 1: Why the organisation was a good context for improvisation research

Firstly, scholars such as Cunha et al. (2003) suggested improvisation could be identified if the participants had formalised procedures, because they could then be used to compare what the interview respondents said about what the team did. The Avatar Group has crafting cards (a type of written procedure) for operators to follow while engaged in manufacturing, process manuals for mould crafters and designers when it came to developing, and various regulations in terms of communication, decision-making, and workshop layouts. These procedures helped the researcher to identify any deviated actions revealed in the interviews. Secondly, people are more likely to improvise when facing unpredictability (Baker et al., 2003; Vera et al., 2016). The Avatar Group was experiencing disruptions caused by the Zero-COVID policies in China, which resulted in a strong intervention on the part of the local government on the company's management and daily operations. For example, a suddenly-announced lockdown could cause changes in many aspects such as plans for NPD, daily production or freight transportation, creating a series of subsequent chain reactions. For example, the restriction on domestic and international trade led directly to supply difficulties, in that the company not only could not ship normally to clients, but could also not receive raw materials. An example of interventions on the part of

the local government was that it would issue compulsory instructions to reduce the number of workers on the same work floor. This forced the company to change the way of managing production lines to project management, so that only a few people would work on a particular spot at a time while the operation was on-going. Thirdly, scholars argue that people improvise to resolve issues when there is a need to act quickly on the site (e.g., Vera & Crossan, 2005; Magni et al., 2013). Employees worked under a tight production schedule in the Avatar Group, and many job tasks were time-limited. For example, client complaints were required to be resolved in eight to twelve days including the possible time spent on incident investigation. In addition, new job tasks such as a production schedule change could be announced on very short notice. Therefore, the Avatar Group was considered as an appropriate context for studying improvisation.

3.3.2 A Chinese manufacturing company during the COVID pandemic

The Avatar Group is a manufacturing company in China. Founded in early 2000, the company has around 2,000 employees, and achieved revenues of over £150 million in 2021. The company has two separate divisions. One engages in auto-parts design and manufacture, while the other focuses on gardening equipment, as well as having several functional departments. Figure 2 provides an overview of the organisational structure.

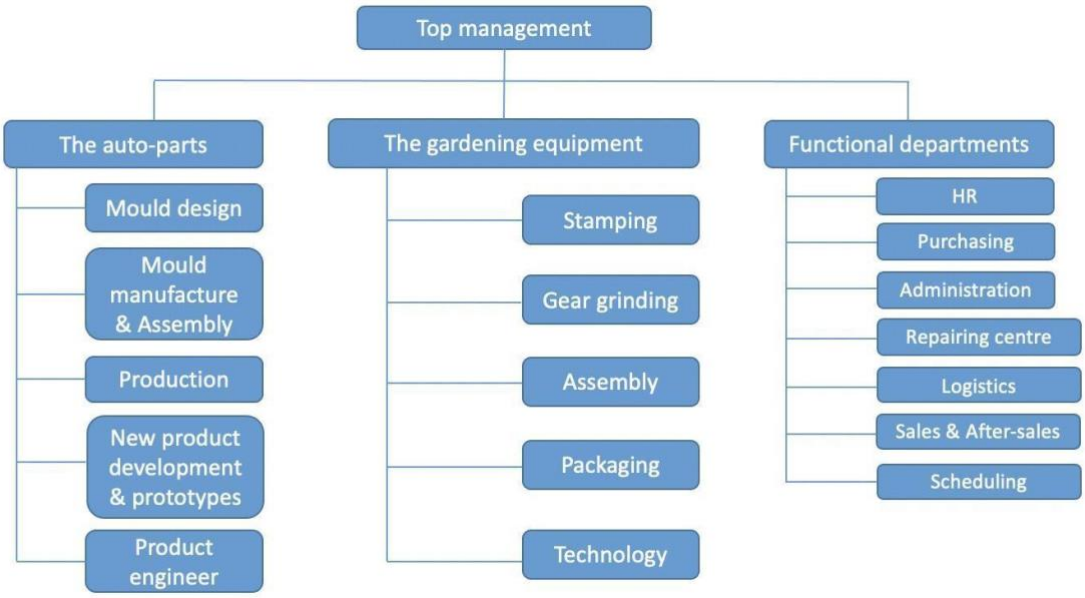


Figure 2: The organisational structure of the Avatar Group

There are several characteristics of the Avatar Group that it worth pointing out because they are likely to influence how the participants behave in the organisation.

In general, the company operates in a highly structured manner with a clear hierarchy within each unit. The formalised departmental structures is as shown in Figure 2 shows. The company's performance is primarily driven by the production of plastic/metal/leather goods, as well as vehicle parts and garden equipment. As the majority of products were designed by client companies, the Avatar Group was mainly responsible for manufacturing. In their daily activities the employees were often responsible for one aspect of the production process (such as metal stamping), so much of their job was highly repetitive. Meanwhile, the company implemented project management in 2021 to cope with the unpredictability and intervention caused by the COVID pandemic and ever-changing Zero-COVID policies in China.

The introduction of project management was meant for give autonomy to employees in order to increase flexibility to allow the company to get through the uncertain periods, allowing capable employees (usually managers from various departments) to form project teams to apply for and carry out job tasks. The project management process requires team leaders to bid for jobs by handing in reports incorporating detailed plans, price lists, and the

employees involved. The top managers then allocated jobs to particular project teams with initial funding if available. The jobs were allocated based on teams performance – the quantity and quality of projects completed. The former simply refers to how many projects a member has completed; the latter involves profit generated and client feedback. At the end of a quarter year, the result of all the project teams are brought together for horizontal comparison to determine whether a member receives bonuses/promotions or is made redundant. As a result, there is a strong sense of internal competition among teams, and members tend to aim to please their clients to obtain better feedback in order to ensure job security.

To be specific, the Avatar Group divides projects into different categories in order to allocate limited resources: a) 'priority', referring to a project fully supported by the functional departments as a priority – these are often projects from long-term clients, and members believe it is easier to achieve better performance in such projects; b) 'regular', referring to projects that are operated on and treated using normal organisational procedures – often projects from medium-term clients; c) 'saline-alkali land' projects, referring to challenging projects with a long development cycle; where members would be expected to work overtime. The literal meaning of 'saline-alkali land' refers to soil which contains too much salt which affects the growth of crops. Such soil widely exists in China causing serious troubles for farming. Since China is a country with an agricultural tradition, the Chinese often use the term 'saline-alkali land' as a metaphor to describe a difficult project. Employees assigned to such projects often face difficulties in achieving a strong performance. As a result, those initially placed on 'saline-alkali land' projects may struggle to secure opportunities to participate in 'priority' projects, as the project allocation system tends to favour individuals with strong performance records.

Moreover, in order to increase employees' proactivity, the company promotes the value of 'the client is the King'. Such a company value was posted everywhere including on factory walls, in the company's front entrance and in the employee canteen. The value was stated in different ways. For example, the phrase 'customer satisfaction is our aim' was hung in Chinese calligraphy on the office walls of some managers. In the most prominent position of the hall of the company's administration building, there was a whole wall hung with trophies and certificates from various clients, stating, for example, 'supplier of the year'. However, the top managers were aware that project teams could be out of control in such an organisational structure and culture, so they launched a system called the 'rectification movement' as a way of detecting and encouraging employees compliance. When a rectification movement was launched, each department or team was asked to report several examples of employee misconduct to top management as a compulsory task. When a member's wrongdoing was reported to top management, the member would be punished, even if the wrongdoing happened a long time ago. It would negatively affect people's career paths even if there was little solid evidence to prove the wrongdoing because the investigation of the wrongdoing automatically damaged the person's reputation, leading to their morality being questioned.

To summarise, the Avatar Group was seriously influenced by the COVID pandemic and the constantly-changing Zero-COVID policies, facing a situation of unpredictability which was largely caused by the intervention of local government. In such an unpredictable environment, the company could be seen as being in crisis; as a result, a series of organisational measures were taken including the introduction of project management, the rectification movement, the categorisation of project types, and the establishment of team performance criteria.

The next section presents the general design of this research.

3.4 General research design

Two studies – Study 1 semi-structured interview and Study 2: Team meeting observation – were incorporated in this qualitative research to best achieve the overall research aim: *understand how different types of microprocesses are shaped during team improvisation*, and answer its subsequent specific research questions: a) *What are the key microprocesses of team improvisation?* b) *What are the key influences of team improvisation?* c) *How do key influences shape microprocesses of team improvisation?* d) *What are the outcomes of team improvisation?* This section outlined the general research design in detail by justifying the reasons behind the choice of the approaches used. In Study 1, one approach was used – semi-structured interviews – while team meetings incorporating the observation method were used in Study 2.

The aim was to capture team improvisation activities. These activities included team actions to analyse microprocesses and contextual information that could be further analysed in order to explore the influences of team improvisation. The semi-structured interview method was chosen because it was able to capture the richness of the data available and preserve the complexity of people's stories (Cassell & Johnson, 2006). In Aage and Meisiek's (2024) research focusing on leadership in improvisation within special operation forces, they adopted the interview method as their primary way of collecting data. The stories of the participants and the world in which they lived were revealed in detail by focusing on how they were briefed, trained, and organised to plan and conduct a mission. In addition, the capture of team improvisation activities was ensured as the participants were asked to share details of such activities. Specifically, the open-ended questions used in the semi-structured interviews were effective for tracking sequences of events by examining the backgrounds, actions, and outcomes (Eisenhardt & Graebner, 2007; Chell, 1998). In the work of Macpherson et al. (2022), when they used the interview method to sort out the action details

of firefighting activities, they used rich data in the form of information from (changes to) standard operating procedures, incident reports, and newsletters to explore how improvisation led to organisational learning. Although the semi-structured interview method has the strengths mentioned above, the self-reported data produced by interviews could lead to bias since the participants might tend to only share examples of successful improvisation for reasons such as self-deception or impression management (Leary & Kowalski, 1990). The team meeting observation method was therefore chosen for Study 2 to offset the downside of self-report data. The reason for observing team meetings was that such meetings represented the principles by which members exchanged information about actions that affected activities and their outcomes (Adler & Adler, 1998). Although it is not guaranteed that improvisation will occur in meetings, the interview method works as insurance to capture team improvisation. In research by Miner et al. (2001), the authors observed 50 product development meetings, and used a process of recursive scrutiny to work out the workflows of team activities with regard to improvisation; as a result, the authors found different types of improvisation. Taken together, this research was a mix of two methods: Study 1 used the semi-structured interview method in order to create a theoretical framework of microprocesses of team improvisation, and Study 2 involved the team meeting observation method to validate and amend that framework in order to increase its robustness. In addition, Study 2 would bring additional insights to add to the Study 1 findings. Therefore, the mix of the two qualitative methods was more rigorous than using only one method while exploring the microprocesses of team improvisation which could not be investigated by quantitative approaches.

In addition, discussing improvisation events may evoke distress on the part of participants, as such recollections often involve revisiting experiences associated with fear or stress (Roux-Dufort & Vidaillet, 2003; Fisher & Barrett, 2019). Additionally, the inherent

nature of improvisation, which frequently involves rule-breaking, may contribute to heightened stress levels (Breslin & Wood, 2016). To address these concerns, this study implemented a distress protocol, approved by the University of Sheffield Research Ethics Committee, to ensure participants' well-being during interviews and observations (see Appendix 1). For instance, if participants displayed signs of distress, such as shaking, crying, or other behaviours indicative of anxiety, the researcher would immediately pause data collection. The researcher would then engage with the participant to assess their condition, and determine whether to continue or permanently terminate the session. In the latter case, all data collected from the session would be discarded to prioritise the participant's welfare.

3.5 Methodological considerations

Ideally, this research should be carried out in an organisational setting where a lot of improvisation occurs. This requires a thorough review of other improvisation studies in terms of how other scholars selected appropriate participants in order to determine the selection criteria for this research. Second, before entering the field for data collection, researchers should have some knowledge of the relevant background of the participants (Blaikie, 2007) because participants are viewed as experts at navigating social life (Blaikie, 2007). This requires researchers to have a pre-understanding of the social/cultural context and practical and organisational skills of the respondents. Third, in the process of data collection, researchers need to consider whether or not the research topic is sensitive and places psychological pressure on the respondents (Badu et al., 2019). Some improvisational scholars (e.g., Cunha et al., 2017; Macpherson et al., 2022) have pointed out that talking about improvisation can be stressful because improvisation can be linked to rule-breaking. Therefore, in terms of research ethics, this research should design a strategy to cope with the possible distress that participants might have. Fourth, when the purpose of the research is to

understand the world of the participants, it is important to distinguish the voices of the participants and the researchers when processing qualitative data (Leeuwen, 2013). As a result, in this research, the participants' voices and the researcher's interpretations should be separated in order to reduce the possibility that the researcher might produce overly contaminated social-scientific constructions (Ong, 2011). Two layers of codes are suggested for use in the data analysis (Charmaz, 2006). The first layer of codes should represent the participants' voices, while the second layer of codes is the researcher's interpretation (Charmaz, 2006)

In the next chapter, it will present how Study 1 is designed and carried out in case of Avatar Group.

Chapter Four: Study 1 - Semi-Structured Interviews

The aim of this study is to achieve the overall research aim: to understand how different types of microprocesses are shaped during the process of team improvisation. This chapter contains seven sections. Initially, this chapter describes the process of sampling appropriate participants to maximise the possibility of obtaining the most relevant data, including how participants were selected and recruited (see 4.1). Then it describes what happened to the participants in 4.2. Specifically, semi-structured interviews were conducted using the critical incident technique. This is followed by a description of how the data was collected (see 4.3) and analysed using thematic analysis (4.4). The analyses searched for the underlying action patterns associated with team improvisation microprocesses and their relationships with different influencing factors and the resulting outcomes. The findings are presented in 4.5. The findings will then be compared with the literature to examine whether any theoretical contribution can be made (see 4.6). Finally, the limitations of this study are stated in 4.7.

4.1 Participant sampling

Purposeful sampling was applied as the strategy to seek participants. This means that the researcher looked for information-rich examples to yield insights and in-depth understanding (Patton, 2002). Although purposeful sampling loses generalisability, the researcher does not aim to apply the findings to a wider population (Patton, 2002). Purposeful sampling allows the researcher to choose a precise purposeful sample to investigate team improvisation.

Given that the Avatar Group was selected as the organisation for the research context (see 3.5), the researcher needed to identify a group of participants that was best suited to

exploring team improvisation. Scholars such as Cunha et al. (2003) and Vera et al. (2016) chose R&D people as participants because the R&D department relies heavily on procedures to complete tasks so that researchers could use the procedures to identify improvisation. Moreover, as suggested by Miner et al. (2001), a project-based approach could be useful in this study to access potential participants since there was no pre-existing R&D department in the Avatar Group. In consultation with the HR manager from the Avatar Group, the participants could talk about experiences in terms of team improvisation with regard to previous projects they had been through. Participants could be from any department as long as they handled a problem or dealt with a situation that had written procedures to follow.

4.1.1 Determining the number of participants

The representativeness of samples is an often-mentioned topic in discussing sample size in qualitative research. According to Maxwell and his colleagues (e.g., Maxwell & Kelly, 2011, Maxwell et al., 2008), sample size only matters when the research aims to generalise from a sample to a broader population. However, the current research is not aiming to achieve such generalisability. The researcher aims to offer insights into the literature by exploring how team improvisation occurs in detail. As a result, readers could then compare how similar/different the contexts and circumstances of this study are to the phenomenon they are interested in. Consequently, readers could decide which part of this study's findings might be appropriate for transfer to their research or be useful in their settings.

Another notion related to sample size is data saturation. When there is enough data to allow for a replication of the research (O'Reilly & Parker, 2013), when it is no longer possible to gather any more data (Guest et al., 2006), and when further coding is not possible, data saturation has occurred (Guest et al., 2006). The failure to achieve data saturation harms the quality of one's research (Kerr et al., 2010). However, no one-size-fits-all method exists

for achieving data saturation (Fusch & Ness, 2015). Dibley (2011) suggests considering data saturation from the richness perspective rather than in terms of sample size. Burmeister and Aitken (2012) assert that data saturation is not about the number of samples (quantity) but the richness of such samples (quality). According to Fusch and Ness (2015), 'rich data is many-layered, intricate, detailed, nuanced, and more' (p. 1409). Morse et al. (2014) reviewed 560 dissertations and found that sample size was rarely related to data saturation. The number of interviews was more commonly related to guidance from other researchers (Mason, 2010). The idea of data saturation can be helpful to one's study (Fusch & Ness, 2015), but it may not be feasible in a time-limited PhD programme context.

The researcher aimed to achieve data saturation while also aiming to provide insights into how team improvisation occurs. Data may not be saturated in the research due to the interruptions caused by lockdowns in China during the data collection process (from July to November 2022). However, a rich array of examples concerning team improvisation were collected through the semi-structured interviews. Meaningful insights about how team improvisation occurs and how the occurrences were influenced were possible using thematic analysis.

4.1.2 Recruiting participants

All participants were recruited in line with by the ethical procedures of the University of Sheffield. Participant information sheets were presented to the participants, and consents were obtained (see Appendix 2 for the participant information sheet and Appendix 3 for the consent forms).

It is important to emphasise that participants were explicitly informed that a company report would be produced at the conclusion of the study. They were assured that all data would be anonymised, including personal names, project names, and team names, ensuring

that the company would not be able to identify individual participants from the report. Furthermore, as a neutral researcher, the researcher was bound by the University of Sheffield's research ethics guidelines, which strictly prohibits the disclosure of any identifiable data to the company.

Small gifts, e.g., tea and fruits, were brought to the participants after the consents were obtained since such reciprocated actions are considered respectful in Chinese culture. The researcher packed small amounts of money in red envelopes as fortune money for the participants after the data collection, as a Chinese cultural gesture to say, thank you. The money was calculated based on participants' engagement time with the research in terms of the local minimum wage, i.e., two pounds per hour per person (see 4.3.2 for reflection of using gifts during data collection).

In July 2022, the researcher sent participant information sheets to the organisational contact, Mr X (the name has been anonymised). The researcher also drafted an email for Mr X to send internally to advertise the research and to ask for volunteers. Mr X sent the email as an invitation to senior managers across departments. The HR manager put information about the research in the company's newsletter and the internal WeChat group. It was made clear that this was a voluntary project. All the people who contacted the researcher were asked questions to ensure they were not pressured to participate – questions such as 'Why are you interested in participating in the research?'

Six people contacted the researcher via email in mid-July 2022 to take part in semi-structured interviews. The researcher met with each person and conducted the interviews in July and August 2022. As the initial advertisement became cold in August 2022, Mr X invited me to meet managers to explain the research. The HR manager posted the recruiting notice for volunteers again in the group chat. As a result of the recruiting exercises, nine people from the auto-parts division agreed to participate, and five from the gardening

equipment division reached me via email. These interviews were carried out throughout September 2022. In total, 20 people were interviewed, with each interview lasting around an hour (see Table 3).

Table 3. *The number and information of Study 1 participants*

Anonym	Position	Division
Andrew	Engineer	Auto-parts
Bob	Packaging designer	
Carter	Supervisor	
Dean	Mould designer	
Eric	Assistant manager	
Ford	Specialist	
Jack	Assistant manager	
Jason	Senior manager	
Miles	Resident machinist	
Oscar	Machinist	
Paul	Senior manager	
Peter	Engineer	
Ryan	Engineer	
Shepherd	Apprentice	
Tanner	Specialist	
Wesley	Salesman	
Carl	Specialist	Gardening equipment
Jake (*excluded, see 4.3.1*)	Supervisor	
Mike	Senior specialist	
Nick	Specialist	

4.2 Method design

The study used one method, semi-structured interviews, to collect data to explore the microprocesses of team improvisation. To identify examples of improvisation, the researcher compared the procedural documents with the interview data to show what should have happened compared with the actual actions the teams carried out (Miner et al., 2001).

In order to encourage the participants to share team improvisation experiences, the critical incident technique (CIT) was used (Flanagan, 1954). During the interviews, the participants were asked to share a memorable team improvisation event, asking them to recall as much of their actions and the context as possible. It has been proven as a useful technique for studying work behaviours (Gremler, 2004) and as a result has been used in many fields of research including improvisation. For example, Macpherson et al. (2022) used CIT to capture 34 improvisational examples and examined the processes of improvisation (Macpherson et al., 2022). A critical incident is an important event that impacts participants' subsequent behaviours and actions (Flanagan, 1954). The use of a CIT therefore allows researchers to explore a specific phenomenon (Gremler, 2004) and infer and predict the behaviour of the person performing the act (Bitner, 1990; Gremler, 2004). Using CIT allows researchers to capture details of the surrounding backgrounds or context (Chell, 1998) and create rich and vivid examples of improvisation. As a result, researchers have been able to identify important thematic details (Gremler, 2004) which helped illustrate how improvisation leads to different types of outcome (Macpherson et al., 2022).

Moreover, CIT has been used in exploring the unfolding of activities. For example, Osei-Frimpong et al. (2015) explored how value was co-created between patients and physicians by investigating memorable incidents from both parties' experiences in consulting service delivery. Burmeister et al. (2015) investigated how the knowledge transfer process unfolds in a repatriation context by analysing incidents reported by repatriated persons.

Team improvisation is the result of socially-negotiated and historically-related processes (Crotty, 1998). A social constructivist's perspective has been suggested to adapt to CIT, which enabled researchers to view participants' experiences as an intricately interconnected, sociocultural, geographic and temporal whole (Ellinger & Watkins, 1998). CIT is thus effective for investigating the unfolding of team improvisation activities because

the researcher could break the improvisation incidents down into actions and make sense of the actions.

According to Watkins et al. (2022), researchers need to elicit sufficient data such that the whole story of the incident is straightforward – what happened when, who said or did what, in what sequence, and with what significance in terms of the phenomena of interest. As a result, a series of interview questions were created to quiz the participants. First, in line with an earlier email communication, the participants were asked to bring a real-life example of team improvisation that they had undertaken to the semi-structured interviews. It was important to note here that the definition of team improvisation, examples of such improvisation from the literature, and a measurement scale of improvisation created by Moorman and Miner (1998a) were all sent to the volunteers by email to help them think of an example of team improvisation. In each interview, the information sheet was given to the participants, and ethical aspects of the research were explained to ensure that they fully understood what was required of them before being asked to sign an informed consent form. The participants were then guided in terms of answering the interview questions (see Appendix 4 for the interview schedule). This started with determining whether the team activities the participants wanted to share fitted with the definition of team improvisation: *one (on behalf of a team) or more team members deviating from written procedures to compose and quickly execute a new solution in order to achieve a shared team goal*. Questions were asked: 'Are you sure the activity you want to share is a team activity, not an individual one?'. If the answer was 'no', the interview was stopped; if the answer was 'yes', they were asked 'Could you please tell me which rule or procedure your team deviated from regarding the team activity you want to share? Is this rule or procedure a written one?'. If the participants confirmed that they did deviate from a written rule or procedure, they were then asked for a written document which contained the rule or procedure the participants had pinpointed. The

participants were then asked ‘What was the new idea the team came up with which deviated from the rule or procedure?’, and ‘Was this new idea executed quickly? Why did you think it was executed quickly?’. The answers to these questions were then compared with the definition of team improvisation, meaning all the incidents used in the study were described as team improvisation by the interviewees.

The participants were then asked to share details of the team improvisation activities. The researcher attempted to sort out the action sequence of the team improvisation regarding what happened to explore microprocesses in order to answer the first research question – *What are the key microprocesses of team improvisation?* A set of questions were asked: ‘What happened that meant your team had to respond in an improvisational way?’, ‘What were your team members doing at that time?’, ‘What did you do next?’, ‘What happened next?’. The sharing was chaotic during the first few interviews since the participants’ memories were chaotic. Consequently, some measures were taken to help the participants recall the actual situation, such as drawing a picture with boxes and arrows regarding actions (see more in 4.3.2 for data collection reflexivity). During the sharing of the team improvisation activities, probing questions were asked to obtain the participants’ thoughts regarding how the team improvisation was influenced in order to answer the second and third research question – *What are the key influences on team improvisation? How do the key influences shape the microprocesses of team improvisation?*: ‘Why did you do/say that?’, ‘What made your team decide to do this? Why?’, ‘What were you thinking when you did/said that?’, ‘What were your team’s considerations with regard to doing this?’, ‘How did you feel?’. When the team improvisation activities were shared, in order to answer the fourth research question – *What are the outcomes of team improvisation?* – the participants were asked: ‘What were the outcomes?’, ‘Could you please tell me about the positive or negative outcomes?’, ‘Did this outcome have a short term or a long-term effect?’ In addition, during

the interviews, questions were asked to clarify jargon, elaborate relationships between employees, and clarify written procedures.

This section described the methods – semi-structured interviews method that this study designed to collect data, the technique used in the method design (Critical Incident Technique), and what kinds of interview questions the participants were required to answer. The next section will describe the process of data collection.

4.3 Data collection

This section presented the process of data collection used in this study. First, the participants were asked to bring details of a team activity that they believed was an example of team improvisation. In each interview, the ethical aspects of this study were explained to the participants as the first step, information sheets were shown, and informed consents forms were signed by the participants. The participants were then asked the interview questions as described in terms of method design in 4.1 in order to collect data. In total, 20 semi-structured interviews were conducted.

Moreover, it was important to pinpoint that the data collection process was halted when there was little in terms of new themes or perspectives being generated in the final few interviews as data saturation was considered to have been achieved (Guest et al., 2006).

The next section describes one semi-structured interview that was excluded from the database.

4.3.1 Sample exclusion

Originally, 20 semi-structured interviews were conducted. After the collection of data, one sample – Jake's interview – was not considered for inclusion as the participant shared a team activity which could not be identified as improvisation. This was because the team did

not deviate from any written procedures. As such, the interview was excluded from the analysis.

4.3.2 Reflexivity on data collection

When I was given a company tour by the organisational contact, Mr X, I met some of my potential participants. I felt these potential participants imagined me as a student from a financially-sound family. The managers I met may have seen me as a naïve student who knew nothing about the manufacturing industry. I was aware of a tension between my social role as a young, inexperienced student and my expectations of how a researcher should act. This tension affected the data I collected by influencing how I guided the interviews such as when, for example, the participant was off the topic of improvisation, and I did not bring the discussion back to the topic. Moreover, I felt it would be rude to stop a senior person from talking. Instead of acting as a researcher, I had slipped unconsciously into my student role and became lost during the interview. As a consequence, I decided to be more dominant in the interviews, I read some papers about reflexivity (e.g., Holland, 1999; Lumsden, 2019); and was able to talk myself out of the student mindset, was reminded of the role of a researcher, who was there to collect valuable data. I continued to remind myself about maintaining the role of researcher until the end of the data collection process.

Moreover, I felt that expressing a degree of sympathy for the participants might be good for data collection. For example, I was aware of how emotional the topic of improvisation could be when I had an interview with a project manager in charge of mould manufacturing. The participant shared his experience about how he made an improvisational decision which had caused the damage to a mould. The decision was that the participant told his members to unload directly from the forklift with the mould turned over. He blamed himself deeply, and I felt sorry for the participant's experience, especially when he said he

still had dreams about the accident. As I wanted to keep asking why he made the decision, I felt I needed to pull him out of that bad memory. Instead of using the word 'you', I used the phrase 'you were back then', and I slowed down the speed of talking and raised my voice when saying the phrase, to emphasise the person who made the mistake was not 'you' at this moment. The participant seemed more comfortable, explaining the reasons for making the decision. Moreover, as I kept using the phrase 'you were back then', the participant started to use 'he', and the conversation moved to a third-person perspective. I found the participant was more open and analytical in talking about the reasons for making the improvisational decision. The participant mentioned that the decision was made because he wanted to show his capability by managing the potential risks of unloading the mould upside down when there were people from other teams around who had a vote in the coming promotion season. Such reasons, I believed, would not have been mentioned if the conversation had stayed in the first-person perspective.

During the data collection, I was worried that influences might contaminate data, but I realised such a concern was affected by positivism. Qualitative researchers consider the emotional reactions of researchers as an inevitability (Alvesson & Skoldberg, 2017), and observing and thinking about the researchers' feelings, assumptions and personalities are invaluable sources of information (Salzman, 2002).

Furthermore, the top management's discouragement of the violations (e.g., the existence of the rectification movement, see 3.5.2) may have influenced the team activities shared by the participants since the definition of team improvisation in this research included a feature 'deviate from written procedures'. When I was explaining what team improvisation was, I came across a question from several participants: 'You mean like a violation?' Although I clarified the definition of team improvisation in a timely manner, for example by stating that this research was not looking for rule-breaking behaviours but was concerned

with team activities involving a quick implementation of a new idea, the participants could be affected by the definition of team improvisation, relating improvisation to rule-breaking behaviours. To offset such an influence, the confidentiality and anonymity of the study and how the data would be managed were repeatedly stressed to the participants to ensure they understood what they shared with me was safe. For example, the ethical aspects of the research were once again explained before each interview even though the participants had previously read it on the information sheet previously. It may be that these practices worked well. During the interview, I did not feel strongly that the interviewees were withholding information (judging by their behaviours during and after the interview; the participants did not seem to change the way they carried themselves after the interview). However, this may be more likely due to the prevalence of improvisational behaviour (or violations) in the company, in that these behaviours were public among a certain group of people, such as all factory members knowing that someone had done something so that the interviewees believed it was safe to discuss a team improvisation activity with me since it was already known by others. Nonetheless, this did not mean that the company's opposition to violations did not have an impact on data collection, because the team improvisation shared by the interviewees was mainly positive, such as successfully solving a problem, negative examples being relatively few in number. This may be because, although top management was averse to improvisation – a suspected rule-breaking behaviour – top managers would have a hard time making the decision to fully eliminate improvisation because the company needed employees to remain flexible, so the company could live through the unpredictable and critical period (see research context in 3.5.2). Therefore, the top managers looked the other way when team improvisation had negative outcomes and involved future risks, which might be the reason for the participants being open to talking about those improvisations with negative outcomes.

In addition, it is necessary to reflect on how the data was influenced by my action of offering small gifts/a small amount of fortune money to the participants compared with other studies regarding improvisation. The act of giving small gifts occurred after the volunteers showed interest in the study and signed the informed consent. Respondents were not aware that they would receive gifts and fortune money, so the act of offering gifts should have had little impact on the voluntary nature of the study. Moreover, unlike the experience of some researchers such as Cunha et al. (2017) or Macpherson et al. (2022), who found that respondents tended to share improvisation with positive consequences, because talking about improvisation could be sensitive for the respondents as it might involve potential rule-breaking. In this study's data collection, I did feel a high degree of willingness to share team improvisation examples with negative outcomes on the part of the participants. This might have been a result of offering small gifts as a way of showing respect in the Chinese culture; the participants perceived me as someone on their side, so they became less sensitive when talking about the team improvisation.

This section described the process and the result of the data collection process – 20 semi-structured interviews were conducted, resulting in 19 interview transcripts (one sample was excluded). The information regarding how the data collection was influenced by the presence of the researcher was also reported in terms of the reflexivity of data collection. The next section will describe how the collected data was analysed.

4.4 Data analysis

The data from the 19 semi-structured interviews was analysed using thematic analysis. Thematic analysis is a technique for finding, analysing, and reporting patterns in data (Braun & Clarke, 2022). Recognising recurring themes helps explain the phenomenon one is attempting to comprehend, so thematic analysis has also considered pattern coding

(Braun & Clarke, 2022). The discovery of patterns enables researchers to develop a conceptual framework that underpins the interpretation of the data and explains how the participant answers are meaningfully connected.

Becker, Bryman, and Ferguson (2012) outlined two ways of conducting thematic analysis: inductive and deductive. The primary analysis was followed by an inductive approach in coding data, meaning that the themes were derived from the data rather than using predetermined themes in the literature (Braun & Clarke, 2022). Due to the exploratory nature of the research topics, an inductive thematic analysis was deemed appropriate for the current study.

In practice, the team improvisation activity needed to be identified based on the definition of team improvisation (see 2.2). The researcher needed to ensure the following. First, the actions needed to be team actions when they were coded out in temporal order, i.e., the performing of the actions involved the interaction of two or more members, or one member acting on behalf of the team. Second, the team actions had to deviate from a written procedure. Third, the execution of a new idea was considered to be quick (the content about how a team action was determined as executing quickly is detailed in the following paragraphs). Therefore, the researcher created a table to list the deviated team actions in temporal order in Word documents (see Figure 3).

Told	Should

Figure 3: Table for the interview data to record deviated team actions

The left column was entitled 'told', reflecting the listed actions told by the participants. The right column was entitled 'should', representing what the team was supposed to do. As the tables clearly showed the team actions listed top-down in temporal order, I needed to examine the time interval between the generation of a new idea and the execution and judge whether the actions were performed quickly. In practice, two criteria were used. First, a team came up with a new idea and executed it on site, indicating a short time interval between the composition of the new idea and its execution. For example, a team decided to fabricate a twisted iron frame, and members immediately looked for iron wires on site (Example 1). Second, the participants explicitly stated that the actions the team engaged in were quick.

After this manual data analysis stage, the researcher started the develop descriptive coding by using NVivo 1.6.2 (later 1.7.1). NVivo is a software that helps organise qualitative data by allowing the coding of such data. The researcher coded the first transcript and identified a number of codes, before moving on to the second transcript. To be specific, texts related to actions were coded for microprocesses, including people's movements, spoken words, and gestures. Texts about the physical and social environment in which the actions took place, and participants' feelings and thoughts including why they believed the need to perform a particular action were coded in terms of influences. Texts about the consequences of their actions were coded in terms of outcomes.

All the data were analysed one after another by building on previous codes. The researcher then started to interpret the descriptive codes to generate the second-order codes (Blaikie, 2007) while considering which codes would be most likely to answer the research questions. The memo-writing function in NVivo helped the interpreting process as it separated the researcher's voices from those of the participants. Consequently, the researcher

could review how the second-order codes were developed and examine the connections between the data and the generated codes (Braun & Clarke, 2022). When producing the second-order codes, the researcher tended to use the words that already existed in the descriptive codes to ensure the second-order codes were close to the intended expression of the raw data. Finally, third-order themes were generated to create some order from the complexity of the data (Blaikie, 2007). The themes emerged through an iterative process of interpreting and engaging with the data (Braun & Clarke, 2022); it was thus important to ensure that the emergent themes were close to the raw data. By constantly checking themes and the data, the researcher ensured that the themes were close to the original data.

4.4.1 Reflexivity on data analysis

Data analysis was one of the most difficult aspects of the PhD journey. The challenge came at the very beginning – choosing an appropriate strategy for analysis. For a few months, I spent a great deal of time learning the techniques of data analysis for the purpose of the research (Langley, 1999), because I believed the data collected should eventually be analysed in a temporal order, since the research question concerns how team improvisation occurs over time. I tested a technique called temporal bracketing: this is a method for dividing an action sequence into different stages by identifying discontinuities in the sequence, so that researchers can generate separate temporal realities (Langley, 1999). A discontinuity occurs when there is a clear breakpoint in time, or the workflow turns in another direction (Langley, 1999). I was obsessed with practising this technique because I assumed that the data collected was processual, and I would end up with it neatly organised by dividing the action sequences of team improvisation activities into phases. However, by adopting such an assumption, I deviated from the intention of conducting a data analysis inductively. In experimenting with the temporal bracketing technique, I had come to realise that it was too difficult to identify

discontinuities in time for activities such as team improvisation happened over a short period; in fact, if there was a clear discontinuity in time, it may not be improvisation but rather the composition of a new solution and its execution might not converge in time (Moorman & Miner, 1998a). However, I expended too much effort to abandon this technique. Consequently, I tried to determine whether the workflow turned in another direction to identify discontinuity; however, I found that the arguments relating to the identified discontinuities were weak because I simply could not identify a clear turning point of workflow direction during team improvisation activities, as team members were sometimes doing something different at the same time on behalf of the team. I had a frustrating time finding out that the temporal bracketing method did not work because I thought that the data collected was too bad to be analysed.

By consulting with my supervisors, I decided to take a step back and start thinking about how qualitative data can be analysed in such a way as to answer the research questions. Thematic analysis met my demand to search for patterns among team actions.

It is worth pointing out that the knowledge that I learnt about process research strategy influenced the practice of using thematic analysis. Initially, my descriptive code included team actions and their associated contexts; however, this made it difficult to find patterns in terms of descriptive codes that would move up to a more abstract level with my interpretations because every descriptive code became unique due to its local context. Upon reflection, I believe the decision to code actions and context together was influenced by the concept of temporal reality, which was highlighted in the method of temporal bracketing. In short, a temporal reality should include actions, perceptions and environments. After discussing it with my supervisor, I found that I seemed lost in the vast sea of data and had forgotten my research question. My purpose was to achieve the aim of exploring: *understand how different types of microprocesses are shaped during team improvisation.* The first step

should be to make a thematic analysis of all team actions to achieve the answer to the first research question: *What are the key microprocesses of team improvisation?* Then, a thematic analysis of the participants' understanding of what influenced them to act, could be carried out to find out what elements enabled team improvisation to occur.

In addition, it is worth mentioning that in the process of using thematic coding, it was found that something was needed to quickly trace back the main context of a team improvisation activity to sort out the sequence of team behaviours in a temporal order so that the coding process could be navigated. Excel spreadsheets were used to list the team members' actions from left to right, but it was soon realised that it was more of a descriptive coding exercise than a tool to help the researcher put the events into chronological order. Then, the researcher found that using a short paragraph to roughly describe the cause and result of the team improvisation activity could well help sort out the teams' actions chronologically as part of the process of thematic coding without missing key information.

This section described how data was analysed in this study, and how the data analysis process was influenced by the development of the researcher's knowledge. The next section presents the findings that came out from the data analysis.

4.5 Findings

By listing 'told' and 'should' columns as shown in Figure 3 in 4.4 and reading the interview transcripts many times, relying on the definition of team improvisation: *one (on behalf of a team) or more team members deviating from written procedures to compose and quickly execute a new solution in order to achieve a shared team goal*; 21 team improvisation examples were derived from the 19 semi-structured interviews. It was necessary to pinpoint that although each participant was only asked to share one team activity, it was found that two participants – Jason (Examples 1 and 2) and Shepherd (Examples 16 and 17) both

provided two examples of team improvisation in their interviews (see Table 4). This happened because the two participants voluntarily offered additional examples to explain what they do at the beginning of the interviews, and the examples were team improvisation as they knew it was the topic of the interviews.

This section describes each team improvisation example in 4.5.1. After providing descriptions of the team improvisation examples, by conducting a thematic analysis, findings are presented with regard to the first research question (see 4.5.2): *What are the key microprocesses of team improvisation?* Then, in order to answer the second research question: *What are the key influences of team improvisation?* themes regarding the influences of team improvisation are presented, with an analysis of how the themes influence the microprocesses of team improvisation in order to answer the third question: *How do the influential components shape microprocesses of team improvisation?* (see 4.5.3). Then, the outcomes of team improvisation are presented in order to answer the fourth research question: *What are the outcomes of team improvisation?* (see 4.5.4).

4.5.1 The descriptions of team improvisation examples

This section aims to provide examples of the descriptions team improvisation (including teams' improvised actions and necessary contextual information) to offer an overall picture with regard to what the teams were improvising, and why it was important to improvise. A total of 21 team improvisation examples are included.

In this section, as the full detailed descriptions of all the team improvisation examples take up a lot of space which might interrupt the narrative of presenting the findings, Table 4 has been created to provide an overview of the team improvisation examples by summarising one example using only one sentence.

Moreover, two full examples are offered to demonstrate the level of detail included regarding team actions for improvising, the contextual information that shows why they improvised, and the outcomes of their improvisation. The remainder of the full examples are provided in Appendix 5.

Table 4. *An overview of the team improvisation examples (Study 1)*

Example number	Overview of the team improvisation examples
1	Jason's team improvised to use some wasted iron wires to successfully solve a product's defection (i.e., cold seams).
2	Jason's team improvised to come up with a new solution (i.e., using water transfer printing) of solving a product's defection (i.e., the colour difference on the surface of a product).
3	Ryan's team improvised to create a protector to refine the heat treatment of metal product.
4	Peter's team improvised to fabricate a diverter pipe to reduce the feeding port blockage of an injection moulding machine.
5	Eric's team improvised to solve a mechanical problem (i.e., a two-gear structure caused dysfunction of a mould) via welding.
6	Paul's team improvised to repair a mould which should be scrapped by stabilising the mould's structure through welding.
7	Andrew's team improvised to use a different way of measuring products.
8	Jack's team improvised to make a promotion which was out of standard procedure to improve a product's assembly process.
9	Oscar's team improvised to conduct an on-site examination on a cutting machine which showed spindle inclination, then left the problem to a night-shift team.
10	Miles's team improvised to solve a product's defection by asking help from an expert who worked for a competitor.
11	Dean's team improvised to skip the internal reviewing procedure on a drawing and passed on the drawing to a manufacturing team.
12	Wesley's team improvised to bypass a R&D team to decide on a product's quality test to get back to a client faster.
13	Tanner's team improvised to mobilise a group of machine operators to help with cargo shipping.
14	Carter's team improvised to shorten the notice period of production rearrangement from three to one day.
15	Ford' team improvised to promise a new client that an under-developing technology would be used in a batch of products, without prior approval from an R&D team.

16	Shepherd's team improvised to use a different way for welding.
17	Shepherd's team improvised to change the welding masks from hand-holding to head-wearing.
18	Mike's team improvised to ask help from other project teams to bypass the testing submission procedure.
19	Carl's team improvised to create a removable physical structure to solve an engineering problem of a mould (i.e., the explosive sounds caused by the air in the mould could not be discharged in time).
20	Nick's team improvised to change the way of packing products in a box to reduce shipping costs.
21	Bob's team improvised to use plastic material (which was not allowed) as water-proofing layer in packaging, then improvised to use large wooden boxes as outside coverage.

Example 1

Jason was the team leader of a team that specialises in the production of plastic products. There were three members in Jason's team. They worked in the production department. The goal of Jason's team was to ensure the daily production of the products they were responsible for, and to resolve any production problems such as mould or machine malfunction. A brief overview of the task that Jason's team carried out was with regard to a panel product which would be used in a high-end drawer of a luxury car. Jason's team noticed there were cold seams around the installation holes of a panel product (see Figure 4 for a graphical representation of cold seams from the Internet).

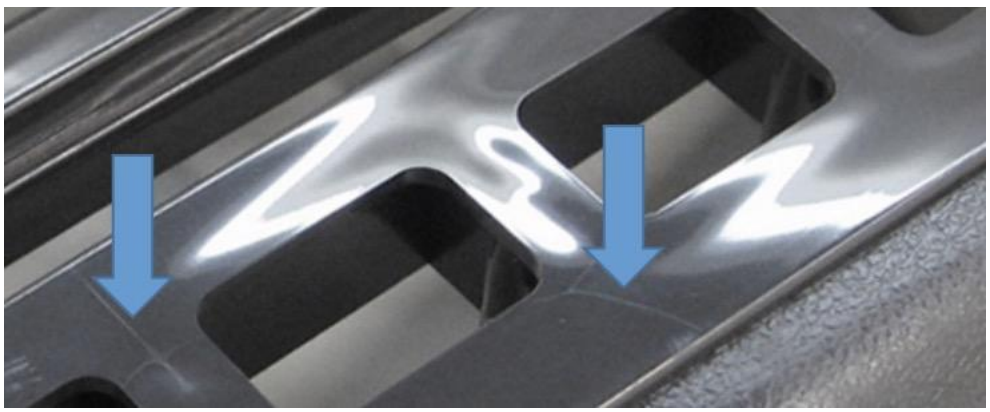


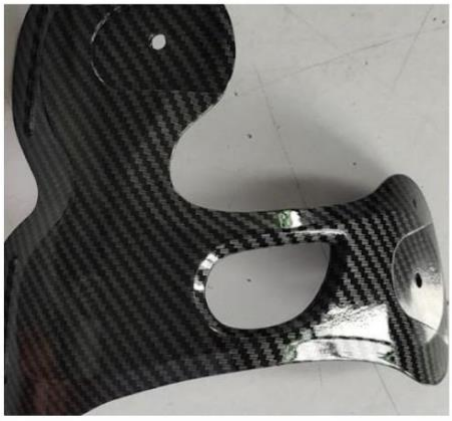
Figure 4: A graphical representation of cold seams

The two blue arrows indicate cold seams. The cause of the cold seams involves the process of injection moulding of a plastic product. When the melted plastic particles are injected into a mould through the moulding pipes, the mould will physically/automatically open to allow the manufactured product to detach from the mould (i.e., de-moulding). At this time, the melted plastic with a higher temperature will leave a mark near the injection moulding mouth which is likely to become attached to the surface of the product. Since the marks are usually found at the seams between a product and a mould and are caused by the temperature dropping, people in the industry refer to them as cold seams. When they noticed the cold seams, the team thought it might be because the overall temperature of the mould had not yet reached the required temperature. Generally speaking, the mould needs time to warm up before producing a normal product. Consequently, the products at the beginning (such as in the first ten minutes) are likely to be defective due to an insufficient temperature leading to inadequate melting of the plastic particles. So, team members wait for 15 minutes (as the procedure suggested), hoping the cold seams would disappear. However, the cold seams did not disappear. As a result, the team members improvised by creating a twisted iron frame, installed at the injection moulding mouths to slow down the flow rate of the plastic, so that the melted plastic would be twined on the twisted iron frame when de-moulding, leaving fewer marks on the product. As a result, the effect of this improvisation was noticeable in that the cold seams were immediately reduced. However, this improvisation would increase the possibility of blockage of the injection moulding pipes, so it was arranged that a team member should supervise the machine. Fortunately, the injection moulding pipes were not blocked until the day's production task had been completed.

Example 2

When manufacturing some samples of a panel product (this was a trial production, and the team needed to obtain the client's further approval to go formally continue), Jason's team found that there was a chromatic aberration on the surface of the panel product. In the absence of mould experts team members improvised by conducting an on-site analysis of the machine, mould and products; as a result, team members believed that the cause of the colour difference was the uneven thickness of the panel. The team then immediately contacted the client to report the situation. Although this was against the company's client contact policy, the participant explained that this was because the client wanted to be informed of the project's progress in real-time. Although the client suggested the team use lacquer baking to cover the surface (so that the colour difference would be covered), the team members believed that the client would not be satisfied with the effect of this method (because the client had told Jason at the beginning of the project that the panel would be used for the car drawer of a high-end car). Therefore, the team members had a discussion and came up with a new solution – using water transfer printing (see Figure 5 for a comparison between treatments involving water transfer printing and lacquer baking).

The treatment of water transfer printing



The treatment of lacquer baking

Figure 5: The comparison of treatments between water transfer printing and lacquer baking, pictures were from the Internet

Figure 5 shows the difference between the two treatments (the products in the Figure 5 were not the products in this example. Pictures were taken from the Internet). The team members believed that the solution involving water transferring printing was better than that involving lacquer baking because the appearance of the products treated by the former was better; Jason therefore called the client on behalf of the team and persuaded the client to adopt the team's new plan. The team then immediately made samples and sent them to the client. In the end, the client was satisfied with the quality of the samples. However, the client believed that the cost was too high, so the client chose another company's low-cost solution: thin rubber coating. Due to the loss of the order, Jason's team lost their bonus for that quarter. Nevertheless, Jason's team still believed that the improvisation was a conscionable choice at that time, because the team members believed they had to provide the best solution for the client to ensure the quality of the product.

In this section, this study identified and described a total of 21 team improvisation activities from the data presented above. This study then used the descriptions of these team improvisation examples as exemplars of the raw data, conducting thematic analysis based on interview transcripts, resulting in the four themes associated with the team improvisation team improvisation microprocesses noted in the next section.

4.5.2 Microprocesses of team improvisation

The literature review led to the definition of the microprocesses of team improvisation as *action patterns that deviate from written procedures to compose and quickly execute a new solution to achieve a shared team goal*.

This study used thematic analysis to identify these microprocesses of team improvisation. Table 5 shows the coding process.

Table 5. *Coding scheme emerging from the data analysis process (Study 1)*

First-order code	Second-order code	Theme
Going to warehouse Searching mobile shelfs Searching the on-site offices Searching carriable toolboxes	Gathering materials	Making 'temporary' devices
Handcrafting materials Machine crafting materials Using the tools Measuring to fit Assembling components Testing out the devices	Fabricating devices	
Adding extra components Restructuring components Removing components	Amending devices	
Changing the scope Claiming not applicable Claiming it is invalid Using analogy Emphasising the local situations	Twisting meanings	Interpreting written procedures and introduced new ideas
Claiming it will be more effective Seizing opportunities Avoiding loss Increasing mediation room Claiming to be flexible	Adding meanings to new ideas	
Highlighting superiors' attitude Mirroring others Elaborating words/phrases from procedures	Weakening the enforcement	
Asking professionals to come by via calling Going to helpers' places Inviting other teams on the site	Different method for reaching out to helpers	Asking for help from outside teams
Asking for instructions Elaborating situations with others Clarifying teams' actions	Bringing insights to solve problems	

Proposing for favours-exchanges Offering gifts	Offering incentives to bypass rules	
Expressing opinions on the cause Checking the equipment Seeking evidence for opinions	Finding causes	Arguing and verifying to construct solutions
Proposing new ideas Comparing new ideas Testing to show ideas' differences Building on each other's idea	Generating new ideas	
Pinpointing costs Pinpointing deadlines Highlighting the convenience Exaggerating the consequences	Convincing each other	

The first-order codes were descriptive codes relating to team actions, representing the action patterns of team members that deviated from a particular written procedure in order to execute a new solution. Therefore each of the first-order codes represented a microprocess that contributed to a team improvisation activity; there were a total of 45 microprocesses identified in the study. The second-order codes categorised the first-order codes in terms of the researcher's interpretations when a group of first-order codes shared a general meaning, resulting in 12 generalised microprocesses. This then led to the creation of themes, which further categorised the second-order codes when a more general meaning was identified. A total of four themes were aggregated as the most abstract ones. Therefore, the whole coding framework as shown in Table 5 represents a categorisation of team improvisation microprocesses.

This section presents the four themes, representing the most generalised microprocesses of team improvisation, identified in this study via thematic analysis, a) *making 'temporary' devices*, b) *interpreting written procedures and introduced new ideas*, c) *asking for help from outside teams*, d) *arguing and verifying to construct solutions*. In each theme, data relating to the second-order codes were used for illustration purposes. Taking the

theme of making ‘temporary’ devices as an example, the reason for providing such detail was based on a clear understanding of exactly how a temporary device was made. Such an understanding could provide analytical dimensions to the analysis of how the microprocess was influenced, to further inform why team improvisation occurred.

In order to offer a description of the categorisation of improvisation microprocesses, what they represent and what examples are involved, Table 6 was created to serve as an introduction to the subsequent descriptions and explanations.

Table 6. *Description of the four themes of the microprocesses (Study 1)*

Number	Theme	Meaning	Involved example
A	Making ‘temporary’ devices	Teams improvised to temporarily create a physical structure to get the job done, the teams tend to repeat the process or production of the improvisation in the future.	Example 1, 3, 4, 6, 13, 17, 19, & 21
B	Interpreting written procedures and introduced new ideas	Teams improvised to interpret written procedures (e.g., organisational regulations or technical manuals) and new ideas in different ways, to make room for actions which deviated from written procedures.	Example 4, 5, 7, 8, 14 & 18
C	Asking help from outside teams	Teams improvised to ask for help from people outside the team (e.g., other team members, experts from competitors) on the site for different purposes (e.g., solving engineering problems, or bypassing organisational rules).	Example 4, 6, 8, 9, 10, 11, 15, 18, 19, & 21
D	Arguing and verifying to construct solutions	Team members improvised to argue with each other regarding problem diagnosis and corresponding solutions, and simultaneously performed actions to validate each other’s ideas to create team consensus regarding a final team plan.	Example 2, 3, 5, 9, 11, 16, 18, & 20

Theme A: Making 'temporary' devices

The theme of making 'temporary' devices represented how teams improvised in such a way as to use readily accessible materials/tools to make a temporary and physical device to get a job done. It would be understandable if teams made such temporary devices to solve field problems to keep the workflow going. However, teams used the method of making temporary devices as a permanent solution as they wished the devices to be a permanent fixture.

This theme contained three second-order codes which represented different stages: a) gathering materials, b) fabricating devices, and c) amending devices.

Gathering materials

Most raw materials that the team used to make a device were readily accessible. Team members went to the warehouse to find things they could use to make a particular device. When Peter's team (Example 4) was responsible for the mass production of a pipe product (a fuel tank inlet pipe), the main feeding port of the injection mould machine became blocked. Instead of unclogging the feeding port, the team improvised by making a diverter to allow the flow of plastics to bypass the feeding port. Peter went to the warehouse and searched for a duct: 'I walked to the warehouse, there is an area for useless items, and I found a duct … the material was the same as that of the main feeding pipe' (Example 4). Necessary tools also had to be collected: 'He [the machinist] brought a shear to me as well' (Example 4). A senior manager described how people looked for material when they wanted to make a small device on the spot.

> 'We will first look for what can be used on the site; for example, we will use the rest of the packaging boxes to set up the machine, go to the warehouse to find what is available … at most, go to the next-door workshop, walk around, but not too far' (Example 6).

After the materials were found, team members roughly checked the quality of the materials to ensure the devices they were making could last for sufficient time to get the job done. A logistics team (Example 13) once had to deal with an urgent delivery and members decided to use whatever they could to load the products, such as placing some wooden slats on two-wheeled carts to transfer product boxes. Tanner was asked by his leader to check the quality of the wooden slats: 'I put one end of the wooden board on the stone step and stamped on it with my foot to see if it could bear my weight' (Example 13).

Fabricating devices

The data analysis found that teams fabricated devices with the materials they found. Tools were used to shape the materials. For example, Peter's team (Example 4) used a pair of shears to cut a duct into an appropriate length to make a diverter pipe. Team members also hand-crafted and assembled the collected materials to create devices. The machinist on Jason's team (Example 1) used his hands to twist the steel wires into a frame: '… with the general feeling … used his [the machinist] hands to twist the wires, twist into a small frame'.

Moreover, teams made changes to existing equipment to improve its efficiency. Shepherd's team (Example 17) used a bending machine to make a small steel shelf that was then installed inside a welding mask with a clamp, and then used rubber to cover the shelf; people could use their teeth to bite the rubber-covered steel shelf, so their hands could be free to weld when necessary.

> 'We used a bending machine which could be operated manually, bent a 2.4 [type of steel] stainless steel welding wire … made sure to bend tiny knots at two ends of the wire, marked the distance between the two screws on the welding mask, then used a clamp to tighten' (Example 17).

Paul reported how his team fabricated a temporary device as a last resort to save a mould (Example 6). Paul once received a handover slip indicating that the mould for a connector product was irreparable because a square tube on the cavity could not be pinned down. Paul's team cut and ground a steel stick using an abrasive cut-off machine and welded the steel stick to support the square tube.

> 'They [people in the repair centre] told me to scrap the mould … we basically made a fixture device, took a 40 [a type of stainless steel] stick, ground it to a suitable size, and welded it to the square tube' (Example 6).

Similarly, when it was found by a quality inspector that Bob's team (Example 21) (the team was responsible for the implementation of the de-plasticised packaging scheme) were using plastic materials as waterproof layers within the packed boxes, it was too late to find suitable paper-based materials to repack because it was the time to load the goods for delivery. The team had to remove all the plastic layers in the packed boxes and find some wood strips and boards to fabricate some large wooden boxes which they used to wrap the packed boxes, to achieve the purpose of waterproofing (since the products were delivered to a city famous for constant rain).

> 'We can only make larger boxes to wrap the packed boxes … with a staple gun … with wood boards and wood strips to wrap them [the packed boxes] according to the size of each box, which was actually using wood to waterproof the products' (Example 21).

Amending devices

When fabricated devices did not work, teams tended to modify them rather than reject them. Peter's team (Example 4) made a diverter pipe to deal with a blockage; the team found that the melted plastic in the diverter pipe flowed faster than that in the main feeding pipe

because the diverter pipe was narrower. The team added a manual valve between the diverter and the main feeding port so that the operator could manually match the flow rate of plastic particles in the diverter to that in the main feeding pipe in real-time by observing whether or not the manufactured products were correctly formed.

> '… the feeding from the back was too fast, the products were not good, it can be seen on the product that the end of the product is heavily stacked, [the machinist] suggests using a manual valve. We added a valve, so he [the operator] can tighten or loosen it' (Example 4).

Similarly, when Paul's team (Example 6) noticed the steel stick (which was installed to support the square tube in the mould) was bent, the team decided to strengthen it: 'We drilled a hole in the middle of the stick then inserted, welded again, it's like double insurance with regard to supporting'.

Furthermore, teams mentioned that they removed some components of the devices to cope with changing situations. To narrow the tolerance range of heat treatment, Ryan's team (Example 3) made a heating protector from springs and bent iron sheets. However, the heating protector stopped the raw steel from reaching a minimum temperature, so the team removed one layer of iron sheet.

> 'We found that the heat protector was too effective … the temperature wouldn't come up, the heat wouldn't go up … the heat protector became a solid shield, we had to wait until it cooled down and then took off one layer [sheet of iron] …' (Example 3)

Theme B: Interpreting written procedures and introduced new ideas

The theme of interpreting written procedures and introduced new ideas represented how teams improvised to interpret procedures and new ideas to make room for actions which

deviated from written procedures. The interpretation took the form of conversation between members, which occurred before the new ideas were put into practice.

This theme contained three second-order codes that indicated how teams improvised to interpret procedures and new ideas: a) twisting meanings of a procedure, b) adding new meanings to new ideas, and c) weakening enforcement of a procedure.

Twisting meanings

As teams were aware of the kinds of actions they were not allowed to do, members talked about the procedures they should follow to change the procedures' meanings to make space for their new ideas' execution. Eric's team was once responsible for a mould trial project (Example 5). However, the mould was not functioning: 'we assembled it, put it in [the injection moulding machine], turned it on, and nothing happened, no sound, no movement'. Eric's team found the problem was that two gears in the centre of the mould should not coexist: 'There should only be one gear, not two … if we get rid of one, the mould will be okay' (Example 5). The team wanted to improvise to weld the two gears together, so the mould could be functional, and the team's job could be done via this simple operation. Before the team conducted the welding work, two team members talked about a procedure called crafting cards – this was a procedure that employees should follow during mould manufacturing. The cards represented the detailed operating steps of manufacturing a mould because the idea of welding the two gears together involved changing the manufacturing process of the mould which the team was not allowed to do in a mould trial phase. When a team conducted a mould trial to test the performance of a mould, the company required the team should conduct the mould trial according to the process of mould manufacturing specified in the crafting cards so that the functionality of each component of the mould could be examined. The team improvised to twist the applicability of the crafting cards in the mould trial phase: 'he [a team member] said the crafting cards became references, and I said the

crafting cards were more like some suggestions to us … we did not violate them [the crafting cards]' (Example 5). By reducing the scope of application, the meaning of crafting cards was twisted in effect, a compulsory procedure thus became optional.

Adding meanings

By packaging the deviated actions as acts of seizing opportunities, teams added new meanings to existing ideas, showing that teams actively chose to deviate from the written procedures in order to improve effectiveness. Jack's team (Example 8) changed the assembly method from complete interchangeable assembly to selective assembly to speed up the production of glass regulators. When the selective assembly was being tested, the team chose one assembler to train others, and then asked the assembler to work as a trainer and field supervisor.

> 'As testing out the selective assembly method … we suddenly saw a product box with many more products than everyone else. We talked about it … whether we should just let the guy [the assembler] do some quick training of others. We all agreed the new idea would be effective … after the testing, we agreed to let him [the assembler] take more responsibility for training and supervising the assembly process' (Example 8).

Jack's team interpreted the new plan in terms of appointing a skilful assembler as a trainer and believed it would be more efficient in terms of speeding up the assembly if the assembler could teach others. Moreover, participants often highlighted the convenience of a new idea. When Peter's team created the diverter pipe to solve the blockage of the main feeding port, the team interpreted convenience as being an important aspect of maintaining the workflow.

> ‘We don’t have to stop the machine [the injection moulding machine] … it’ll take ages to clean, cleaning blockage like that is a messy job … machine stop, production delay, paperwork … with the diverter pipe, no need for all of that’ (Example 4).

Moreover, Andrew’s team (Example 7) found that if one calliper was used for all parts of the product (wheel control joints), the task of measuring could be finished quickly; the team had a conversation about the effectiveness of the idea of using only one calliper.

> ‘We talked about the idea of measuring (all parts of the product of wheel control joints with a vernier calliper), it would be quick … effective … we measured with our fingers against the clamp, then the clamp is mobile, we can flexibly measure any part of the product’ (Example 7).

Weakening enforcement

Participants were found to interpret procedures by weakening the enforcement. When Eric reported the progress of the project to a superior, it was clear that the two gears were welded together after manufacturing, and the superior accepted the team’s explanation (Example 5). Eric mentioned that the team had the expectation that the superior would be tolerant of their deviated actions.

> ‘When he [the machinist] and I reported the project progress to the boss, we also clarified that the two gears were welded together after manufacturing. My boss didn’t say anything bad … we kind of knew what would happen; he [the superior] was always very nice to us, he used to say that procedures are rigid, but people are flexible’ (Example 5).

Not only could a superior’s attitude help teams weaken the meanings of procedures, but also other people’s behaviours. For example, when Mike’s team (Example 18) found that

they would spend a lot of time submitting the testing requests for steel materials (at that time, the team had at least two dozen requests to submit), the team wanted to ask other teams to submit some of them on their behalf, so as to speed up the completion of the testing. Before implementing this idea, the team discussed the testing submission procedure.

> 'The testing procedure itself did not apply to us, and the result of our conversation at that time was that many people were doing such a thing (i.e., submitting testing requests on behalf of each other) … and we were, strictly speaking, not breaking the rules, a request was still contained one object and one purpose …' (Example 18).

Given that interpreting and submitting testing requests on behalf of each other was a common occurrence in the company, the team weakened the enforcement of the testing submission procedure. Moreover, teams would choose to interpret a specific word or phrase in the regulation so that the meaning of the regulation was weakened. A project team from the production scheduling office once replaced the production of a hub with an axle with one day's notice (Example 14). However, the 'Regulation of production arrangement in production workshop' explicitly stated, 'To maintain the production order, changes to production arrangements require at least three days' notice'. The team leader, Carter, interpreted the word 'order' in the regulation.

> '… but to meet the shipment deadline is the order [voice raised] … the order which is more important … it allows the company to deliver regularly, allows the company to receive payment on time. The regulations say three days [in advance] … we announced it one day before, the warehouse, the workshop, the mould change, the transportation … all were in order' (Example 14).

Theme C: Asking for help from outside teams

The theme – asking for help from outside teams – represented how teams improvised in such a way as to ask for help from outside teams on the site in different ways and for various purposes, something which was not allowed according to the project management system.

This theme contained three second-order codes: a) different methods for reaching out to helpers; b) bringing insights to solve problems; and c) offering incentives to bypass rules.

Different methods for reaching out to helpers

Teams used various ways of reaching out to a helper. For example, Miles called his master to solve the problem of colour changes (Example 10). Dean's team emailed a friend who was a mould designer to solve some computer modelling problems (Example 11). Moreover, one participant reported it was common to ask people from other project teams face-to-face to look at problems in the factory, whereas the company discouraged project teams from interfering with each other.

> 'Let's say my team was in trouble here, and your team was just next to us dealing with your mould, product or whatever. Of course we will ask you to come over and have a look; it's always good to have another voice' (Example 9).

The help could be very minor. For example, members of one team asked front-line operators to help hold the diverter pipe while they were looking for a manual valve for adjustment purposes (Example 4).

Bringing insights to solve problems

To solve problems, teams asked for help from outside teams in an attempt to understand what they were dealing with. For example, when an injection moulding machine produced an abnormal sound, Carl (Example 19) video-recorded the machine making the

abnormal sound and sent the video to the head of the technology department, asking for advice to help the team decide what caused the sound and where the sound originated from.

> 'I walked around the machine, recorded a video, and sent it to my boss [the head of the technology department] who forwarded the video to a machine maintenance WeChat group … we wanted to see whether other people could help us figure out what we were dealing with …' (Example 19).

To ask for help, teams had to explain the situation they faced and what they had done as they tried to tackle the problem by themselves. For example, when Jack's team tried to improve the efficiency of the process of assembling the glass regulator product, the team asked advice from a supervisor from the office equipment office (who had previously worked in assembly) and visited the HR department (Example 8). Jack explained what his team was required to do to the supervisor, and another member of Jack's team asked for information about re-training and recruiting from the HR department.

> 'I went to his office [the supervisor who previously worked in assembly], told him about the low assembly efficiency … to see if he had some comments … he [another member of Jack's team] went to see the HR people … If the assembly method was changed and some employees could not keep up with the schedule … to see if the HR would work with us, or just see what they [HR people] wanted to say on this … to do training or new hiring …' (Example 8).

Offering incentives to bypass rules

Apart from explicitly bypassing rules in asking for help from the repair centre as Paul's team did in Example 6, rule bypassing could be implicit. For example, the quality control department should arrange the same type of testing in order of arrival. Although the rule of 'first come, first served' was stressed at previous management meetings, teams could

circumvent this by asking for favours. Mike's team (Example 18) wanted to know about different steel materials' metallographic phases when the team refined a type of blade product. The team wanted the results quickly, so they asked a favour from the quality control department to prioritise the team's request and asked other teams to submit testing requests for them; small gifts were given to the people the team asked for help from.

> 'Too many tests needed to be done … too long to queue up. My boss told me to go to the quality control people with the prototypes of the blades, and the head of the technology department said just stay there till the tests were all done … we brought some fruits, tea, and snacks to say thank you' (Example 18).

Moreover, cigarettes and alcohol served as gifts regardless of whether the helpers were smokers or drinkers. A manager described using cigarettes and expensive rice wine as a way of showing respect to helpers. When Ford's marketing team (Example 15) wanted to ask the R&D team to improve a new technology to meet a new client's preference, Ford's team brought cigarettes and rice wine to the leader of the R&D team during a visit.

> 'It does not matter whether the person smokes or drinks… even if you don't smoke, you need to share cigarettes, the action of sharing alone is important, you have to show some respect when you ask for help, right? … they [the helpers] could go to a shop and convert cigarettes into money … or give the rice wine to others as gifts' (Example 15).

Interestingly, a participant mentioned the differences between the gifts.

> 'Usually, cigarettes are used for important events and are usually given to people who are friends, whereas gifts such as fruit and tea are given to people who don't know each other well and when it is a small favour, not big … if you want to show that you

value the other person, if the other person is a man, there are usually men in the factory. Cigarettes and liquor are best' (Example 21).

Theme D: Arguing and verifying to construct solutions

The theme of arguing and verifying to construct solutions related to how team members interacted for improvisation purposes regarding the analysis of encountered problems and the corresponding solutions, and simultaneously performed actions to validate each other's ideas in order to create team consensus and arrive at a final team plan.

This theme contained three second-order codes: a) finding the cause, b) generating new ideas, c) convincing each other.

Finding causes

To figure out what teams were dealing with, members argued over the cause of a problem and acted simultaneously to find evidence for the cause. For example, Oscar noticed some deformation in cutting pipes (Example 9) and the team members speculated over what might have caused the problem. The machinist in the team thought it was due to the inclined lathe spindle, while Oscar believed it was because of the increased temperature. An engineer argued it was because of the radiation from the mould warmer while the project leader argued that the aluminium pipe was affected by a temperature imbalance.

'Everyone has their own ideas. I think it's because of the environmental temperature. It is so hot in summer right? … [the machinist] says the lathe itself is inclined, or [the engineer] thinks the radiation of the mould warmer, the boss [the project manager] said that it was the material, the error is normal, we have to let the machine run for some time, it will be fine … we argued, they [the guesses of the cause] were all possible' (Example 9).

When team members expressed opinions, they acted to provide evidence: the engineer said it was because of the radiation of the mould warmer, and he walked to the mould warmer to see whether it was turned on (Example 9). The project manager used a gradient application on his phone to check whether the lathe was inclined.

> '… he [the engineer] said as he walked over to have a look [at the mould warmer] … when the machinist suggested it was because the lathe was inclined, my boss [the project manager] pulled out his phone, and used a gradient application' (Example 9).

Team members sought factual evidence to prove the cause of the problems, even when only two people were there. Eric's team had different opinions for why the mould was not working (Example 5). Eric believed the connecting rod and the mould slider should be checked first, while the machinist argued for examining the mechanical structure. Then, Eric opened up the mould, and the machinist checked the transmission of the bevel gears.

> 'I said I thought it was the connecting rod and the slider, he thought it was the mechanical structure, the gear, the coupling shaft, etc. … so we went two ways to find out why the mould was not working … after all, you provide me with the proof, then I'll admit, okay, you are right' (Example 5).

Generating new ideas

As teams found what they were dealing with, team members proposed ideas to solve the problem. For example, Ryan's team found that the surface of a buckle product had suffered from decarbonisation and that there was severe oxidation (Example 3). Decarbonisation refers to the process of reducing the carbon content of steel. Ryan proposed using a heating protector to prevent the heater from harming the product; however, the machinist suggested painting to protect the product's surface: 'I said to use a heater protector,

and he [the machinist] said to add a coat of paint to the surface …' (Example 3). Then, the team members elaborated on their proposed ideas.

> 'I said we could add springs to the heating rods, which would allow the heating process to be gentle, so as not to damage the product … and this would be the most cost-effective way … he [the machinist] was saying about using sprayed epoxy powder and some other equipment… how good that will be …' (Example 3).

The proposed ideas were more than opinions, and participants demonstrated their ideas to simulate how they would make a difference to the product. As mould designers, members of Dean's team (Example 11) usually created copy drawings with the proposed changes representing their new ideas, showing them to each other because a spoken description would be unclear.

> 'If we have any ideas about mould design to make changes … oral communication is not enough. You have to draw it, construct the mould structure, show your idea … Otherwise, I don't know what you are talking about …' (Example 11).

A participant from the technology department of the gardening equipment division pointed out that any new ideas needed to be supported with evidence: 'Everyone has an idea, you have to present it with something solid … make a sample, a prototype, to show that your idea is good' (Example 18). Mike was once responsible for refining a blade for a weeding machine (Example 18). Members of the technology department were divided into two groups with regard to different opinions about choosing steel materials (Example 18). One group argued for the need to increase its hardness, while the other wanted to reduce the hardness to increase wear resistance. As a result, the technology department manufactured blade samples with different materials for quality testing purposes.

> '… the steel material has an impact on the later processing … we have experience … we know what kinds of steel are best in terms of hardness, or flexibility … but you never know until the blade is manufactured. There are too many variables … do it, prove your idea, get the metallography detection done … they [the samples] will speak for you' (Example 18).

As the ideas proposed by team members were meant to be compared, elaborating the ideas and the actions for proving the ideas could occur simultaneously. Nick and his two colleagues were all front-line workers in packaging, and they were trying to find a way to reduce the wear on blades during transportation (Example 20). Nick explained his idea by showing his colleagues how to place the blades in a box.

> 'As I spoke, I placed one blade wrapped in corrugated paper horizontally at the bottom of the box, then another blade along the lines of the corrugated paper, and so on, making the placement of the blades tighter' (Example 20).

Convincing each other

Although a proposed idea supported by evidence might indicate which idea is better, it did not automatically enable team members to reach an agreement. A team agreement would be easier to reach if the team leader had a strong opinion on how things should be done, and costs implications were often pointed out by leaders to convince other members. For example, lower costs were highlighted by Jason (the team leader) to convince a machinist to use water transfer printing to hide colour differences rather than using a covering (Example 2). Team agreement was more difficult to achieve when there were only members and the team leader was not involved. For example, the machinist and the engineer locked horns over how the colour differences should be coped with, before the team leader stepped in: 'Before I said anything about costs and budgets, they [the engineer and the machinist] were arguing for

more than ten minutes about what should be done [to deal with the colour difference]' (Example 2). Therefore, total agreement was essential when members were making decisions, the team members' suggestions would be more likely to be supported by members.

The data also showed that members chose the most convenient way to do things. When it was getting closer to the end of the day's shift, teams convinced themselves to go with the plans which involved the least effort. Oscar's team were in agreement that the deformation of the pipe products was likely due to high temperatures, but they were not sure of the heat source (Example 9). Members proposed ideas with regard to the heat source such as radiation from the mould warmer, hot weather, and overworking the lathe's spindle (Example 9). Instead of checking the heat source, the team left the problem to the night shift; members convinced themselves that the heat source was the hot weather and that the deformation of pipes would disappear when the night shift took over.

> 'I wasn't sure why it was happening; I didn't know who said that we should leave it to the night shift team so we could rule out the weather … we were getting off work, and there was nothing more we could do' (Example 9).

Interestingly, members exaggerated the negative consequences of the ideas of others when dealing with a problem in order to convince the other members. For instance, when a just-welded spot came apart, a machinist suggested that Shepherd's team change the welding sequence and leave the corner part to last (Example 16). As the machinist noticed Shepherd was not changing the welding sequence, he claimed Shepherd would destroy the whole mould if he kept on doing the same thing.

> '… there was a seam on the side of a mould, broken … he [the machinist] said that I welded in the wrong order, and I had to save the corner until the end, but in fact, it was OK. Then he said that if I continued to weld like this, it would still break, I said it

would be OK, and he said that it might be OK at the beginning, but after the mould was installed and started production, it would break in the machine, and the mould would be destroyed … that was crazy talk …' (Example 16).

The machinist was trying to convince Shepherd's team to weld the corner last, whereas Shepherd was not listening to the machinist. The attempt to convince him became threatening because the machinist told Shepherd that his team would have to do extra work if the corner part was not welded last: 'He [the machinist] said if I didn't do it, he'd let me do all the welding in the workshop' (Example 16).

In summary, this section described four themes with regard to improvisation with their corresponding second-order codes. These were identified through a thematic analysis of 19 semi-structured interviews using the critical incident technique, representing a categorisation of team improvisation microprocesses. The four themes were: a) making 'temporary devices, b) interpreting written procedures and introduced new ideas, c) asking for help from outside teams, and d) arguing and verifying to construct solutions.

The second research question for the study was *What are influential components of team improvisation?* Therefore, the next section will provide insight into the reasons why the participants improvised.

4.5.3 Structural, social, and cognitive influences of team improvisation

In asking participants why they did something, or what they were thinking when they did or said something, they described the elements that influenced their actions according to their understanding. By looking for patterns in the data regarding the answers to the relevant interview questions, five themes with regard to influences were identified using thematic analysis: 1) location distance (*structural influence*), 2) power (*social influence*), 3) worry

(*cognitive influence*), 4) time pressure (*cognitive influence*), and 5) team climate (*cognitive influence*).

In this section, an overall introduction with regard to the five themes and their second-order codes will be provided. This will demonstrate the meanings of the themes and the second-order codes underpinning them with evidence from the data. The themes were categorised into structural, social, and cognitive aspects, with the reasons provided in each theme's introduction. Then, in order to answer the third research question: *How do the key influences shape microprocesses of team improvisation?* analysis was provided to show how these microprocesses of team improvisation were affected by the five themes relating to influences. Table 7 provides the coding scheme for the influences.

Table 7. *Coding scheme of the influences emerging from the data analysis process (Study 1)*

First order code	Second order code	Theme
The executive building Production lines in the factory The temporary factory office The factory sharing an office	Physical distance between team members	Location distance
The sliding containers in the factory The warehouse outside the factory The working stands next to the machines	Physical distance between team members and the tools/materials they needed	
Position rank in the organisation Position rank in the project management system 'Chief responsibility system'	Position ranks in the organisation	Power
Length of service Skills and capability	Seniority	
Project allocation system Lack of factory workers Growing orders	The worry about falling behind	Worry
Unpredicted rectification movements	The worry about being punished in the future	
Tight schedules Task deadlines Client's demands	Approaching deadlines	Time pressure
Surprises happening Increasing damage	Urgent field situation	
Colleagues' praise	Positive attitude toward successful improvisation	Team climate
Leaders not intervening Leaders helped cover-up Leaders not criticising	The protective attitude of leaders	
The belief that errors are inevitable Belief on unpredictability The necessity of testing	High tolerance with regard to unpredictability	
The slogan 'the client is God.' Training about how to serve clients	Client is King	

Introduction of the themes and their second-order codes

Theme 1 Location distance

Participants reported that location distance was an important element to consider when a team decided to improvise. The physical distance between the location of people, and of tools and materials would be taken into account when it came to improvising. One participant described how he considered the location distance when improvising: 'If something is not visible to my eyes, I will not approach it [to improvise]' (Example 19). Therefore, in a boarder sense, the theme of location distance should be considered as a *structural* influence on team improvisation because it involves how the physical environment affects the way people make decisions.

The theme of location distance comprised two second-order codes: (1) *physical distance between team members* and (2) *physical distance between the team members and the tools/materials they needed*.

(1) Physical distance between team members

Participants reported improvisations were affected by the physical distance between people. Team members could generally be divided into engineers, machinists, and mould specialists, machine operators, and team leaders. Although a team should work together, team members were often located in different places. Engineers usually had factory desks, entitled on-site desks, or temporary areas in the factory enclosed by foam panels; senior engineers could be allocated a seat in an office upstairs. Machinists usually walked around the factory to inspect the products/moulds they were responsible for. Mould specialists were based in the executive building, a 15-minute' walk from the factory, or they could be on a task at the factory, in the repair centre (20 minutes' walk from the factory). Machine operators had fixed places (next to the machines) in the factory.

It could be seen from the data that team members, with the exception of machine operators, did not seem to have a fixed work area; they were often on the move because they usually worked on several projects simultaneously.

Given such a situation with members being separated and unaware of where each other was, members who encountered a problem relied heavily on the team members who were present. One participant described the importance of the people on the spot when it came to improvisation.

> 'You have to rely on the people who are in the field to do an improvisational activity, and the people who are most connected to you are the people who found the problem with you, and then, next, [are] the people who will respond when you call out their names' (Example 3).

Moreover, all participants understood the necessity of helping others in an emergency, especially when observing the emergency occurring nearby: 'If there is an emergency happening right next to me, and you see others scrambling to deal with it, how could I just stand there and do nothing?' (Example 7). However, when respondents found themselves distant from the team that needed help, members would consider not helping because they thought a closer person would do so: 'such helping has a distance limit, I can't run to the other end of the factory to help people … there will be people who are closer' (Example 18).

(2) Physical distance between team members and the tools/materials they needed

One senior manager pointed out that team members were very used to relying on reachable resources which could be quickly obtained to ensure the on-going workflow.

> ‘We usually try to fix the problem on the spot, using whatever tools we can quickly use … For example, if a machine leaks oil and the waste oil bucket is far away, we will use a nearby trash bucket to catch the leaking oil’ (Example 6).

The closer the tools/materials were to the team members, the more they would be utilised for improvisation. For example, a participant described his consideration of the distance in terms of improvising.

> ‘Generally speaking, to improvise … If something [tools/materials] is far away from you, like the thing you needed is in the warehouse, you have to walk 15 minutes to get there … then you have to find out where this thing is … it takes more than an hour to go there and come back, you wouldn’t go there at the first place right? You won’t be able to improvise because of such distance’ (Example 3).

It suggested the location distance of the tools/materials was a consideration for team members when it came to deciding whether or not to improvise.

Theme 2 Power

Participants recognised that power was one of the influencing elements when it came to improvising. Power was represented as one’s ability to make others obey without question. So, it is appropriate to consider the theme of power as a *social* influence on team improvisation because power can not be impactful without each other. In the Avatar Group, power was centralised to leaders since the company adopted a ‘leader responsibility system’, meaning the highest ranked person took all the responsibility, with every organised group having a leader.

Participants mentioned that members could not question a leader’s decision: ‘I believe that it is impossible for people to raise questions about a leader’s decisions in public’

(Example 4). Moreover, team members tended to follow leaders' orders even if they thought that the leader's instruction might be wrong. This was because the leader would take responsibility if the plan went wrong.

> 'Even if I feel what he [the leader] said may not work, I will not say it out loud … I will try to do what he [the leader] asked me to do, so that I will not be blamed … because anyway, if the final result is not good, it will be the responsibility of the leader, not mine' (Example 14).

With power, leaders were less sensitive to the possible negative outcomes of improvisation; leaders thus could be innovative and reckless at the same time.

The theme power came from two sources which appeared to cause team improvisation (i.e., second-order codes): (1) *position ranks in the organisation* and (2) *seniority*.

(1) Position ranks in the organisation

The top-down sequence in the company took the form of top management, division head, director and unit head, manager, supervisor and ordinary employee. Each higher level has more power than the lower ones. Since the Avatar Group implemented a project management system, team leaders have more power than team members. Moreover, with the application of the 'leader responsibility system', a leader oversees everything within a project team. Although the company designated a leader (who could be thought of as a managing director) as being responsible for everything, there would usually be a few cadres around that individual who had been appointed informally by the leader; these cadres thus held some degree of power as they were the persons who had access to the leader.

(2) Seniority

The power of seniority highlighted that more senior members of the organisation were more readily listened to even if they were from outside the team. Employees tended to ask senior people's suggestions because they had higher-level skills and capabilities. For example, as a two-year-old member of the company, Carl mentioned that he would seek the advice of senior members and follow it: 'I usually ask my senior for advice, and if he gives me advice, I take it' (Example 19).

Theme 3 Worry

The theme of worry reflected how the microprocesses of team improvisation were shaped as team members experienced a sense of worry. Therefore, it is appropriate to understand the theme of worry as a *cognitive* influence on team improvisation as it represents how participants think and reason.

In this study, participants indicated they felt worried when improvising.

> '… it's a feeling of being worried … when you don't have to do that [improvising], you feel worried if you don't [improvising] … when you have to do it [improvising], you will be worried as well' (Example 6).

Such a sense of worry made people restless and anxious, and the feeling of worry was a constant in the work: 'It's not like that's [improvisation] the only time you're on pins and needles, you're worried all the time' (Example 1). One participant described the feeling of worry as dissatisfaction with the status quo.

> 'When everything is running normally, you will not feel satisfied … you always want better, such as changing the mould faster … as soon as possible to finish this batch of products, so we can move on to the next batch' (Example 19).

Participants highlighted that members would be worried that if they did not improvise to speed up a workflow they would not be able to keep up with the tight production schedule. The purpose of keeping up with the production schedule was ultimately to complete a project. Moreover, members worried about being punished in the future, so they improvised to mitigate the risks.

The theme of worry consisted of two types of worry (i.e., the second-order codes) which might be reasons for improvising: (1) *the worry about falling behind* and (2) *the worry about being punished* in the future.

(1) The worry about falling behind

Such a worry pushed teams to act quickly in their daily work. The worry was caused by the company's project allocation system, which caused competition among teams to do things quickly. In the Avatar Group, the top management allocated projects received from clients to particular teams of employees, with the projects being divided into "priority projects" and "saline-alkali land projects". The former referred to projects from long-term clients who had made a down payment; these projects were flagged as having priority within the company. The latter referred to challenging projects with a long development cycle; members would be expected to work overtime. The top management chose employees with good records to work on these priority projects. As a result, teams were competitors in such a system. A unit head described this kind of intangible competition.

> 'Your team needs to be better than others; although the projects are different, usually, you will be judged by the number of projects and how fast you finish the project … it's like a competition. You have to win this horizontal comparison, so the next time, you will be assigned to a better project, or the company will give your team extra support' (Example 6).

Due to the competition, the worry about falling behind has long existed in the company which could be a reason for introducing improvisation.

(2) The worry about being punished in the future

Such worry originated from the rectification movements in the company. Rectification movements were carried out occasionally by top management, aiming to uncover employee behaviours that violated organisational procedures. A rectification movement could happen before important potential clients or local government officials come over for a factory visit. Such a movement might focus on a specific topic, such as checking the implementation of the company dress code, meeting deadlines, and reporting system effectiveness. Sometimes each department or team would be asked to report several negative examples to top management. One participant described how a rectification movement concerning discipline was conducted before the visit of an important client.

> '… we are required to report some violations and give them [the top management] some names, usually a fixed number … Your department is required to report three examples. Your head [of department] will assign the job to three teams, and each team writes one report … the report must have a few points, who, what, how it was resolved, and what to do next, etc. … if you say no [there is no violation], they [the top management] will speak to you alone, encourage you to provide a tip-off … sometimes they [the top management] say you can report your colleagues by sending a direct email' (Example 21).

When a member's wrongdoing was reported to top management, the member would be punished even if the wrongdoing happened long ago. It would negatively affect people's career paths even if there was little solid evidence to prove the wrongdoing because the

investigation of the possible wrongdoing automatically damaged the person's reputation, which led to his/her morality being questionable.

Worrying about being punished in the future could promote improvisation with the aim of reducing the risk of being held accountable when team members wanted to deviate from a procedure for improvement, or had to make deviant actions to deal with surprises.

Theme 4 Time pressure

The theme of time pressure reflected how the perceptions of time pressure caused by approaching deadlines and urgent field situations affect improvisation. The theme of time pressure is thus appropriately seen as a *cognitive* influence with regard to team improvisation.

All participants (19 interviewees) indicated that a certain level of time pressure was involved in the consideration of team improvisation. A resident engineer described his work as 'racing against time', so he had to improvise.

> 'A big part of my job is racing against time … It is important to complete work tasks in a short time, which means that I could deal with as many problems as possible to ensure the smooth running of the production lines that I'm responsible for …' (Example 10).

Other respondents also repeatedly cited a lack of time to explain why they were improvising. For example, Peter explained why the team did not think of reporting the feeding port blockage: 'There was no time to report it … it's getting worse and worse as I'm watching it' (Example 4).

The theme of time pressure contained two sources of time pressure (i.e., the second-order codes) which seemed to be the reasons for improvising: (1) *approaching deadlines* and (2) *urgent field situations*.

(1) Approaching deadlines

In general, the time pressure associated with approaching deadlines was caused by tight schedules. Facing the increasing costs of raw materials, shipping, and labour, the Avatar Group maintained its profitability by lowering prices on each product, taking in more small manufacturing orders, and expanding its business scope by entering the after-sales market. The Avatar Group introduced tight production schedules to keep the company growing. A senior manager described his feelings about the production schedule.

> '… the production is pre-scheduled tightly. It was done according to the stock holdings and the urgency of delivery … even if there was no urgent deadline, you have to be prepared for the future, fill up the warehouse … and it was not in our [project team] control … all we can do is work, work, work, finish this one, move to the next one' (Example 6).

Moreover, specific task deadlines needed to be met by teams, such as meeting deadlines for sample delivery and mould trials. In addition, although the deadline dates remained the same when clients changed (usually increased) their demand, the time pressure was from the increased workload to meet deadlines.

(2) Urgent field situation

Unexpected situations cause a strong sense of urgency, and teams need to react as soon as possible to cope with the increasing time pressure. Participants provided examples which reflected the time pressure caused by urgent field situations. In Example 9, team members turned off the cutting machine when they noticed the deformation of the pipe products.

> '… I rushed to turn off the cutting machine, because the deformation of the pipe indicated that the machine itself may have calibration problems … if I let the machine continue to run, the consequences would be unimaginable' (Example 9).

Theme 5 Team climate

The theme of team climate reflected that the team believed they operated within a safe atmosphere, which allowed team leaders and members to perform and justify unconventional actions. It is thus appropriate to understand the theme of team climate as a *cognitive* influence on team improvisation.

The theme of team climate comprised four second-order codes which appeared to be influential in terms of team improvisation: (1) *positive attitude toward successful improvisation*, (2) the *protective attitude of leaders*, (3) *high tolerance with regard to unpredictability* and (4) the value of the *client is King*.

(1) The positive attitude toward successful improvisation

Colleagues adopted a positive attitude toward improvisation as long as it solved a problem. For example, Peter described how colleagues complimented his team for solving the feeding blockage by making a diverter pipe and introducing a manual valve.

> 'We heard people say we were smart, decisive … because if we hadn't made the diverter pipe, the machine would have been shut down for at least one day … there was a heroic feeling as you saved it' (Example 4).

Moreover, a member of the welding team described how other employees complimented the team's improvisation, i.e., a temporary device: the rubber-covered steel shelf: 'When they [other employees] heard that we had made it [the rubber-covered steel shelf inside the welding mask] ourselves, everyone said it was a good job' (Example 17).

(4) The protective attitude of leaders

Such an attitude reflected in the leaders' previous responses to team improvisation, such as helping to cover up and not intervening with regard to a team improvisation. This made team members believe they would be protected if they improvised. For example, against company guidelines, Andrew's team had been using the same callipers to measure different parts of a product, and the team's project manager used to help the team cover this situation in their reports (Example 7). Similarly, he did not criticise the improvisation. Similarly, Eric's team was not criticised by their leader when he knew that the team had changed the mould structure by welding the two gears together (Example 5). In the example when Miles and a machinist asked for help from an outsider and changed the percentage of nylon to reduce honeycomb-shaped holes that had appeared inside the pipes, the superior did not intervene in these field deviating actions He was aware of what was happening on the site but did not acting to stop them (Example 10). These protective actions on the part of the leader conveyed a message to the team members, i.e., deviation from the procedures will be protected if it means that the problem is solved.

(3) High tolerance with regard to unpredictability

As they believed it was inevitable that mistakes would be made, members had a high tolerance for unpredictability. For example, one resident engineer was responsible for correcting daily malfunctions and, as he said: 'Errors are normal … I'd be panicking if no one called for me for an hour' (Example 10). These unforeseen circumstances led to the need for improvisation, and the constantly changing environment was reinforced by the experiences related to ever-changing COVID-19 restrictions.

> '… three trucks were trapped at service stations on the highways … the provincial police said okay, you can go. However, each city had its own policy … we should re-

check it [the policy], but again you never knew until you wanted to get off the highway … no one can be blamed really, it's out of our control' (Example 11).

(4) Client is King

The company promoted the value that the client is the King, a slogan placed almost everywhere in the company such as on the factory wall, the front entrance, and the employee canteen; such a value was reinforced by company training. Team members often took such a value to be a defence, and for an excuse to justify a team's improvisation, one which the company widely accepted. For example, a senior manager used the client's response to justify the team's improvisation: '[although] we did not contact the client as required [by the procedure] … but the merits balance out, right? The client liked our new proposal …' (Example 2).

This section describes the meanings of the five themes (i.e., location distance, power, worry, time pressure, and team climate) and their influences on team improvisation based on the second-order codes identified via thematic analysis of the 19 semi-structured interviews. In the next section, the five themes with regard to influences will be mapped on the themes of the microprocesses of team improvisation in order to examine how team improvisation can be influenced to provide insight to the third research question: '*How do the influential components shape microprocesses of team improvisation?'*.

4.5.3.1 Analysis of how the microprocesses of team improvisation are affected by the influences

This section shows how the microprocesses of team improvisation identified in 4.5.2 are affected by the five themes relating to influences, so the influences were mapped on the microprocesses. This analysis involved the themes and second-order codes of influences and microprocesses. First-order codes were not included in order to achieve a balance between

attaining parsimony and establishing richness. Figure 6 was created to offer an overview of the analysis.

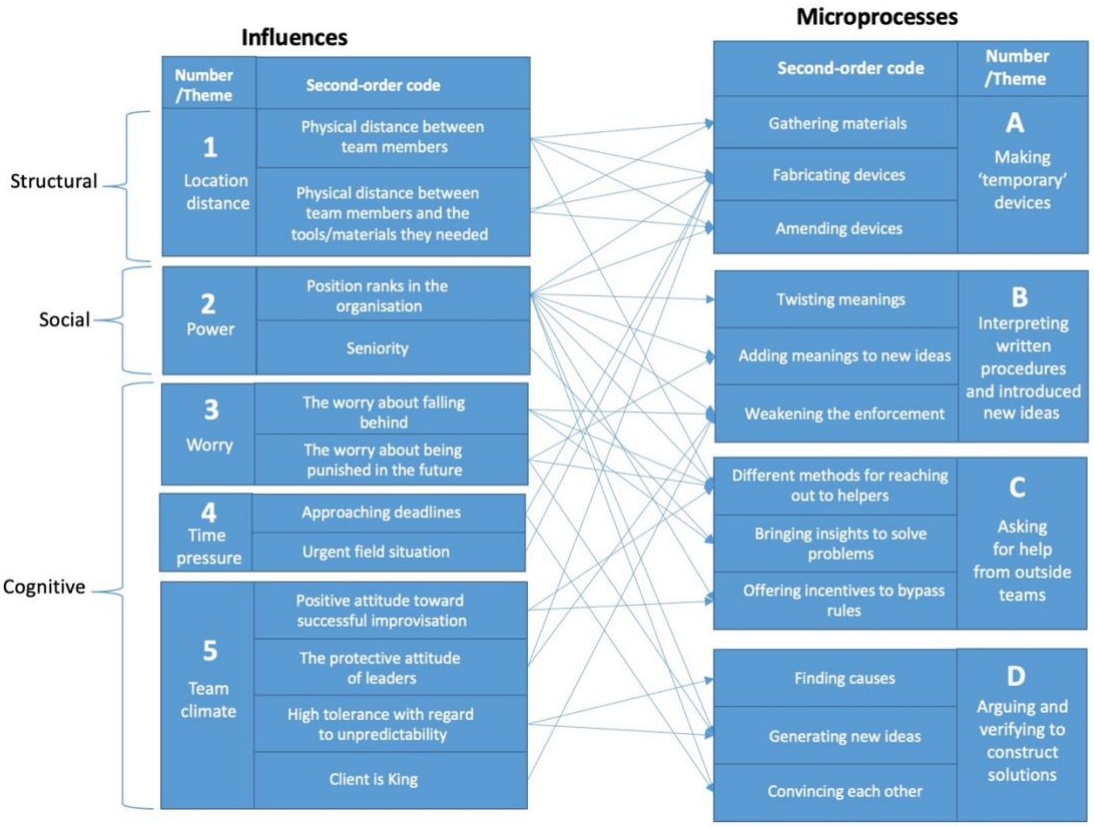


Figure 6: An overview of how the microprocesses are affected by the influences (Study 1)

In Figure 6, on the left-hand side, there are themes of influences (numbered 1, 2, 3, 4, and 5) and the corresponding second-order codes, with the themes being categorised into structural, social, and cognitive. On the right-hand side, there are the themes of microprocesses (numbered A, B, C, and D) with the corresponding second-order codes (also representing microprocesses). The arrows in the middle connect the influences with the microprocesses to show which influence affects which microprocess.

The following paragraphs will analyse how the microprocesses are affected by the influences. As the entire analysis would cover many pages, this section will demonstrate the situation by offering two examples. Firstly, the analysis presents how the Theme A (Making 'temporary' devices) was influenced by Theme 1 (Location distance), Theme 2 (Power), Theme 4 (Time pressure) and Theme 5 (Team climate). This is followed by the analysis of

Theme B (Interpreting written procedures and introduced new ideas) as influenced by Theme 2 (Power), Theme 3 (Worry), and Theme 5 (Team climate). The rest of the analyses are attached in Appendix 6.

Theme A Making 'temporary' devices as influenced by Theme 1 Location distance

Firstly, when members were separated by operating in different locations, members had to rely on field members to improvise if there was a problem. It was found that teams improvised when it came to making physical devices (including gathering essential materials, fabricating the devices, and making necessary amendments) without consulting specialists due to the physical distance between the team members and the specialists. In Example 1, a team decided to make a twisted steel frame to reduce the occurrence of cold seams without consulting its mould specialist because it was not the team's first instinct to gather all members in light of the physical separation. The team considered that the time needed for a mould specialist to travel from the executive building to the factory might hinder on-site problem-solving: 'By the time he [the mould specialist] could come, it might be too late' (Example 1). The physical separation would further cause duty overstepping because time was considered a scarce resource in the field; members at present would tend to do the absent member's work to save time. For example, Jason and a machinist measured the mould to adjust the device's size to fit into the mounting mouths of the mould, whereas the measurement should be made by a mould specialist (Example 1). A similar team improvisation happened in the case of Eric's team. When the team suspected a two-gear mechanical mechanism was stopping the mould from functioning, Eric and a machinist welded the two gears together without discussing the situation with a mould specialist as to whether the welding would have negative structural consequences (Example 5). Given that the mould specialist was stationed in the executive building, there was little incentive for Eric's team to ask the mould specialist to come to the site to look at the situation.

> ‘We almost never thought of letting him [the mould specialist] come and see what was going on … In fact, the separation made us all accustomed to cleaning our own front door, he [the mould specialist] did the designing, and we were responsible for making the mould pass the trial’ (Example 5).

Secondly, team members tended to make the decision with regard to improvisation because the tools/materials they needed for improvisation were close at hand. For example, the steel wires that Jason’s team used were on the working stand next to the injection moulding machine: ‘The wires were right there, hand reachable distance you know, so I thought why not just try it out’ (Example 1). Shepherd described the importance of having the items the team needed for creating devices close to where the team members were working.

> ‘We wanted to build something very quickly that would free our hands to do the welding work … fortunately we had a lot of different lengths of iron pipes and some rubber gaskets around us … just on the sliding container, so it took us about two or three minutes to make it [a rubber-covered steel shelf inside a welding mask]’ (Example 17).

Peter also highlighted the importance of distance when a team member went to the warehouse to look for a duct that could be used for creating and amending a diverter pipe: ‘I think the warehouse is as far as we can go to make it [the diverter pipe], and any further is not worth it because of time cost’ (Example 4).

Theme A Making ‘temporary’ devices as influenced by Theme 2 Power

Firstly, lack of rank power has been found to lead team members to improvise to fabricate physical structures. In Example 17, because Shepherd’s team was a lower-level welder apprentice team, the members were not assigned headgear masks by the company, and when it was found that the latest supplies were not assigned to them, the team members

improvised to fabricate rubber-covered steel shelves and soldered them to the back of the handheld masks.

Secondly, having much rank power could cause the tendency of strengthening a temporary device because members wanted to agree with their leaders to avoid taking responsibility. For example, in Example 4, when the leader decided to make a diverter pipe to deal with a feeding port blockage, but it was found that the plastic flowed faster in the diverter pipe, members proposed adding a manual valve to adjust the flow rate. Moreover, the decision would be more likely to be irreversible if the leader was involved in the device fabrication process. For example, as a team leader, Paul made a fastening device to repair a mould which changed the mould's structure permanently (Example 6). Conversely, when team members improvised to weld a grip handler to a mould to reduce abnormal sounds, the grip handler was attached to the mould's outer surface and could be removed easily (Example 19). Such a difference could mean that leaders were more reckless and members were more cautious when it came to team improvisation because the members tended to want to avoid the possibility of future punishments.

Theme A Making 'temporary' devices as influenced by Theme 4 Time pressure

Firstly, the time pressure caused by approaching deadlines strongly motivated teams to improvise to meet these deadlines. Although it was not guaranteed that teams would speed up workflow by fabricating physical devices, such devices would be created when a team believed it was the quickest way to get the job done. For example, Paul's team aimed to produce a small batch of water pipe joints as samples, scheduled for shipping in two days (Example 6). The team decided to make a fastening device to repair the mould rather than following the repair centre's suggestion to scrap it; the consideration of meeting the deadline played a vital role in the decision to create the fastening device.

> ‘We could reset the engraving machine and re-make the mould if we still have the 3D data, but it is impossible to make a batch of samples within two days anyway… we can only try our best to repair the mould, carefully inspect the produced samples, one by one, and then ship them, even if it is only 20 or 30 samples … They [clients] won’t wait for you. If you can’t do it right, they’ll [the clients] find someone who can do it immediately’ [Example 6].

The pressure caused by an approaching deadline was mainly due to the possible adverse outcomes of not meeting the deadline, such as the possible order loss in Example 6. Interestingly, when the source of the time pressure was vague, members seemed more affected, possibly because they wanted to move out of an uncertain situation.

Secondly, when the time pressure was caused by an urgent field situation, teams improvised by building temporary devices to cope with the unexpected. For example, in Example 4, a blockage in the feeding port suspended production. In response, the team designed and built a diverter pipe to meet that day’s production target. The diverter would be removed, and the normal procedure would be returned to, i.e., following feeding port cleaning (Example 4). Another example was when the goods were being loaded for delivery, Bob’s team (Example 21) was informed by an inspector that their packaging was inappropriate because the plastic material used a waterproof layer (at that moment the team had little time to engage in repacking as the goods were being loading), so the team had to improvise a batch of larger wooden boxes in which to wrap the packed boxes.

Theme A Making ‘temporary’ devices as influenced by Theme 5 Team climate

Chiefly, when the team members perceived their improvisation would be protected by their leaders, in this study, the members tended to improvise by fabricating physical structures in order to deal with the unexpected. For example, as a team leader, Jason was

happy that the twisted iron frame reduced the occurrence of cold seams: ‘To be honest, I think it’s good, it solves the problem, I don’t care if it’s against the rules’ (Example 1).

Theme B Interpreting written procedures and introduced new ideas as influenced by Theme 2 Power

Firstly, powerful leaders would twist the meaning of a procedure by making his/her version of it. For example, a team leader, Carter, interpreted the word ‘order’ in ‘Regulation of production arrangement in production workshop’ to justify the deviated action of changing the notice period from three to one day.

Secondly, when lower ranked members interpreted a procedure, they tended to add meaning to generate new ideas, instead of criticising the procedure. For example, Andrew’s team (Example 7) discussed how the new idea, i.e., using one calliper for all types of measurement, was more effective; the new solution was justified as the team explained it as being more effective than the original procedure.

> ‘… using one calliper was more effective … because by flexibly adjusting the measurement gear with our fingers … we could obtain data from more angles for verification, whereas previously we could only perform mechanical measurement at one angle’ (Example 7).

Thirdly, teams would weaken the enforcement of the procedures in order to make room for improvisation. Leaders tended to explicitly question the applicability of the procedure to the current situation. For example, when Eric, the team leader, found that the two-gear structure disturbed the mould function during the mould trial, he explained the crafting cards (i.e., the manufacturing procedure) as being a ‘suggestion’ which the team could choose not to apply.

'… we have entered the stage of testing the mould to see whether it works … we talked about this back then … I said the crafting cards were more like some suggestions to us … we did not change them [the crafting cards]' (Example 5).

Leaders were more confident in terms of interpreting a procedure because the power was centralised to them in their groups. Due to this position of power, interpreting a procedure on the part of leaders-involved teams was more abrasive, whereas lower ranked team members tended to interpret a procedure more diplomatically. Such obvious supremacy on the part of the leaders with regard to the procedures would make the employees ponder about the leaders' attitude towards improvisation and be more proactive. In Example 14, a leader from the scheduling office open-handedly admitted that his team's improvisation in terms of changing the notice period from three to one day violated production arrangement procedure, but the leader stressed the aim of the procedure was still achieved – maintaining the order of overall production – under his management.

Theme B Interpreting written procedures and introduced new ideas as influenced by Theme 3 Worry

Firstly, the worry about falling behind influences the microprocess of weakening the enforcement of procedures. Example 7 offered an example; Andrew's team was responsible for measuring the accuracy of parts of the product. Team members were assigned five types of products to measure and then to fill out the evaluation reports (Example 7). Concerns existed about falling behind schedule and behind other teams, motivating team members to change from complete checking to selective checking to simplify the measuring process in an attempt to save time; so, the team improvised to weaken the enforcement of the procedure of product measurement procedure.

> ‘We also wanted to do it [measuring] in the right way, but other teams didn’t do that … in theory, it’s normal to do measuring for two types of products; I’m talking about the whole package … but if you don’t finish four to five per day, your team will fall behind others … so we had to change to selective sampling, we had to make it simple, fast’ (Example 7).

Secondly, when a team wanted to improvise in such a way as to improve the work, members interpreted the new idea for improvisation as an opportunity before putting it into practice, because team members were aware of the potential risk of being punished in the future. For example, Jack’s team interpreted the new plan in terms of appointing a skilful assembler as a trainer as a more efficient method for speeding up the assembly process (Example 8).

> ‘Instead of recognising this [improvisation of appointing a skilful assembler as a trainer] as a deviation of the procedure of selective assembly … we believed it was an improvement, if everyone could have the skill like him [the skilful assembler], our testing [of using the selective assembly] would turn out much more efficient’ (Example 8).

Peter’s team used a similar justification for creating a diverter pipe, i.e., the new plan saved a lot of time: ‘We don’t have to stop the machine [the injection moulding machine]’ (Example 4).

Theme B Interpreting written procedures and introduced new ideas as influenced by Theme 5 Team climate

Firstly, when team members are aware of a leader’s protective attitude with regard to improvisation, members would have more confidence to improvise. For example, Eric acknowledged that he considered how his leader would act with regard to the team’s

improvisation, i.e., protecting the team. The perceived acceptance of improvisation by leaders gave Eric's team the confidence to weaken the enforcement of the procedure (the use of crafting cards) to weld the two gears together (Example 5).

Secondly, the company value of 'best for the client' was used by teams to weaken the enforcement of the procedures, so that the improvisation could be defended. In the Avatar Group, through public advertising within the company and lecture training, participants were constantly taught to think of clients' needs in such a way as to provide better services and products. As the value of gaining client satisfaction was deeply rooted, the importance of the client's requirements exceeded the organisational procedures. The highlighting of the clients satisfaction pushed employees away from following procedures, and team members used the client's recognition of a new idea as the team's defence when it came to abandoning the procedure. For example, in Example 2, with the client's approval of the new plan, the team members believed they would not be punished, although they had broken with procedure: 'I cannot think of any reason for a company to punish its employees for keeping a client happy'. The fabrication of temporary devices could be explained as a way of better serving clients because the team members satisfied the client by ensuring product samples were delivered on time (e.g., Example 6). However, such a value also set a potential boundary for improvisational behaviours because team members were restrained when a procedure was directly connected to the client's requirements, such as with regard to product quality and quantity. For example, crafting cards were known to contain as the must-follow procedure because they determined the manufacturing sequence which directly linked to product quality. A participant described product quality as the key in terms of what is best for the client.

> 'Crafting cards are directly related to the quality of the product … what temperature, how you operated, they are all stipulated ... All the work will be represented in the

product, quality is the key, they [the clients] want quality, this is how we earn money' (Example 8).

In summary, in order to answer the third research question: '*How do the key influences shape the microprocesses of team improvisation?*', this section has analysed how the themes of the microprocesses of team improvisation were affected by the themes of influences. The highest themes and second-order codes were involved in this analysis (see Appendix 6 for the rest of the analysis).

In the next section, in order to answer the fourth research question: '*What are the outcomes of team improvisation?*', it will demonstrate the outcomes of team improvisation. This will be useful in terms of materials for understanding why improvisation is pervasive in this research, as well as understanding the reasons why the participants improvised, and why the participant kept improvisation local/hidden.

4.5.4 Outcomes of team improvisation

In order to answer the final research question (RQ4), the participants were asked to explain the outcomes of team improvisation. They described various consequences based on their understanding. In general, the consequences of team improvisation were complicated, because the same improvisation can have different results if viewed from two different perspectives.

First, the participants described how a single team improvisation could have outcomes in different time scales: each team improvisation often had an immediate outcome such as quality improvement; then, the same team improvisation might have a short-term outcome such as team performance improvement; finally, the team improvisation could have a long-term impact such as increase in job security. It is important to note that some of the long-term outcomes mentioned by the respondents were not entirely based on actual occurrences but

were instead assumed. For instance, the risk of an information leak was hypothesised by participants as one potential long-term outcome. In such cases, an external expert was invited to the workshop to address a problem through unauthorised means. While the expert would gain access to certain product-related technological information, respondents were unaware of the extent to which sensitive company information might be disclosed. However, when participants were asked to share negative consequences during the interviews, the participants hypothesised their answers by saying that improvisation could strengthen the competitiveness of rival firms if key technological data was leaked. Second, outcomes were described by the participants as appearing in different levels, such as individual, team, and organisational levels. With regard to these two outlined perspectives, the outcomes could either be positive or negative. As a result, in order to better understand the participants' worlds, this study adopted the perspectives of time scale and levels to examine whether the outcomes are likely to positive or negative.

In addition, it is necessary to point out that team improvisation activities do not occur outside social structures. Therefore, the researcher's interpretations as to whether the outcomes of team improvisation are positive or negative largely relate to the organisational context, i.e., the Avatar Group was making large-scale redundancies due to the adverse impact of COVID and Zero-COVID policy, and the redundancy (or promotion) was based on team performance, which in turn was judged by the quantity and quality (largely decided by client feedback) of the projects. Such a background can influence the participants. For example, they might tend to tell the researcher about team improvisations which had positive outcomes as they were worried about being made redundant.

This section presents two representative examples of outcomes of team improvisation because the whole presentation of outcomes would require many pages. The full description of the 21 examples of outcomes can be found in Appendix 7.

Example 3

To immediately solve the problem of oxidation of a metal product, Ryan's team improvised by creating a heat protector out of metal wastes, rather than improving the heat treatment. In the short-term, the team was able to complete the day's production and achieve early delivery. Moreover, as they had successfully completed the project, the team members would have a better chance for applying for future projects involving similar technical processes. The team members also hypothesised that the team members' job security might be enhanced against a background of company downsizing. However, the team might lose an opportunity to learn more about the heat treatment process, which might be negative in the long-term.

Example 13

To cope with the unpredictability caused by the Zero-COVID policy in China, Tanner's team improvised by mobilising some front-line operators to organise a quick shipment. Although the team successfully shipped a large amount of cargo in a short time to reduce warehouse cargo accumulation, the safety of some front-line workers was put at risk because they were asked by the team to operate forklifts without a licence. Moreover, the team's improvisation occupied about 30 minutes of the front-line workers' working time, which had a negative impact on the day's production.

Overall interpretation of outcomes

Through a careful reading of the examples, focusing particularly on their outcomes, this study summarised the outcomes using the two perspectives of time scale and levels, to examine whether an outcome is positive or negative. A total of 12 types of outcome were identified: efficiency, client satisfaction, company operation disturbance, well-being, information leak, job security, learning opportunity loss, machine operation, financial loss/profit, quality, team performance, team cohesion. Figure 7 provides an overview of these

positive and negative outcomes of team improvisation categorised according to level (individual, team or organisational) and timescale (immediate, short-term and long-term).

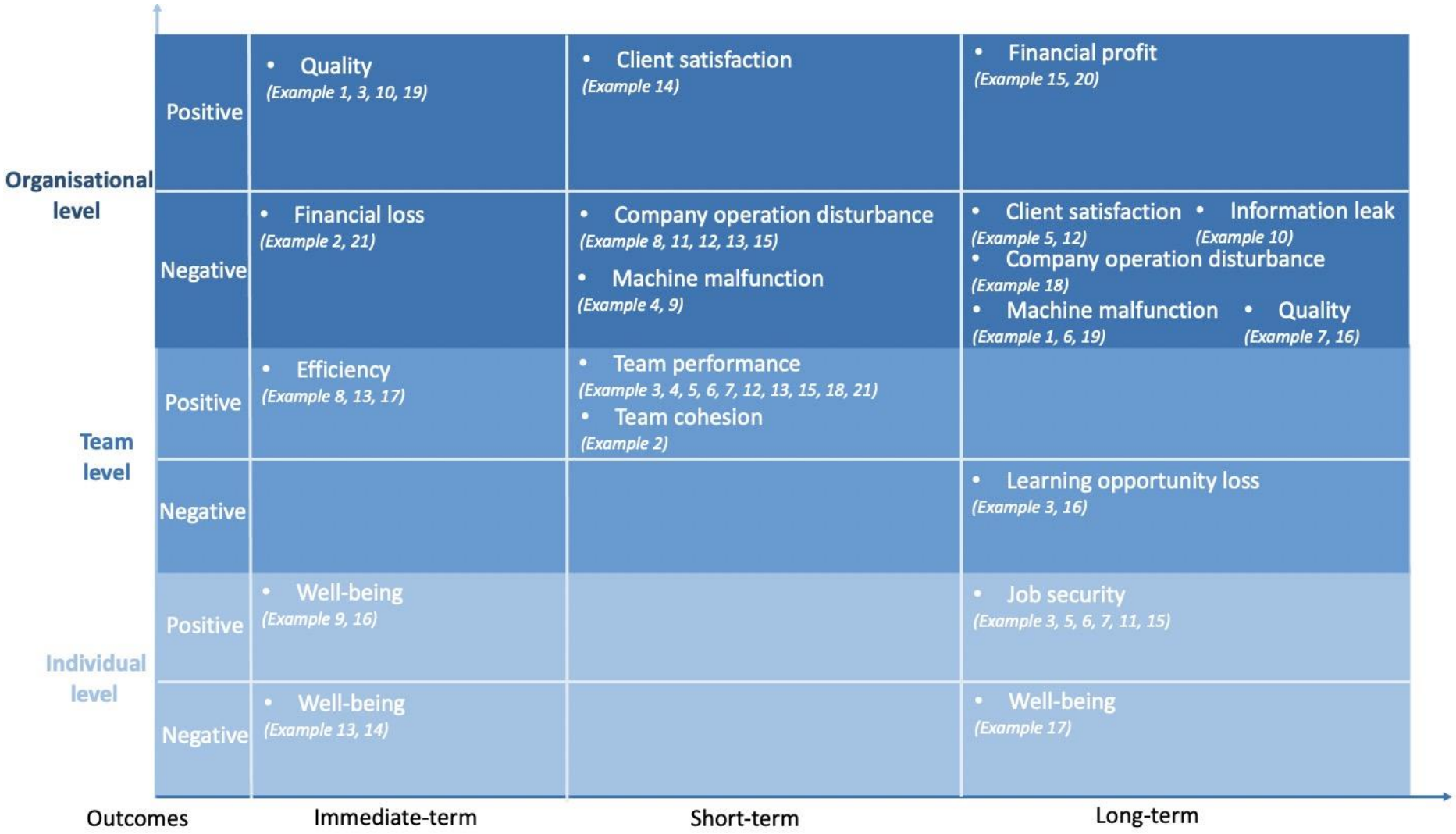


Figure 7: An overview of outcomes of team improvisation in Study 1

Overall, the examples of team improvisation showed an interesting mix of positive and negative outcomes, often from the same episode. As shown in Figure 7, the most notable characteristic is the tension between positive and negative outcomes at different levels at different time points. First, when considering time scales, immediate/short-term positive outcomes transitioned into negative outcomes in the long-term in many examples. For example, a team improvisation usually results in an immediate positive outcome; as shown in Example 1 where Jason's team improvised to make a twisted iron frame and cold seams were immediately reduced, the product quality was improved. Consequently, in the short-term, the improvisation enabled the team to complete the day's production task with fewer product defects, which was good for team performance (Example 1). However, in the long-term, the twisted iron frame increased the possibility of machine malfunction because the frame blocked the flow of melted plastics to a degree while reducing the cold seams (Example 1).

Second, when considering levels, team improvisations which had a positive impact at the individual level sometimes had a negative impact at the team/organisational levels. For example, in Example 16, where the team improvised by carrying out welding work in a different way, the individual members might have felt less bored, i.e., the improvisation was good for individuals' well-being, but the quality of the welding work could be reduced for the organisation. At the team level, the team lost the opportunity to learn and improve their welding skills (Example 16).

Specifically, there are three important messages in terms of outcomes resulting from team improvisation. First, the positive outcomes concentrated upon individual and team levels, such as job security at the individual level and performance at the team level. It is necessary to note that job security was a hypothesised long-term outcome. Second, the organisation was experiencing most of the negative impacts of team improvisation across different time points. For example, the team improvisation often interfered with the normal

work of other departments or teams which caused a disturbance to company operations. Third, individual members' well-being could be harmed by team improvisation, both physically and mentally.

In summary, this study assessed the outcomes of team improvisation in order to answer the fourth research question: '*What are the outcomes of team improvisation?*' It was found that the microprocesses of team improvisation produced mixed positive and negative outcomes, representing tensions between levels (individual, team, and organisational levels) and times (immediate-, short-, and long-term). Besides, such complexity in terms of outcomes demonstrated that it was difficult to judge which microprocesses were most associated with positive or negative outcomes because they appeared simultaneously and kept changing over time. At this point, all research questions have been answered. The next section will connect the findings to the relevant literature to draw out the theoretical contributions.

4.6 Discussion

The overall aim of this research is to develop a deeper understanding of the way in which teams improvise by exploring the microprocesses which underpin decisions about improvisation. The data from the semi-structured interviews identified 21 team improvisation examples using the definition of team improvisation the researcher opted for (see 2.2). The examples were provided with descriptions in 4.5.1. Using thematic analysis, a total of 45 microprocesses (i.e., the first-order codes) were identified based on the definition of microprocesses of team improvisation (see 2.3). These microprocesses were categorised into 12 generalised microprocesses (i.e., the second-order codes). Then, four themes were determined as the highest-level generalisation of microprocesses: a) Making 'temporary' devices, b) Interpreting written procedures and introducing new ideas, c) Asking for help

from outside teams, and d) Arguing and verifying to construct solutions. Moreover, five themes with regard to influences were identified using thematic analysis, 1) Location distance, 2) Power, 3) Worry, 4) Time pressure and 5) Team climate (see 4.5.3). Furthermore, the outcomes of the team improvisation examples were presented in 4.5.4, demonstrating mixed positive and negative outcomes, also showing tensions at different levels and times produced as a result of team improvisation. Taken together, these themes can be viewed as a framework – the team improvisation of microprocesses framework (TIMF).

In order to set a basis for discussing the potential theoretical links with the literature, Figure 8 was created to show how the TIMF is related to the influences and the different types of outcomes.

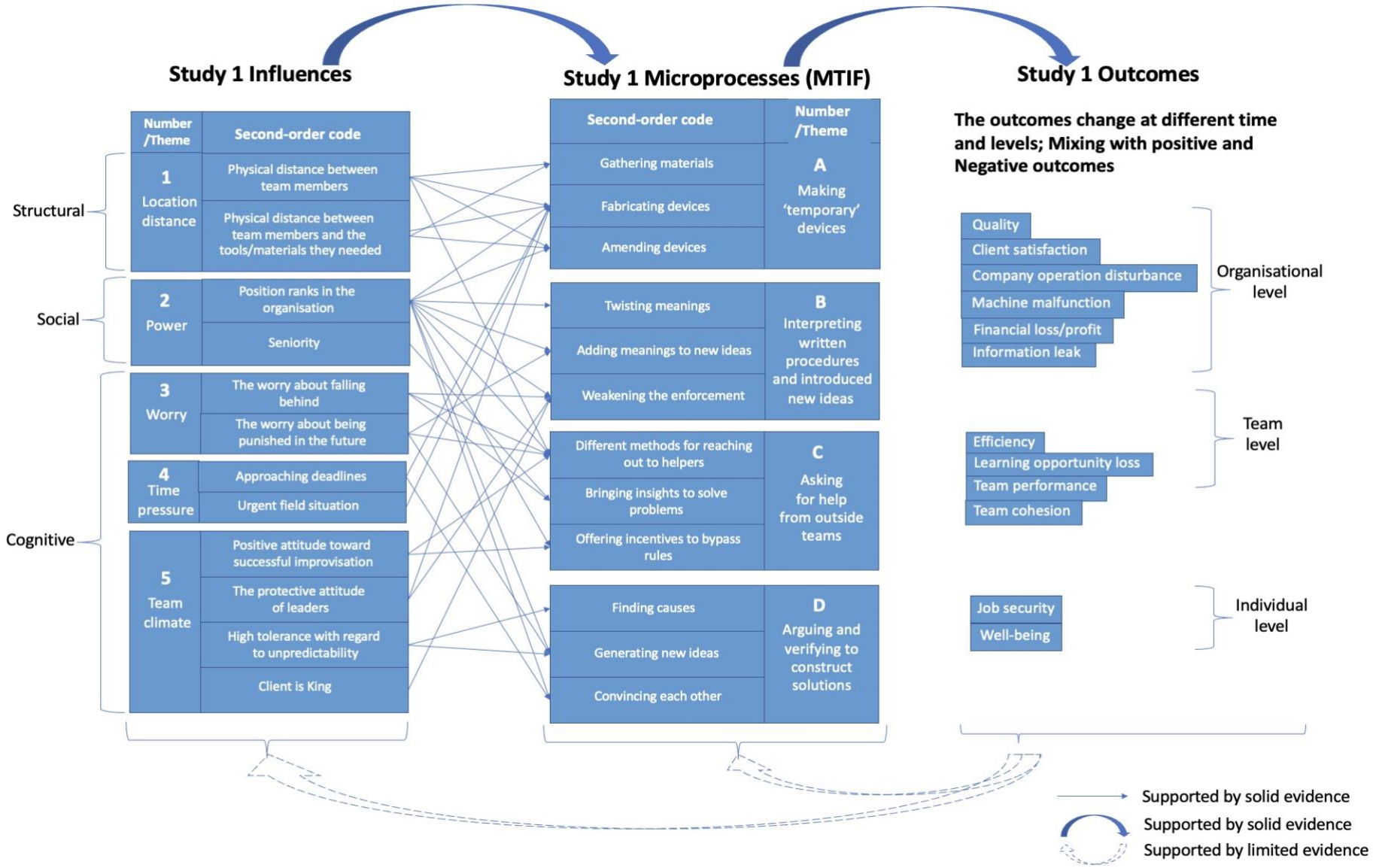


Figure 8: An overview of Study 1 findings

According to Figure 8, Study 1 identified a number of influences (detailed on the left-hand side) which could be categorised into structural, social, and cognitive aspects (Ciuchta et al., 2021), each affecting the microprocesses in the middle (shown by the thick curved arrow at the top of the two columns). The first-order codes with regard to influences and microprocesses were not listed in Figure 8 in order to maintain a balance between parsimony and richness. The slim solid arrows between the influences and the microprocesses indicate which microprocess is affected by which influence. The outcomes are then demonstrated on the right-hand side (the thick curved arrow at the top indicates the outcomes which were produced by the microprocesses). These outcomes can be divided into organisational, team, and individual levels. In addition, the thick curved/dotted arrows at the bottom of Figure 8 indicate that the outcomes may impact the microprocesses or the influences.

This section aims to examine how the outlined findings contribute to the literature, existing theories and theoretical constructs. Other scholars' findings garnered from the literature are therefore used to examine the findings that emerged from Study 1. This section thus includes four sub-sections. First, by viewing this study's findings as an overall structure in terms of inputs, process, and outputs, an overall discussion is provided in 4.6.1. Second, the categorisation of microprocesses was examined in 4.6.2, followed by a discussion of themes of the influences regarding the microprocesses in 4.6.3. The outcomes of team improvisation are then discussed in 4.6.4. Each sub-section will discuss the findings in terms of the literature in an order, from overall/general to specific/detailed.

4.6.1 Overall discussion

The relationship between improvisation and similar constructs

In general, this study contributes to the clarification of the concept of improvisation in team settings within the broader conceptual framework of the organisational behaviour

literature. On the one hand, it identifies 45 microprocesses relating to team improvisation, which emphasise the emergent and temporal nature of improvisation as a key factor distinguishing improvisation from other related constructs such as bricolage, creativity, innovation, adaptation, and proactivity. On the other hand, this study provides empirical evidence with regard to elucidating the interplay between improvisation and these similar concepts. For example, the identified microprocesses support the view that improvisation can be distinguished from bricolage through its focus on physical materials, although the two concepts may overlap when immediate action is required (Abrantes et al., 2022; Silva et al., 2024). Furthermore, the microprocesses demonstrate how creativity, innovation, and adaptation manifest in team settings within improvisational contexts, and how improvisation functions as a distinctive form of decision-making in which rapid decisions are critical (Campbell, 1989; Dougherty, 1996; Miner et al., 2001). Additionally, this study suggests that both improvisation and proactivity involve taking an active role; while emphasising that improvisation is characterised by a focus on the present moment and real-time actions. In contrast, proactivity typically involves strategically-planned actions aimed at achieving long-term outcomes (Ashford & Black, 1996).

The use of the Input-Process-Output (IPO) model

The IPO model is applied to examine this study's findings. The inputs are stable features of the team, team processes are how the team works together, and outputs are what the team produces (Hackman & Morris, 1975). This study's findings share a similar time-based structure (i.e., influences, microprocesses, and outcomes) with the IPO model (i.e., inputs, processes, and outputs). In addition, the aim of analysing how microprocesses are shaped by the influences is also similar to the IPO model, as it tries to understand the role of group process to a degree. In the improvisation field, the IPO model was used to examine the role of particular processes. For example, relying on the IPO model, Abrantes et al. (2018)

tested out the processes of team improvised adaption and team pre-emptive adaption in terms of their playing a mediating role in the relationship between shared temporal cognition (influences) and team performance (outcomes). Such a study showed that the IPO model is useful when researchers aim to examine the relationships between influences, team level processes relating to improvisation, and outcomes. Therefore, it is appropriate to adopt the IPO model to examine this study's findings. The following will compare the similarities and differences between the IPO model and these findings.

Firstly, in terms of the inputs, the IPO model suggests that inputs are stable and structural features of teams, including such aspects as personality, group size/structure, or the reward system operated by a company (Hackman & Morris, 1975). Similarly, this study found that the team structure largely shapes the way a team improvises in that having power and not having power both had an impact on teams improvisation. In the Figure 8, the box containing the theme of power is the one most commonly associated with the microprocesses. This fits with the idea of group structure affecting group processes (Hackman & Morris, 1975). However, the influences of this study have a greater range of differences compared with the inputs proposed in the IPO model, which might be because this study has adopted an inductive approach, without testing the inputs highlighted in the IPO model. A key difference is that the IPO model stresses the stable features of teams as in the form of inputs, while this study identified a number of 'unstable' influences. For example, people's perceptions (e.g., members feel worried or under time pressure as they perceived they might fall behind schedule or other teams if they do not improvise), which might change over time and in different circumstances. As a result, the IPO model might need to include some unstable team characteristics of teams such as inputs involve perceptual experiences, while this study approach can be used to investigate stable features of teams as influences such as personalities in the future.

Secondly, in terms of group processes, although the IPO model proposed by Hackman and Morris (1975) initially focused on group interaction processes, other scholars (e.g., Anderson & West, 1998; Kurtzberg & Amabile, 2001) tested different types of team processes, until Marks et al. (2001) summarised and proposed a taxonomy of team processes.

According to Marks et al. (2001), there are three types of team processes: 'transition processes, action processes, and interpersonal processes' (p. 363). Transition processes can be identified when teams focus on evaluating and planning activities to guide their accomplishment of a team goal, including processes involving analysing missions, setting goals, and formulating strategies (Marks et al., 2001). Action processes can be observed when teams conduct activities leading to goal achievement, including processes such as monitoring progress, providing feedback or coaching or assisting other members behaviourally (Marks et al., 2001). Interpersonal processes can be found when team members manage conflicts/emotions, or build motivation/confidence (Marks et al., 2001).

In this current study's findings the categorisation of microprocesses finds some similarities with the taxonomy of team processes proposed by Marks et al. (2001). The microprocesses of a) bringing insights to solve problems, b) finding causes of problems and c) generating new ideas, all fit with the concept of transition processes, because the microprocesses show that team members analyse the problems they faced to find out what has gone wrong, and then formulate a possible alternative by generating new ideas in conjunction with simultaneous actions to verify the feasibility of these new ideas. Moreover, the microprocesses of a) gathering materials, b) fabricating devices, c) amending devices fit with the idea of action processes because these microprocesses demonstrated the teams organised behaviours leading directly to problem-solving. However, the difference was that the action processes included in Marks et al.'s (2001) taxonomy stressed the importance of general team activities such as task monitoring, while this study's microprocesses are context

specific. This may be because a preference for creating devices and equipment to solve problems might be largely associated with the mechanical and engineering backgrounds of the participants, and the factory environment in which various materials/tools are accessible. Furthermore, the microprocesses of a) adding meaning to new ideas and b) weakening enforcement can be understood as team members trying to build confidence and motivation to implement improvisational ideas, although members may be concerned that the improvisation might fail and they might be held accountable in the future. Besides, there was one example (Example 8) which showed that, during the microprocess of convincing each other, team members would choose to take a break, such as leaving the meeting room for ten minutes to ease an overheated discussion. This means that this study supports the action process of managing conflicts highlighted by Marks et al. (2001).

Thirdly, both positive and negative outputs such as group effectiveness (Hackman & Morris, 1975) and creativity (Sacramento et al., 2024) receive attention in the IPO model. Study 1 aligns with the literature by finding a number of mixed positive and negative outcomes produced by the microprocesses of team improvisation, and further indicates that whether an outcome of a microprocess is positive or not may vary at different times and levels. The reason for such a difference might be due to the nature of the improvisation, i.e., people do not know for sure what kinds of outputs an improvisation can produce since the decisions for improvisation are often made quickly. Another difference is that the IPO model aims to explicitly test the relationships between inputs/processes and outputs (Hülsheger et al., 2009); however, in this study, the causal relationship between a microprocess and an outcome can be difficult to judge as the outcomes change over time and appeared across different levels in either a positive or negative manner.

In summary, this section used the IPO model proposed by Hackman and Morris (1975) (including the taxonomy of team processes summarised by Marks et al., 2001) to

examine the overall findings of Study 1. The next section will discuss the theoretical and practical value of identifying the microprocesses of team improvisation by comparing the microprocesses with the relevant literature.

4.6.2 Microprocesses of team improvisation

In this research, the microprocesses of team improvisation were defined as *action patterns that deviating from written procedures in order to compose and quickly execute a new solution to achieve a shared team goal;* this means that these microprocesses relate to the central constituent processes elements of improvisation at the team level (Ciuchta et al., 2021). A number of theoretical constructs have been used regarding improvisation at the micro level to examine the microprocesses which represent a categorisation of team improvisation microprocesses.

Overall contribution

Chiefly, as discussed in the literature review (see 2.1.2), there is currently a knowledge gap regarding team microprocesses during improvisation that underpin decisions surrounding how to improvise (Vera et al., 2024; Hadjimichael, 2024). This gap exists because many studies have focused on exploring processes concerning when to improvise in order to identify components triggering improvisation, and identifying conditions that making improvisation effective (e.g., Weick, 1993a; Mendonça, 2007; Suarez & Montes, 2019). Only the two metaphorical concepts of synchronisation (e.g., Gilson et al., 2001) and yes-and (Vera & Crossan, 2004) were found to explain the team microprocesses involved in improvisation (Hadida et al., 2015). However, it could be argued that these are questionable as explanations of the processes of team improvisation in an organisational setting. This is because synchronisation can be a subjective phenomenon in a jazz music context for people to judge, and which are even difficult to describe (Hadadi et al., 2015); while yes-and is

might not be the same case of how team members interact during improvisation because they are often under time pressure, improvising to cope with surprises (O'Toole et al., 2020; Yanow & Tsoukas, 2009). Therefore, as an overall contribution, the categorisation of microprocesses of team improvisation provides significant empirical evidence to address the research gap with regard to how team improvisation occurs, because many microprocesses are included to show how team members act and interact as part of the improvisation process.

The following sections will consider the specific aspects of each of the microprocesses themes in relation to the relevant literature to determine specific contributions.

Theme A Making 'temporary' devices

This theme refers to team members improvising in such a way as to fabricate temporary physical structures and treat them as a more permanent solution – suggesting that team members intend to repeat the improvisation in the future.

According to Miner et al. (2001), artefactual improvisation refers to practitioners creating a new physical structure without prior design, such as improvising a new circuit board to accommodate faulty cables during product design (Miner et al., 2001). In their study, the authors report a physical structure created as a result of team discussion about how to develop new product features, which is a relatively formal process. For example, team members configure products into different packaging and design prototypes (Miner et al., 2001). This means that in this case the purpose of artefactual improvisation is innovation because the authors observed an NPD team. Moreover, another group of scholars noticed that such improvisation involving creating temporary structures can be myopic (Cunha et al., 2022; Cunha & Berti, 2024), meaning that organisational actors will treat a serendipitous discovery as a replicable design/process because it displays a local value in terms of coping with emergencies such as ease of doing (Miner & O'Toole, 2024).

Theme A supports the concept of artefactual improvisation, as well as aligning with the concept of myopic improvisation. Since teams in the present study can produce a structured physical device quickly on-site without much communication, these temporary devices are probably not the first time they have been created. The teams regard the experience of how to make temporary devices as a memory that can be accessed at any time, to be used whenever needed for expediency. Therefore, comparing this with the literature, this theme found a set of new microprocesses existing prior to the actual creation of physical structures, i.e., a) team members search for necessary materials and tools, b) fabricate them on-site, and c) make amendments where necessary. Therefore, this theme provides additional insights regarding how myopic improvisation which results in physical structures being prepared and acted upon by the team members, involves accessing relevant microprocesses prior to the creation of the physical structure.

Theme B: Interpreting written procedures and introduced new ideas

This theme means that team members interpret a procedure (by twisting it or weakening its enforcement) or an alternative idea (by adding new meaning to it) to make room for its execution. In this study, the interpretation activities occur prior to the improvisation actions.

According to Miner et al. (2001), the concept of interpretive improvisation refers to practitioners improvising by adding new interpretations (Miner et al., 2001). For example, when an engineer found that the correction of a programme caused an improvement in terms of the programme's running speed, the team interpreted it as being a new speedy feature which could be used for marketing purposes (Miner et al., 2001). In Miner et al.'s (2001) description, team members interpreted or reframed an event to add beneficial features to an existing product or an ongoing situation. This means that the interpretation is itself a type of improvisation. Another group of scholars (e.g., Strang & Meyer, 1993; Greenwood et al.,

2002; Kostova et al., 2008; Smet et al., 2012) highlighted the interpretation as protecting an intended alternative that occurred prior to the improvisation. For example, by examining how improvisation on the part of professionals from a law firm led to organisational changes, Smet et al. (2012) found the practitioners improvised to re-orient a rule, norm, or regulation via interpreting. They did this to shield an emerging alternative from the application of organisational discipline, and to buffer social risks, such that a local situation could be dealt with. As a result, the authors identified such improvisation as practice-driven justification which aims to justify an improvisation due to its pragmatic efficiency (Smet et al., 2012).

Theme B supports the concept of practice-driven justification as proposed by Smet et al. (2012). In this theme, by interpreting the relationship between a current situation and an organisational/technical procedure, team members separated the improvisational behaviours they want to perform (i.e., putting in place a new solution) from the stipulated actions specified by organisational procedures. Or, by interpreting the practicability of a new idea in terms of how quickly/well the new approach could solve a mechanical/engineering problem which could facilitate a team's work, the team members protected their pragmatic new ideas from the application of technical procedures. Besides, when such interpretations involved all the members on site, they could reduce the social risk of being accused of rule-breaking. This was necessary because there was a mechanism referred to as the rectification movement in the company (see 3.5.2 for research context), which encouraged team members to report others' suspected rule-breaking behaviours.

Moreover, it is necessary to note that the actions associated with practice-driven justification are often reported in multinational organisations because practitioners need to simplify the degree of institutional complexity since different types of law and regulations can be applied to an event or situation (Kostova et al., 2008; Smet et al., 2012). Relatively few studies have been conducted to demonstrate how organisational/technical procedures

have been changed when they are applied to organisational members. This theme thus extends the concept of practice-driven justification by finding that in the daily operations of a company, team members may interpret organisational/technical procedures in different ways in order to protect a new idea and reduce social risk. This suggests that such an interpretation with regard to justification could widely exist.

This finding is important because future scholars can therefore usefully further explore a microcosmic world: what happens when organisational/technical procedures infiltrate the thinking of organisational members, and what impact members' interpretation of procedures have on the organisation in return.

Theme C Asking for help from outside teams

This theme refers to team members improvising by asking for help from outside teams via various channels for purposes such as problem-solving and rule-bypassing.

Similar to theme A, theme C also supports the concept of myopic improvisation because the local value of this theme in this study remained at the stage of problem-solving, such as dealing with mould dysfunctions and machine breakdowns during a manufacturing company's daily operation.

The microprocess of offering incentives to bypass rules

Although theme C supports the concept of myopic improvisation, it does not explain why the participants wanted to ask for help from outside teams to bypass organisational procedures. Given that Theme C Asking for help from outside teams included a microprocess in the form of offering incentives to bypass rules (i.e., one of the second-order codes in Theme C), it aligns with the argument of several scholars (e.g., Dunfee & Warren, 2001; Chen & Chen, 2012) that the Confucian culture as a national culture could relate to deviant behaviours in the Chinese cultural context.

With an emphasis on interpersonal relationships and their devotion and commitments, Confucian culture in China developed a type of ethics that supports personal relationships between one individual and another, thereby forming a prominent 'relationalism' relationship structure – guanxi (Chen & Chen, 2012; Hwang et al., 2009). Guanxi is a cultural phenomenon that refers to relationships among people – a social network comprising family, friends, acquaintances, colleagues, leaders, and members (Jacobs, 1982). The core idea of guanxi involves relationships between or among individuals, creating obligations for the continued exchange of favours (Dunfee & Warren, 2001). Scholars have thus pinpointed that behaviours related to guanxi are exploitative and outside organisational norms, which makes them deviant; for example, typical guanxi behaviours are seeking assistance from family, helping friends, and offering favours to colleagues or collaborators (Gao et al., 2012). Guo et al. (2018) further identified three dimensions of guanxi behaviour, all of which involve gift-giving: a) bribery behaviour, referring to actions that exploit guanxi to ask others for profits or to passively accept benefits from others; b) transaction behaviour, whereby parties exploit guanxi to obtain shortcuts and backroom trading privileges; c) guanxi alliance, whereby people form a guanxi alliance by guanxi clinging, allowing members to enjoy the shelter of the alliance and its inequitable resource distribution. Scholars (e.g., Guo et al., 2018; Donaldson & Dunfee, 1999; Dunfee & Warren, 2001) have also argued that a stable/strong guanxi tends to develop over time through practitioners engaging in continuous guanxi behaviours.

This microprocess of offering incentives to bypass rules supports the concept of guanxi behaviour because team members in the current research tended to seek help or ask favours from people who had a good personal relationship with them, such as previous colleagues and teachers, facilitated by gift-giving (usually cigarettes, fruits, expensive rice wine, and tea). As a result, team members could obtain shortcuts, such as getting more

quality tests done in a short time and omitting organisational procedures to speed up the workflow or make things easier. This suggests that this microprocess is likely to be a manifestation of guanxi behaviour in the domain of team improvisation.

This finding is important because it adds a national cultural perspective on why people improvise by suggesting that the participants might improvise due to the demand of developing guanxi with others, and the issue with regard to gift giving has not been addressed.

Theme D Arguing and verifying to construct a solution

This theme shows how team members interact to create a team solution, relating to how practitioners argue with each other over opinions/ideas concerning a current situation and simultaneously act on verifying these in an attempt to convince each other.

The literature review identified a number of concepts regarding team interaction as part of the improvisation process. From a metaphorical point of view, synchronisation refers to a state when musicians jointly create a continuous rhythm (Hadida et al., 2015). Relatedly, in an organisational context, scholars believe that team members need to achieve a coordinated state of action, reflecting in team interaction as a timely exchange of information which leads to improvisation that allows team members to cope with unexpected change (Barrick et al., 2007; Carmeli & Schaubroeck, 2006). Magni et al. (2009) further tested the relationship between behavioural integration and improvisation, and found that the former is positively related to the latter. Consequently, behavioural integration is considered an influence on improvisation at the team level. The process regarding how such behavioural integration is achieved has received relatively little attention (Ciuchta et al., 2021; Miner et al., 2024). Vera and Crossan (2004) propose a concept called ‘yes-and’, referring to stage performers accepting the creation of others and building on them. Oortmerssen et al. (2015) propose the concept of interaction flow, meaning team members take turns to speak, and help

build on one another's contribution by reflexive reframing. Both concepts are considered to be influenced by the artistic metaphor. In the organisational field however, improvisation usually occurs with a certain degree of urgency (Miner et al., 2024), Consequently, taking turns to speak as a characteristic of team interaction seems less likely, particularly in this study's context where production activities are tightly scheduled, and teams aim to do things in a short period of time. Therefore, to develop improvisation theory, more insights are needed regarding how team members behave synchronously to achieve behavioural integration.

Theme D provides insights into how teams interact to achieve behavioural integration in terms of improvisation – team members propose their ideas in an argumentative way, reflecting as conflicts between members occur, in terms of arguing what is going on and what is the best solution at the moment; members contest each other's ideas almost as soon as an idea is proposed. As the teams in this study usually dealt with mechanical and engineering problems, the team members often split into groups during team discussions due to opposite technical opinions, then members acted to find evidence to support themselves or convince others. Team consensus was achieved by proving which idea was best, and the process of achieving team agreement was an iteration process as members continued to have opposing opinions on technical details. This continued until a final solution emerged. Therefore, this microprocess suggests that behavioural integration in team improvisation might experience a process of a constant pursuit of a team consensus, driven by conflicting opinions and concurrent verification actions.

This section discussed the overall microprocesses of team improvisation with the use of existing measurement scales with regard to improvisation to suggest a context and action-specific scale to identify team improvisation. The four specific themes were then connected to the relevant literature to draw out potential theoretical contributions. The next section will

discuss the findings regarding the themes of influences on team improvisation in terms of the extant literature.

4.6.3 Structural, social, and cognitive influences of team improvisation

In this study, five themes were identified from the data to answer the second research question: '*What are the key influences of team improvisation?*'. The themes are 1) location distance, 2) power, 3) worry, 4) time pressure, and 5) team climate. Along with the presentation of the findings, an analysis regarding how these themes of influences affected the microprocesses of team improvisation was provided in order to answer the third research question: '*How do the key influences shape the microprocesses of team improvisation?*'. The themes of influences were divided into the structural/social/cognitive dimensions suggested by Ciuchta et al. (2021).

By applying these dimensions, the themes of influences were divided into these aspects. Structural influences included the theme of location distance, social influences including the theme of power, and the cognitive influences containing the themes of worry, time pressure and team climate. This section aims to connect this research's findings with regard to influences to the literature, and to discuss what else might be going on to explain the findings. A number of theories and empirical evidence found by other researchers were used to connect with this research's findings to examine how team improvisation may be shaped.

Structural influences (Theme 1 Location distance)

Structural influences refer to the environment in which people live as enabling conditions for improvisation (Ciuchta et al., 2021). The theme of location distance was categorised as a structural influence as it involved the physical environment in which participants operated.

In the improvisation literature, an eye-catching structural influence on improvisation is turbulence in the business environment (Ciuchta et al., 2021), but it has not been highlighted in this study. The reason could be that many studies (e.g., Cunha et al., 2019; Singh et al., 2022; Gomes, 2024) have focused on the role of improvisation at the strategic level and applied the perspectives of senior leaders and managers who were particularly sensitive to changes such as technological change in the wider business environment. However, in this current study, the participants were mostly responsible for company operation, such as ensuring production. Consequently, they might be less sensitive than senior managers to the effects of environmental turbulence.

Moreover, another commonly-mentioned structural influence in the literature is organisational structure/rules (Ciuchta et al., 2021). Although the team members did not explicitly mention the influence of organisational structures/rules on their improvisation, it was noticed that such structural influences were perceived in a more social way. For example, in this study, the microprocesses of team improvisation were affected by position rank which was designed within the organisational structure. Another example is that the participants explained organisational rules through oral communication within the teams (by misinterpreting the meaning of the rules or weakening the enforcement of them) to gain confidence before improvisation and reduce the social risks.

Furthermore, the other structural influence in the literature was physical environment. The theme of location distance is related to the fact that members were often in separate locations and not proximate to of team members or the materials/tools they needed for improvising; meaning this was a structural influence. The microprocesses showed that the reality of team dispersion could lead to an understaffing situation for team members, who then had to improvise by relying on help from outside teams to fill gaps in the skills or knowledge that the team has due to the absence of personnel.

Magni et al. (2013) found that separation between team members can reduce the positive effect of team improvisation on performance. Moreover, a study carried out subsequent to this research confirmed that physical distance might be an influence in choosing different types of strategies when it comes to improvising in response to different levels of time pressure (Magni & Maruping, 2024). Dispersion was identified as having a role to play in shaping the sense-making processes of improvisation, rather than an influence that created the circumstances in which improvisation was more likely to happen (Magni & Maruping, 2024).

The theme of location distance adds to Magni and colleagues' research regarding the role of team dispersion by suggesting the physical distance between team members might lead to improvisation because members would improvise by asking for help from outside teams on the site to solve problems or bypass organisational rules. The participants pointed out that they would offer help when they noticed that someone close to them needed help, as they feared that rejecting a person asking for help would reduce the possibility of receiving help when needed. Such a view was rooted in Chinese Confucian culture which stresses inter-personal relationships – guanxi (Chen & Chen, 2012). Favour asking was viewed as an important aspect for maintaining, strengthening, and developing guanxi (Guo et al., 2018). Improvisation might therefore be considered as a result of meeting the demands of guanxi practice.

Social influences (Theme 2 Power)

Social influences refer to social resources such as interpersonal relationships in which practitioners are embedded as influences for improvisation (Ciuchta et al., 2021). The theme of power was classified as a social influence, because this theme involves social relationships between leaders and members.

One social influence mentioned in the literature is power, as Silva (2002) points out that the influence of power could not exist without people. People with greater power can improvise within the boundaries of their authority, which is the aspect which researchers are concerned with most. For example, Bechky and Okhuysen (2011) mentioned that in a film production crew, when a camera operator was not present, the executive producer (who has a high rank power) improvised by promoting a cinematographer to be camera operator on the spot. In addition, the literature mentions that the improvisation is more likely to occur when a customer changes demands or improvisation is widely accepted in a group (Molnar et al., 2017; Mendonça & Wallace, 2007).

This theme of power supports these scholars' analysis of having power as a social influence on team improvisation. In addition, as this study includes an example (i.e., Example 17) that a group of lower-ranked apprentices improvised to create a piece of equipment (i.e., welding headgear) which was only equipped to higher-rank employees; the reason for such a team improvisation was that they were not satisfied with the company's equipment allocation and believed they should have the same gear as the higher-rank employees. This suggests that team members might improvise due to anger and frustration resulting from their lack of power. The theme of power thus enriches the discussion of emotion as an enabling condition of improvisation by finding that a lack of power could be a social condition leading to negative emotions which might in turn lead to team improvisation. This unexpected finding is important because it enriches the few existing studies on the relationship between emotion, power and improvisation, by finding the interlink between power and anger in terms of causing improvisation.

Moreover, some of the team improvisation examples can be explained by the Milgram experiment. Milgram (1963) conducted a social psychology experiment to test whether or not participants would obey an authority figure. The participants were led to believe they were

merely assisting in an experiment in which they had to administer electric shocks to a 'volunteer' who was an actor (Milgram, 1963). As a result, although the participants were uncomfortable assisting the giving of electric shocks and paused to question the experiment, most of them continued after being assured by the experimenter (Milgram, 1963). Milgram (1974) further explained the participants' obedience in terms of when people allowed others to direct their actions, the responsibility for the consequences was passed on to the person who gave orders – they act as agents for others' will.

In this research, it was found that team members were sometimes instructed by their leaders during improvisation, and showed a tendency to follow the leaders' suggestions. When members disagreed with the leaders on technical methods for handling products, although the members questioned the leaders' ideas or proposed alternative ideas, the members could be easily convinced otherwise, and then remained silence. Such a phenomenon can be explained by Milgram's agency theory regarding obedience, in that team members who questioned the leader felt that they had done their part and would not be held accountable for a negative outcome as they were merely acting on the leaders' will.

Cognitive influences (Theme 3 Worry, Theme 4 Time pressure, Theme 5 Team climate)

Three themes were categorised as cognitive influences as they all related to how people feel, think, believe, and value: a) Theme 3 Worry was deemed to be a cognitive influence because it referred to team members feeling anxious; b) Theme 4 Time pressure referred to the fact that participants believed they were under time pressure due to approaching deadlines and on-site emergencies; c) Theme 5 Team climate referred to a safe atmosphere caused by a set of perceptions, beliefs and values which allowed teams to perform and justify improvisations. The following sections will discuss each of the outlined themes by connecting them to the literature in order to identify contributions.

Theme 3 Worry

The theme referred to team members feeling anxious because they were concerned with the possibility of a) falling behind other teams, and b) being punished in the future. This theme represents a cognitive influence which was likely to enable the microprocesses, reflecting in a number of the team improvisation activities revealed in this study.

Emotion as an influence of improvisation has been relatively little noticed in the improvisation literature (Cunha et al., 2017; Hadjimichael & Tsoukas, 2023; Hadjimichael, 2024). Ciuchta et al. (2021) argued that investigation of the relationship between emotion and improvisation could offer meaningful insights into the reason why organisational members choose to improvise in the first place, instead of ignoring triggers of improvisation or making new plans. A small group of scholars (e.g., Fisher & Barrett, 2019) propose that emotion has an important role to play in provoking improvisation. In addition, Mirvis (1998) proposed that improvisation is stimulated by a combination of anxiety and confidence. Mirvis (1998) considered anxiety to be a source of material for improvisation training, in that positive anxiety could be mixed with confidence by pre-rehearsing responses to crises; as a result, organisational members would know how to deal with a similar unexpected situation. However, what did positive anxiety look likes is unknown (Ciuchta et al., 2021).

The theme of worry brings insight to the literature on the relationship between emotion and improvisation, by providing empirical evidence of a theoretical assumption – improvisation can be triggered because organisational actors are eager to suppress a particular emotion (Hadjimichael, 2024). From the perspective of suppressing anxiety, the theme of worry provides an insight into why organisational members choose to improvise in the first place, instead of engaging in other actions such as following procedures even though they know it will not work, or passing on the problem to management to get them to solve it. The question of why improvisation occurs is important, because it can reveal the psychological

components that relate to improvisation. In the present study, the project management system led to internal competition between teams, and the fact that the company was losing clients due to the epidemic meant that management was making redundancies depending on the horizontal comparison of teams' performance. Team members were thus likely to be in a state of anxiety at work because they knew that the project they were working on had to be completed quickly in order to compete with other teams when it came to achieving better team performance which in turn led to high bonuses or promotion opportunities, or because they faced the possibility of redundancy. By acting quickly to put new ideas into practice, members could achieve a sense of progress, confronting the anxiety they perceived. This meant that team improvisation made the members feel that they were making progress, and they were creating an advantage in the internal competition with other teams. Consequently, their anxiety regarding job security was reduced. In such a context, if team members chose to revise the team plan, hand over the problem to management, or implement a procedure they knew would not work, members were simply wasting their own time.

Moreover, although it is generally accepted by researchers into improvisation that anxiety is an emotion experienced by practitioners during improvisation, relatively little research has been conducted on the theoretical insights involved, even after Mirvis (1998) proposed that improvisation was stimulated by a combination of anxiety and confidence. The theme of worry partially supports Mirvis's (1998) metaphorical assertion that improvisation is born of a mixture of anxiety and confidence, by confirming that a certain level of anxiety can stimulate team members to improvise. Taking Mirvis's (1998) view, a consideration of the theme of worry further clarified the types of work-related anxiety (e.g., anxiety with regard to falling behind others or being punished in the future) as a feature of training materials, which means that future researchers can start by looking at the different types of work-related anxiety that exist in organisations.

This finding is important because managers can design specific training interventions involving mixing anxiety with confidence, which will allow practitioners to improvise in a way that serves the organisation's interests.

Theme 4 Time pressure

This theme referred to the time pressure perceived by the participants due to all kinds of work-related deadlines and on-site emergencies, which served as a cognitive influence on the categorisation of the microprocesses of team improvisation.

A group of scholars have focused on the influence of time pressure caused by unexpected events/surprises/crises on improvisation (e.g., Lai et al., 2014; Hodge & Ratten, 2015). Since improvisation often involves doing things in a different way (involving solving an unexpected problem or creating additional value), Miner et al. (2001) pointed out that time pressure contributes to the uniqueness of improvisation as a way of learning – a type of organisational learning informed by real-time experience. Therefore, scholars have chosen to pay particular attention to those aspects of improvisation that lead to organisational learning, because improvisation creates idiosyncratic knowledge in a certain time or scene (Miner et al., 2001). Similarly, positive improvisation that creates additional value or seizes opportunities, has captured a great deal of attention, and scholars have explored the relationship between improvisation and creativity (e.g., Kyriakopoulous, 2011; Nisula & Kianto, 2018) or improvisation and innovation (e.g., Vera & Cross, 2005). Popular participants in studying improvisation were therefore NPD teams (e.g., Akgün & Lynn, 2002) or employees responsible for product innovation (e.g., Miner et al., 2001). However, it should be noted that the uniqueness of improvisation in terms of problem solving in local situations to keep companies operating, has been somewhat overlooked. In the research background with regard to maintaining production schedules considered in this study, when the temporal urgency was caused by approaching deadlines and on-site emergencies, time pressure became

a variable when it came to shaping team improvisation, forcing team members to be more focused on problem-solving. In the microprocesses framework, microprocesses have shown team members improvising for purposes of expediency. For example, a microprocess showed that team members tend to create temporary devices to get by as a permanent solution. In adding to the existing literature, the theme of time pressure suggests that improvisation could be different in the case of teams with different goals. Improvisation tends to play a role in promoting innovation in teams working on new product features (Vera & Crossan, 2005), while improvisation tends to play a more important role in maintaining the production schedule of the company. Temporal urgency in the former encourages improvisation when it comes to creating unique knowledge, while in the latter it shapes improvisation to become a unique problem-solving approach – the way of solving a problem only known by a limited group of team members locally. By doing so, team members could create a level of uniqueness to the team itself by knowing something only the team members can use to solve a problem. There are team improvisation microprocesses that can reflect this tendency, such as creating a temporary device only known by the team or interpreting a procedure in a particular way to improvise an alternative. In this study, the participants often improvised to solve mechanical and engineering problems on the spot, and team members would take advantage of their own uniqueness with regard to a technical aspect.

This finding is important because this theme helps turn attention from the relationships between positive improvisation and learning/innovation to the perspective of organisational daily operations, and to explore why people improvise, all of which may be equally important aspects for an organisation.

Theme 5 Team climate

This theme refers to a safe team climate which is caused by a set of collective perceptions which allow teams to engage in and justify improvisation; therefore, this theme represents a cognitive influence with regard to team improvisation.

By comparing Theme 5 with concepts in the literature such as innovative team climate (Van Der Vegt et al., 2005) and experimental culture (Cunha et al., 1999; Yao et al., 2017), it becomes evident that the range of collective beliefs in Theme 5 closely aligns with these constructs. This theme highlights the view that team members' improvisation is a) recognised by colleagues, b) supported by leadership, and c) stimulated by company values such as 'the Client is King', as such an organisational value encourages team members to take proactive actions. Firstly, the theme emphasises that the impact on improvisation of an innovative climate extends beyond the individual level (Su et al., 2022) and influences the team as a whole. Secondly, the concept of experimental culture, derived from the artistic metaphor (Vera & Crossan, 2004), has been shown in the literature to be linked with the occurrence of improvisation (Vera & Crossan, 2005) and to have partially positive effects on effective improvisation (Liao et al., 2023). However, few studies have provided an empirical foundation for the existence of such an experimental culture in an organisational setting. This theme largely confirms the key characteristics of an experimental culture such as action promotion, error tolerance, and support (Vera & Crossan, 2004; Yao et al., 2017), thus offering an empirical basis within organisations for the metaphorical concept of experimental culture.

Moreover, this theme underscores the view that collective beliefs are highly contextual. Team members' beliefs are shaped a) by the organisation's active promotion (e.g., top managers endorsing the value of customer satisfaction), b) by organisational rules (e.g., inter-team competition introduced by project management as a means of encouraging positive

team behaviour) and c) by the social environment (e.g., the uncertainty caused by the COVID-19 epidemic increasing tolerance for unpredictability on the part of team members).

Furthermore, the literature provides a possible explanation for the influence of team climate on improvisation. The literature suggests that when team members perceive their environment as being free from interpersonal threats and is supportive or even tolerant of taking risks and exploring new approaches, it fosters higher levels of psychological safety and greater engagement in creative processes such as improvisation (Edmondson, 1999; Gilson & Shalley, 2004; Vera et al., 2024). Sacramento et al. (2024) found that team members were more able to develop novel and useful ideas when they believed they were in a safe place for risk-taking, or when they were curious and open to experimenting with new ideas. Similarly, in Study 1, team members demonstrated a positive attitude towards improvisation and exhibited a high tolerance for uncertainty, while leaders provided protection and support for improvisational activities. Meanwhile, the organisation encouraged teams to adopt proactive strategies to fulfil clients' requirements. Consequently, it could be inferred that team members perceived their environment as one in which taking even risky actions was safe, thereby increasing their likelihood of engaging in team improvisation.

In addition, the literature review identified memory as a cognitive influence (Ciuchta et al., 2021), including procedural memory such as that related to skills and background information (Kyriakopoulos, 2011) and declarative memory related to facts and previous events (Moorman & Miner, 1998b). In terms of procedural memory, the participants in Study 1 rarely mentioned memory. However, the fact that the microprocesses in this study happened quickly without much communication might implicitly indicate that procedural memory was applied by the participants to a certain degree. Because some scholars (Crossan et al., 2005; Moorman & Miner, 1998b) claim team members are more likely to have fast responses when applying procedural memory because they are very familiar with those

memories, sometimes without even realising it. The participants in Study 1 may have been unconsciously applying skills they possessed, or using tacit knowledge they had known for a long time. Besides, in terms of declarative memory, this study found that, based on previous events, the participants would adjust their actions when improvising. The participants perceived that their leaders would protect them when a team improvisation went wrong, due to the leaders' behaviours in the past, such as noticing the team was improvising but choosing not to intervene. In this research, it is suggested that the application of such declarative memory might help the teams feel safe, resulting in team improvisation such as using mechanical approaches to solve design issues without the need to consult specialists.

Summary

In summary, this section discussed five themes with regard to influences on team improvisation in terms of structural, social and cognitive dimensions (i.e., location distance, power, worry, time pressure, and team climate) in relation to the categorisation of the microprocesses of team improvisation as revealed by the relevant literature; as a result, five major insights were arrived at. Firstly, team dispersion may create circumstances where improvisation is more likely to occur when there is a problem. Secondly, the development of guanxi as a need from Chinese Confucian culture might be a reason for improvising on site. Thirdly, improvisation might be undertaken in an attempt to suppress anxiety. Fourthly, temporal urgency might shape the team improvisation in a unique way in terms of improving team performance. Fifthly, team climate for improvisation is accepted, protected and supported, reflecting characteristics of a particular organisational culture which might be the reason for choosing improvisation.

The next section will discuss the outcomes of team improvisation to examine whether there any new insights could be made.

4.6.4 Outcomes of team improvisation

Regarding the outcomes of team improvisation, this study found a number of different outcomes (see right-hand side of Figure 8).

In general, the balanced scorecard (BSC) is a good framework to apply here when considering the various categories of team improvisation outcomes that were evidenced in this study. This is because the BSC is a performance metric that businesses use to provide feedback on internal processes and external outcomes in order to improve performance (Kaplan & Norton, 1992). The BSC provides four perspectives to categorise the result of actions: a) financial, referring to results involved bottom-line improvement (e.g., profitability) which is associated with survival and success; b) customer, referring to results which relate to customers' views with regard to a company; c) internal, referring to results about a company's internal operations and d) innovation and learning, referring to results which relate to the ability of the company to introduce/expand continual improvements to the existing products and processes (Kaplan & Norton, 1992). Table 8 was therefore created to categorise the outcomes of team improvisation into the outlined perspectives.

Table 8. *A categorisation of the Study 1 outcomes of team improvisation according to the balanced scorecard*

Perspectives from the BSC	Outcomes
Financial	Financial loss/profit, job security
Customer	Quality, team performance, client satisfaction
Internal	Efficiency, team cohesion, company operation disturbance, machine malfunction, information leak
Innovation and learning	Learning opportunity loss

As shown in Table 8, in general, the outcomes of team improvisation could, to a large degree, be categorised with the use of the BSC.

To be specific, Study 1 found tensions between positive and negative outcomes at different levels at different time points. Similar phenomena were mentioned in the literature and, as noted in the literature review above, the outcomes of improvisation tended to be viewed in terms of a time scale to examine whether an outcome was positive or negative (Ciuchta et al., 2021; Cunha et al., 2017). Scholars such as Cunha et al. (2022) and Cunha & Berti (2024) found that practitioners tended to perform on-the-spot unplanned actions or repeated an improvisation process to enjoy a short-term local value, an improvisation known as myopic improvisation. Within the literature, novel physical structures (Miner et al., 2001), performance and efficiency, (Kyriakopoulos, 2011; Moorman & Miner, 1998a), and innovation (Vera & Crossan, 2005) have been identified as short-term outcomes of improvisation.

This study's findings support the concept of myopic improvisation. Almost all the team improvisation examples (19 out of 21) produced positive immediate or short-term outcomes, including improvement of product quality as a result of creating physical devices, improving team performance and increasing efficiency.

Moreover, a group of scholars (e.g., Vendelø, 2009; Gross, 2014) have also reported that immediate or short-term positive outcomes of improvisation could have a long-term negative impact, meaning the conditions in which improvisations are embedded could change their outcomes.

This study supports the idea that short-term positive outcomes at individual or team levels will turn negative at the organisational level (Vendelø, 2009; Ciuchta et al., 2021) because this study found a number of examples (ten out of 21) which showed positive outcomes within the short-term at individual or team level, but which were presumed to have risks in the longer term at the organisational level. The reason could be that team improvisation produced both positive and negative outcomes in the short term, and the risks

generated by the latter are likely to accumulate over time, and ultimately be borne by the organisation. For example, clients might be lost due to a decline in client satisfaction (Example 5, 12). However, it needs to be mentioned that some of the long-term outcomes were anticipated rather than actual, since the data collection period was limited by the Covid-19 situation.

This finding is important, because the current literature focuses particularly on effective improvisation, while this study found evidence to show that improvisation produces almost as many negative outcomes as positive ones, and such a situation could create more risks for organisations in the long run. Future scholars may want to explore some of the conditions that lead to negative improvisation, for example, the conditions that lead to the absence of organisational learning (see more in the next section as additional reflection).

To further discuss the details regarding the specific types of outcome, the literature highlights flexibility as a common outcome of improvisation because organisational members can achieve flexibility by improvising in order to manage uncertainty (Cunha et al., 1999; Moorman & Miner, 1998a; O'Toole et al., 2020). Although none of the outcomes of team improvisation summarised in this study was named as flexibility, all the team improvisation activities were meant to keep production procedures flexible in order to cope with surprises in daily work. This study's findings with regard to outcomes should be seen as empirical evidence supporting the literature pinpointing flexibility as a key outcome of improvisation.

Organisational learning is another widely-noticed outcome of improvisation (Cunha et al., 1999). The improvisation literature suggests that the improvisation does not fade away after its occurrence, but is learnt by the practitioners who are involved with improvisation (Miner et al., 1996). The literature highlights three ways of learning: first, team members learn how to improvise by performing an improvisation (Weick, 1999); second, organisational members reflect on improvisation to formalise it into an item of company

procedure (Macpherson et al., 2022); third, organisational members treat improvisation as a way of learning to obtain some benefit from any mistakes and failures (Miner et al., 2001). Learning as an outcome of improvisation means that microprocesses of improvisation (i.e., the unfolding of improvisation) are likely to be shaped by what and how employees learn because, on the timeline, the outcomes of a previous improvisation should affect the way the follow-up improvisation takes place, if members learn from the previous improvisation.

Surprisingly, as learning is widely-mentioned in the improvisation literature, as well as pinpointing it by the BSC as an important category of results of organisational actions, this study did not find much evidence to reflect that the team members had learned anything from team improvisation. This might have been because the researcher did not ask learning-related questions during the interviews. Such an abnormal circumstance needs further reflection. A follow-up sub-section has therefore been included, as there might be other potential explanations for an apparent lack of learning.

Reflection on the absence of the learning outcomes

The absence of learning outcomes means that this study does not have solid evidence to demonstrate that the outcomes produced by team improvisation were learned by the participants and fed back to affect the microprocesses and the relevant influences.

Although explicit evidence with regard to supporting learning outcomes was not found in Study 1, there were some data suggesting that the participants were ready to replicate an improvisation process or changes in production when the outcomes were positive. This implies that the participants learned from the outcomes of team improvisation. For example, this was the case for the teams which improvised by creating temporary devices (Example 3, 4, 6), when they found that they could improvise to improve product quality or repair the moulds or machines for production allowing them to successfully meet their deadlines. Teams would consider the method of making physical structures as an alternative

in their daily work. If a similar on-site accident (e.g., defective products appearing during production) occurred, the teams would repeat their improvisation.

Moreover, it was not found that the outcomes of team improvisation explicitly fed back in such a way as to affect the influences on the microprocesses (see the thick curved/dotted arrows at the bottom of Figure 8). However, some outcomes might implicitly strengthen these influences. For example, as teams improvised in such a way as to lead to negative outcomes (e.g., company operation disturbance and machine malfunction) as well as positive ones, the teams were not told to stop improvisation or were not punished financially by management. This meant that the teams' beliefs about their improvisation could be justified, would be protected, and were implicitly verified; as a result, the team beliefs might be strengthened encouraging team improvisation to continue to occur.

Although some implicit evidence might show the existence of a feedback loop, the absence of learning outcomes as a result of team improvisation needs further explanations. Three factors might explain this. Firstly, due to the impact of the COVID pandemic and the Zero-COVID policy, the participants were faced with a great deal of unpredictability (e.g., Example 13). The surprises overwhelmed the team members in their daily work, forcing them to constantly improvise in a firefighting manner, so they were exhausted by having to deal with unexpected situations with a focus on problem-solving, rather than retaining the capacity to reflect on the team improvisation activities and to learn from them. Secondly, the Avatar Group was making redundancies due to the tight cash flow during the COVID pandemic. Consequently, team members had to exceed other teams' performances to gain advantage for the sake of job security. To achieve such an advantage, team members had to either increase the number of completed projects by increasing their speed of operation, or try their best to please clients and receive positive client feedback. The team members in this study might therefore have ignored the learning outcomes because their job security was threatened, and

they might have used improvisation as a way of improving job security. Thirdly, the Avatar Group promoted a corporate value in the form of 'Client is King', which encouraged employees to try their best to meet the needs of clients. This in turn might have given a strong hint to team members that they were empowered to do whatever they wanted to please the client. Therefore, it is likely that the participants consider improvisation to be a normal practice, indicating that improvisation had become habitual. Consequently, team members would not be consciously reflecting on improvisation and, as a result, learning would not take place (Miner et al., 1996; Gong et al., 2008; Gomes, 2024). It should be emphasised that the findings of this study should not be seen as a criticism of the literature, but as a supplementary discussion relating to the possibility that learning as an outcome of improvisation might be curbed in certain circumstances.

Another aspect that needs further reflection is that this study found that team improvisation could simultaneously produce both positive and negative outcomes. In this study, the leaders were aware of the occurrence of team improvisation activities, but they chose not to intervene. A paradoxical situation is thus identified, why do leaders still allow members to improvise while knowing team improvisation might have negative outcomes? The reason could be that the leaders found themselves needing members to improvise to deal with the high degree of unpredictability, but at the same time, those leaders could not then avoid the risks brought about the team improvisation. The unpredictability caused the team improvisation to be short-sighted, because team members needed to be ready to constantly improvise to deal with surprises that might arise at any time.

4.6.6 Theoretical contributions

This study contributes to the current literature in several ways. Chiefly, it does so by providing a categorisation of team improvisation microprocesses. Team improvisation

microprocesses have received limited attention because most discussion is focused on the individual or organisational levels (Weick, 1993a; Bingham & Eisenhardt, 2011; O'Toole & Miner, 2020). Consequently, the categorisation of the microprocesses of team improvisation enriches our knowledge of the core theory of improvisation in terms of providing information about different ways in which teams improvise. This study builds on the work of a particular group of scholars (Weick, 1993a; Miner & O'Toole, 2024) by showing *how* teams improvise (Vera et al., 2024), rather than focusing on *when* improvisation takes place and *how effectively or frequently* improvisation occurs (Ciuchta et al., 2021).

In addition, this study contributes to the literature by highlighting the interpersonal nature of team improvisation. The theme of arguing and verifying to construct solutions represents a unique microprocess involving resolving disagreements, demonstrating that team members co-ordinate their actions by iteratively resolving conflict by simultaneously checking out each other's ideas. In the extant literature, although behavioural integration has been shown to be positively associated with improvisation, the need for problem solving skills and the importance of negotiation to reach agreement was not clearly identified by studying improvisation at the individual and organisational level (Magni et al., 2009; Vera & Crossan, 2004). The theme of arguing and verifying to construct solutions thus fills the gap resulting from insufficient discussion as to how synchronisation in team improvisation is achieved by highlighting the way of working through conflicts as and when they arise.

Moreover, this study contributes to the literature by highlighting a type of team climate which shares key characteristics with the metaphorical concept of experimental culture. The theme of team climate demonstrates that team improvisation is widely accepted by employees, protected and supported by leaders, and promoted by the organisation. In the improvisation literature, relying on metaphor translation, the idea of experimental culture was conceptualised into three dimensions – action promotion, error tolerance, and organisational

support (Vera & Crossan, 2004; Yao et al., 2017). Although such a concept has been discussed in the literature and scholars have suggested a positive association with improvisation regarding its effectiveness and occurrence (Cunha et al., 1999; Vera & Crossan, 2005; Su et al., 2022), few studies have provided empirical evidence to demonstrate its existence within organisational contexts. The theme of team climate thus fills the gap by providing empirical evidence relating to the metaphorical concept of experimental culture which is frequently mentioned in the literature.

Furthermore, this study contributes to the literature by highlighting a reason for why people choose to improvise. This study has found that teams want to improvise because it reduces their anxiety. Although the extant literature has noted that emotions such as fear and excitement are experienced by employees during improvisation (Mirvis, 1998; Fisher & Barrett, 2019), the literature has tended to overlook emotions as an influence on improvisation (Ciuchta et al., 2021; Hadjimichael, 2024). This study finds that teams treat improvisation as a way of achieving certainty, given that members of the team can create an immediate positive outcome in terms of continuing production. In so doing, this study enriches the improvisation literature from an emotional perspective with regard to why people choose to improvise in the first place.

Finally, this study contributes to the improvisation literature by highlighting the tensions between positive and negative outcomes at different levels and at different time points. By applying the time and level dimensions suggested by Ciuchta et al. (2021), this study finds that team improvisation activities can lead to both positive and negative outcomes in the immediate, short-term, and long-term, and at the individual, team, and organisational level. Although the extant literature traditionally tends to focus on improvisation activities with positive outcomes (Cunha et al., 1999; Vendelø, 2009; Ciuchta et al., 2021) and some researchers have explored how improvisation tends to lead to negative outcomes (Flach,

2014; O'Toole et al., 2024), few studies have reported how team improvisation can lead to a mix of outcomes at different levels and time points (Miner & O'Toole, 2024).

4.7 Limitations

This study has a number of limitations due to the use of the interview methods to investigate the microprocesses of team improvisation and how they were shaped. Participants found it difficult to articulate the detailed actions taking place during the unfolding of a team improvisation activity because improvisation happened over a relatively short period of time. Both the participants and the researcher, had to go back and forth during the interviews to fill in the blanks regarding team action. Although measures such as drawing pictures of action sequences were taken to facilitate the participants' recalling of memories during the interviews, it was possible that there was something missing in the data collected. Moreover, in order to explore the influences of team improvisation, participants were interrupted to a certain extent when they were sharing details of team actions, because the participants were asked to explain why he/she had performed an action. As a result, the data collection with regard to microprocesses could have been negatively affected. Furthermore, the self-reported data generated by the semi-structured interview method might be biased as a result of what is known as social desirability (Zerbe & Paulhus, 1987). Participants tend to provide favourable self-descriptions to others – so-called impression management – and deny negative attributes (Paulhus & Reid, 1991). In this study, the fact that most of the team improvisation activities were successful showed that the participants told the researcher about things that made them look good. As improvisation scholars such as Macpherson et al. (2022) have noted, the direct observation method is needed for improvisation studies as this can directly record the sequence of team members' actions, and it would be beneficial to collect some additional contextual data. Therefore, although the semi-structured interviews worked as a way of

exploring the unfolding of an activity and capturing the influences of improvisation, additional insights would have been be provided if this research had included a direct observation-based study. Besides, the validity/robustness of the Study 1 findings could be examined by using a different methodology. Study 2 was therefore necessary to examine whether or not the same types of microprocesses associated with team improvisation occur as was the case in Study 1, or new ones occur.

The next chapter presents how the Study 2 team meeting observation was designed and carried out.

Chapter Five Study 2 Team Meeting Observation

The aims of this study are to check the validity and robustness of the findings of Study 1 and to offset its limitations. As noted above, the self-reported data from Study 1 might be biased due to social desirability (Zerbe & Paulhus, 1987); besides, when using the semi-structured interview method, the participants needed to recall a team activity that had occurred some time previously. Consequently, they might miss some information regarding team actions with regard to improvisation, and how they might have been influenced during the team improvisation process. Therefore, this study is necessary to incorporate observation as an additional research method, with the aim of achieving two overall research aims:

1) Scrutinise whether the Study 1 findings can be confirmed by the Study 2 data
2) Identify whether the Study 2 data provides new findings that differ from those of Study 1

This study starts by describing the method of team meeting observation (see 5.1) where the data is generated via field notes since not all participants agreed to the audio recording of the meetings (see 5.2). To achieve the first research aim, a deductive thematic analysis is used to examine Study 2 data using the coding scheme from Study 1 as a coding manual.

To achieve the second overall research aim, it is necessary to note that additional inductive coding is included as it is possible that important information might be missed if the researcher is only applying a deductive approach for confirmation purposes. As a result, the process of how the codes were connected and reframed is presented in 5.3.

The Study 2 findings are then discussed in conjunction with the Study 1 findings to reveal similarities and differences, with reasons being included to explain the latter. Theoretical contributions are presented in 5.4, followed by the limitations of the approach in 5.5.

5.1 Method design

This study was designed to observe team meetings in an attempt to capture team improvisation in terms of how it occurred and how it was influenced. The consideration when it came to observing team meetings was that the meetings represented the principal means by which members exchanged information about actions that affected activities and their outcomes (Adler & Adler, 1998). Miner et al. (2001) used the team meeting observation method and successfully captured different forms of improvisation. In Miner et al.'s (2001) study, they observed and audio-recorded approximately 50-60 team meetings in total at two different organisations to collect data about how team decisions were made regarding improvisation. The authors asked the participants to report what they had done on behalf of the team after the meetings, so the authors could ensure that meetings captured a representative set of actions by the team (Miner et al., 2001). The real-time data collected by the team meeting observation method was designed to test the validity of the Study 1 findings and examine whether any new information had been missed. The next section will describe the process of finding an appropriate project team for observation purposes.

5.1.1 Finding a project team

Similar to Study 1, Study 2 also needed to search for participants who would be likely to improvise; purposeful sampling was therefore deemed to be a suitable method (Patton, 2002). The same criteria utilised in Study 1 were applied to identify appropriate participants; these were employees who (1) have formalised procedures to follow, (2) are in an unpredictable environment, (3) often face time pressure (see detail in 4.1 for the identification of the participant sampling criteria). Therefore, it was still appropriate for this study to select the project teams from the Avatar Group as participants (see detail in 3.5.1 for justification for using the project teams in the Avatar Group as participants). More specifically, in this

study, the participants observed had to meet the three criteria outlined above with an additional criterion, that is, (4) the project teams needed to have team meetings. To maintain the voluntary nature of this study, the participants were expected to be selected from those who wanted to participate in the team meeting observation method and who had a shared ongoing project.

It was decided that I would observe an NPD project for hedge machine accessories for the following reasons based on the selection criteria: (1) the employees had procedures to follow, such as an NPD manual, so team improvisation could be captured if it occurred by comparing the procedures and the team actions; (2) the team was in an unpredictable environment – the COVID pandemic period in China where a Zero-COVID policy caused a great deal of unpredictability; (3) the team faced time pressure, as the client had asked the team to deliver a small number of samples in two months to determine whether to make a long-term order if the samples passed quality tests; (4) the team had regular meetings. Therefore, the team members on this project were likely to improvise during meetings and report any improvisation that happened between meetings.

Other practical aspects were considered to determine whether or not this project was appropriate for observation purposes. Firstly, this project was relatively easy for the researcher to understand because it was not particularly complicated, as it involved few manufacturing steps and not a great deal of technical knowledge. Secondly, there were sufficient design materials such as the machine blueprint for the old model, so it was expected that the team would develop the new accessories quickly.

All the participants were recruited whilst abiding by the ethical procedures of the University of Sheffield. Participant information sheets were presented to them, and consent was obtained. As in Study 1, participants in this study were explicitly informed, prior to signing the consent form, that a report would be provided to the company following the

study. This assurance was given on the condition that their anonymity would be strictly maintained.

The recruitment for the team meeting observation started in late July 2022. By consulting the HR manager, the researcher established that the employees with managerial positions were more likely to have regular meetings. Thus, the organisational contact, Mr X, sent emails with the participant information sheets attached as an invitation to senior managers across all departments. However, employees in the auto-parts division of the Avatar Group could not volunteer to participate in the team meeting observation due to concerns about sensitive technology information. Moreover, no ongoing shared projects could be identified among the volunteers from the company's gardening equipment division.

At the end of July 2022, the researcher was contacted by Mr Y (the name has been anonymised) from the gardening equipment division. The researcher was welcomed to observe the team meeting because the technical knowledge was relatively transparent in the case of manufacturing gardening equipment. Then, after deciding which project was appropriate for observation (see the later paragraphs), the researcher was invited to attend an introductory session on the project (see information on the project observed in 5.1.2). The researcher had the opportunity to explain his research and obtained consent from all nine people. The team meeting observations lasted from August to October 2022 and resulted in 17 meetings.

Table 9. *The number and information of participants in Study 2*

Anonym	Position	Specific section
James	Senior manager	Manager team
Linda	Manager	
Robert	Manager	
Susan	Manager	Technical team
David	Supervisor	
John	Supervisor	

Mike	Senior engineer	
Carl	Engineer	
Kevin	Engineer	

According to Table 9, the project team was further divided into a management team and technical team. The managerial team coordinated resources and supported the technical section to develop the new product. James was the highest rank person in the team, and oversaw the entire project; Linda was in charge of purchasing new materials and equipment and drafting expense accounts; Robert was responsible for supervising the manufacturing of new product samples. In the technical team, Susan was the technical manager and the leader; David was from the quality control department and was responsible for communicating with the testing centre for recording NPD data; Mike, Carl and Kevin were engineers with their own technical expertise. The next section will provide contextual information about the observed project.

5.1.2 The context of the observed project

By attending the introductory session at the end of July 2022, some general information was gathered; Table 10 includes the general information about the project to facilitate an understanding of the findings in 5.4.

Table 10. *General information on the observed new product development project*

Client	Daito machinery (Pseudonym)	
Meeting frequency	Every week	
Observed duration	August to October 2022	
Developing components	Blade	Handrail
Requirements	• Type: double-side • Better in hardness • Length: 500mm	• Fit in style • Deliver prototype 15/10/2022

	• Thickness: 2.0mm • Higher blade surface roughness • Processing: Open • Colour: Open • Surface treatment: Open • Deliver prototype on 1/10/2022 • Selling points	

The first row in this table shows the pseudonym of the client, Daito; it was a trading and manufacturing company mainly associated with many accessory suppliers and was responsible for gardening machine assembly. Daito had a hedging machine entitled the VS60 model, but sales were declining; therefore, the client wanted a new version of the VS60 with a new blade and handrail. The second row indicates that the team meetings would occur weekly. The third row shows that the duration of the observation was from August to October 2022 since the samples were required to be delivered in October 2022. The fourth row shows a new blade and handrail, the components for which the project team was responsible for developing, and the row below demonstrates the detailed requirements that the client, Daito, proposed.

Moreover, there is some noteworthy background information. This project was considered to be a “priority project” according to the project management system within the Avatar Group because the head of the technology department wished to use this project to expand the division’s business scope from downstream manufacturing to upstream product design. The team members were implicitly empowered beyond the responsibilities of the technology department itself, such as in terms of mobilising personnel and resources from other departments, prioritising sample manufacturing and testing, and changing the original production schedule. The reason for describing the empowerment as implicit is that there were no official written orders from the senior management stating what kinds of authority

had been given to the project team members; it was flagged as red in the company intranet, meaning the highest priority. Moreover, affected by the company's redundancy and the Zero-COVID policy, the NPD team, as one of the few sets of employees who could walk around between different workshops, was required to take charge of a certain amount of front-line production work in different workshops (mainly assembly and packaging) regardless of their expertise in order to ensure shipments.

In addition, since Study 2 also took place in the Avatar Group, it is important to restate some key features with regard to the organisational background in that they are helpful when it comes to understanding the findings of this study. Firstly, during the observation period, the Avatar Group had to deal with a great deal of unpredictability and overt intervention on the part of the local government due to the COVID and Zero-COVID policy in China. The company thus changed from hierarchical management to project management in 2021. Secondly, the company was facing a negative impact caused by COVID and Zero-COVID in China, such as the loss of foreign clients due to the reduction of international freight, domestic transportation restrictions resulting in delivery difficulties, while whether or not factory employees could come to work became a daily question due to the travel restrictions and strict industrial park (where the company was located) management. Thirdly, by applying the project management system, an internal competition was created, with teams with a low number of projects completed, and a low quality of completed products would be at risk of being made redundant – something the Avatar Group referred to as being "graduated" from the company.

5.1.3 The method for data collection

The researcher initially set out to record the meetings via audio recording; unfortunately, a few participants did not give permission to be audio-recorded. Writing field

notes thus became the primary method for data collection. Field notes are researchers' written accounts of what they hear, see, experience, and think in the course of collecting and reflecting on their data. It involves only the researcher, which allows the creation of an ongoing record with continuity (DeWalt & DeWalt, 2010). Compared with audio/video transcriptions which requires an audio/video recording device on the site, the participants' behaviours might be affected by the presence of the audio/video recording devices, and the participants might possibly be interrupted as the recording equipment might need adjustments during the observation (DeWalt & DeWalt, 2010).

There are two aspects of observational fieldwork. The first is observing, which means that the researcher should actively look and listen to observe the phenomenon being researched (DeWalt & DeWalt, 2010) such as, for example, the words said by the participants, their actions, body language, and any environmental information such as seating plans (Jarzabkowski & Seidl, 2008). When Miner et al. (2001) observed improvisation in team meetings, they found it difficult to identify an improvisation during the data collection process, which made later data analysis challenging. In this study, it would be better if the researcher was aware of when improvisation was likely to occur, since trying to observe all communication in meetings or record all interactions among people, might result in limited observation. Scholars (DeWalt & DeWalt, 2010; Werner & Schoepfle, 1987) have also asserted that observation works most effectively when researchers know where to look, so the observation can focus specifically on the phenomenon being researched. As a result, relying on the improvisation literature, several highlighted circumstances in which improvisation was likely to occur were noted during the data collection with regard to this study. These situations were (1) people questioning an original plan (e.g., Miner et al., 2001), (2) when a surprise occurs (e.g., Yanow & Tsoukas, 2009), (3) people acting under time pressure (e.g., Macpherson et al., 2022) and (4) people raising an alternative idea (e.g., Suarez & Montes,

2019). These four conditions were written on a paper card that the researcher carried while observing to remind him to stay alert for these conditions occurring as the team members were likely to improvise. Moreover, given that improvisation was defined as the convergence of the composition of a new solution and its execution (see 2.2 for definition), Miner et al. (2001) suggested that participants should be asked to report their actions after the meeting to examine whether a novel design agreed during team meetings was actually executed. They suggested that participants list all the things they had done on behalf of the team by sending such information via email (Miner et al., 2001). In this study, the participants were asked to email the researcher to report what they had done for the project on a weekly basis so that the researcher could compare their actions to the decisions and agendas agreed upon in order to identify examples of team improvisation.

Secondly, writing means that researchers should write detailed field notes of the activities observed (DeWalt & DeWalt, 2010). In this study, field note writing was the primary means of obtaining data from the observation of the meeting (DeWalt & DeWalt, 2010). Two stages of notetaking were involved. Firstly, descriptive notes aimed to record what had happened in the field (DeWalt & DeWalt, 2010). Secondly, analytic notes generated insights through reflecting, interpreting, and making inferences from the descriptive notes, which was then fed into the analysis (Bernard, 2012; DeWalt & DeWalt, 2010). This study's descriptive and analytic notes have been regarded as primary data. To write descriptive notes, "on-the-spot", contemporaneous notes should be taken as the first step during observation; these are called jots (DeWalt & DeWalt, 2010). The jots were therefore taken publicly in this study. There is a debate about publicly taking jots that is worth mentioning. Scholars such as Whyte (1984) chose to travel home or go to the bathroom to take notes because participants felt uncomfortable with jots being made in their presence. However, researchers such as DeWalt and DeWalt (2010) suggest taking notes publicly, because participants could assume

that what they said is unimportant if the researchers were not taking notes, and researchers might forget what happened if there is a delay between observing and note-taking.

During the data collection with regard to this study, the researcher sat beside of team members to take notes when the team meetings were ongoing; the participants raised no complaints. Moreover, scholars (Creswell & Miller, 2000) have suggested that researchers should ask the participants to review the jots for accuracy by asking questions such as 'Do you think these notes accurately reflect the meeting?' In this study, one or two participants were asked to review the contemporaneous notes in each meeting. The researcher elaborated the jots in order by paraphrasing while the participants were reading the notes so they could understand what the notes stood for. The notes were refined based on the participants' comments. Words and phrases related to actions during the team meetings could be jotted down, and sketch maps and diagrams could also be used if they were helpful to expand the contemporaneous notes because the jots should be expanded into a complete description of what had happened (DeWalt & DeWalt, 2010). Bernard (2012) asserted that the work of expansion needs to be started shortly after finishing a day's observation and the researcher should operate under a time constraint. In this study, the researcher returned home within 30 minutes to conduct the expansion work, which then took two to three hours.

With regard to the analytic notes, DeWalt and DeWalt (2010) suggested that these should be produced simultaneously as an expansion of the jots, to represent a level of inference and analysis. The writing of analytic notes should occur multiple times as the data collection proceeds since the interpretations might shift as the understanding goes deeper (DeWalt & DeWalt, 2010; Bernard & Ryan, 2009). In this study, an observational framework provided by Cross and Cross (1995) was used to produce analytic notes because their framework was designed to observe teamwork in product design, which fitted with the project observed in this study. Six dimensions were offered by Cross and Cross (1995) as

perspectives for analysing the descriptive notes; these were roles and relationships (Minneman & Leifer, 1993), planning and acting (Guindon, 1990), information gathering and sharing (Kuffner & Ullman, 1991), problem analysing and understanding (Fricke, 1993), concept generating and adopting (Visser, 1993), and conflict avoiding and resolving (Klein & Lu, 1989). A field note template was created as shown in Table 11 below.

Table 11. *Field note template*

<table>
<tr><td colspan="3">Serial number</td></tr>
<tr><td>Date/time Location</td><td>Team goal</td><td>Communication channel</td></tr>
<tr><td>Project code
Team code
Participant codes</td><td>Aim of the meeting</td><td>Equipment used</td></tr>
<tr><td>Meeting environment</td><td colspan="2">Reasons for holding the meeting</td></tr>
<tr><td colspan="3">Seating situation/room layout (Picture drawing with specific participant codes)</td></tr>
<tr><td colspan="3">On behalf of the project, things that members have done:

Timeframe:</td></tr>
<tr><td colspan="3">Descriptive notes

Analytic notes using the framework by Cross and Cross (1995)
· Roles and relationships
· Planning and acting
· Gather and share information
· Analyse and understand problem
· Generate and adopt concepts
· Avoid and resolve conflicts</td></tr>
<tr><td colspan="3">Question
Did you do exactly what was agreed in the team meeting? If not, why not?</td></tr>
</table>

The use of field notes in this research can be divided into three stages. Stage one: before the meeting started. The researcher would write down the serial number of the field note, such as 1 (in the first row), and the codes corresponding to the participants; he should write down the time and place of the meeting and details of the environment of the meeting, such as the environment being quiet, clean/messy, etc. Stage two: during the meetings. At the beginning of the meeting, team members would be asked to share what they had done for the project between meetings. The researcher would write down the details in the sixth row of the field note template and mark the date the team member did it. At the end of their sharing, the researcher would ask: "Did you do exactly what was agreed in the team meeting? If not, why not?", and write down the answer on the last row of the template. Then, the team leader would introduce information about the goals of the team, the aim of the meeting, and why the meeting was being held; such information would be recorded in the second, third, and fourth rows, respectively. When the discussion started, the researcher would record what the team members said (the main meaning) in a notebook by quickly writing keywords and marking who said what, and noting the more prominent body language (such as individuals standing up, raising hands). Stage three: after the meeting. When the researcher was still at the meeting place, he would record the communication channels, such as face-to-face communication, and the equipment used, such as projectors and whiteboards. He then invited participants to read his notes and ask if they accurately reflected what the meeting was about. The researcher would then drive home and, based on my on-the-spot notes, I would recall the meeting and take descriptive notes (in the seventh row). After that, in order to promote the subsequent data analysis, the researcher would take the framework suggested by Cross and Cross (1995) as perspectives and write analytical notes to summarise and abstract the contents of the meeting to a higher level or explore the possible causes of the phenomena that emerged during the meeting.

To show what raw data the researcher ended up analysing, a completed example of one filled-out field note is included in Appendix 8. The next section will describe the process of data collection.

5.2 Data collection

Two types of team meetings were observed with regard to the project teams: management meetings and technical meetings. The former resolved issues reported by the latter, which was held weekly. The researcher planned to observe each type of meeting once as a pilot, to evaluate whether or not he could effectively obtain useful data and test whether Cross and Cross's (1995) (see 5.1 for method design) framework worked in terms of writing descriptive notes.

5.2.1 Pilot data collection

By observing the management meeting on 3 August 2022 and another technology meeting on 10 August 2022, the framework proposed by Cross and Cross (1995) helped the researcher generate analytical notes because it offered perspectives to understand the team members' actions and words. However, several difficulties were identified and resolved in

order to collect useful data (see Figure 9).

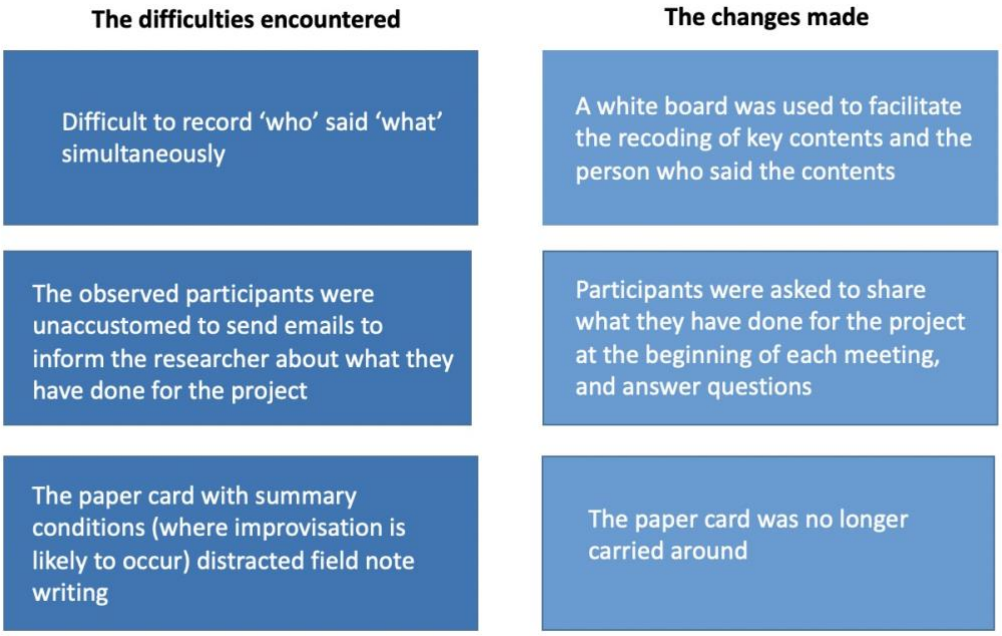


Figure 9: How difficulties during data collection were resolved

Firstly, it was found difficult to write on-the-spot notes about the content of the meeting and concurrently note the person who was speaking. It was essential to record the information about 'who said what' because such information could reveal how the team members interacted. The team members often scribbled ideas on a whiteboard when discussing how to do things, so the participants were asked to write down the 'who said what' key information on the whiteboard.

Secondly, although the participants agreed to send emails to report what they had done for the project, I only received a few such emails, and the things they listed in the emails were often vague. This may be because intra-team communication in China rarely uses emails. With limited information on members' execution of the ideas agreed upon in the meetings, it was impossible to identify examples of improvisation. To cope with this, the participants were asked to elaborate on what they had done to advance the development and progress at the beginning of a meeting. Moreover, to better identify whether the team

members had improvised and gathered contextual information after the participants had shared what they had done for the project, they were asked to answer two questions: 'Did you do exactly what was agreed in the team meeting? If not, why not?'

Thirdly, I found that the paper card with the four circumstances about when improvisation would be likely to happen was not working, because it was difficult to write the notes and simultaneously be aware of the occurrence of the four conditions. The existence of the card distracted the researcher from notetaking. This experience matches Miner et al. (2001), as they found it challenging to identify improvisation during team meeting observation; hence, it was suggested that the identification of improvisation should be conducted during data analysis. Therefore, it was decided to focus entirely on taking notes about what was happening during the meetings, instead of consistently looking at the paper card to judge whether one of the circumstances had just happened.

5.2.2 Formal data collection

With the improvements obtained from the pilot, 17 team meetings were observed including 11 technology and six management meetings. Two meetings were excluded (see 5.2.3) (including the two from the pilot), Field notes were written, with the researcher relying on the field note template (see Table 11). The schedule of team meeting observations is shown in Table 12 below.

Table 12. *The schedule of team meeting observation*

Date	Observed meeting type	Field note (FN) number
3 August 2022	Management	FN1
10 August 2022	Technology	FN2
15 August 2022	Management	FN3
20 August 2022	Technology	FN4

25 August 2022	Technology	FN5
31 August 2022	Technology	FN6
2 September 2022	Management	FN7
3 September 2022	Technology	FN8
9 September 2022	Technology	FN9
13 September 2022	Technology	FN10
15 September 2022	Management	FN11
20 September 2022	Management	FN12
22 September 2022	Technology	FN13
28 September 2022 (*excluded*)	Technology	FN14
11 October 2022	Technology	FN15
14 October 2022	Management	FN16
19 October 2022 (*excluded*)	Technology	FN17

5.2.3 Sample exclusion

Two sets of field notes were excluded from data analysis in this study. One was a technology meeting held on 28 September 2022, which was cancelled because two members did not attend. The other was a technology meeting held on 19 October 2022 because it was a summary meeting held after the project was finished, and no team improvisation activities were identified during the meeting.

5.2.4 Reflexivity on data collection

Researchers are encouraged to be reflexive during observational research because their presence in organisational settings could have epistemological outcomes (Buscatto, 2008; Palaganas et al., 2017). For example, the findings of a section of a study might be influenced by how the observed participants behaved differently as they were aware there was an observer in the room. During this study's team meeting observations, I noticed that

the fact that I had obtained organisational access via the senior management somehow gave me a more powerful position than any of the participants. They perceived me as a person who was very close to someone from the senior management, which made them want to look good when I was present. Such a situation was noticed during the introductory session at the end of July 2022; the team members tried to show the best work attitude/ethics by emphasising the importance of the project and company values.

At the first few team meetings, I found that team members spent an excessive amount of time explaining and discussing why a proposed idea was reasonable or appropriate, which I felt was to show me – a person whom they believed had a close relationship with the senior management – that they were not doing anything wrong. I was often asked about my opinions about the team plans made after a meeting or was asked questions such as 'Are you a relative of some board member of the company?' This study's topic might also explain why team members were cautious, because improvisation was about finding what a team did differently from the organisational procedures, and might have constituted rule-breaking behaviours. The participants' assumption that I was a person who would report their wrongdoings to senior management had an advantage for the project, which was that the team plans were made more rigorously. However, it may not have been good for my research, as I wanted to observe team improvisation, and my presence changed the participants' actions since they saw me as an extension of management power, and consequently put on an act to protect themselves..

I realised that I needed to promote myself as a neutral researcher to reduce such a perception. I often asked the participants to help me review the contemporaneous notes to convey that I only recorded the meeting information and was not afraid to show them. By doing so the participants felt that I was not aiming to reveal any violations. When the participants read that I had only written notes about who said or did something or who said

what to whom, they asked me, ‘Is it going to help your research by documenting our boring stuff?’ Sometimes, the participants asked me what they could do to help me more with the research. I politely smiled and said, ‘Just pretend I was not here’. These questions from the participants indicated that they had received the message that I was a neutral researcher rather than a person who worked for top management. Moreover, I further tried to ensure the participants understood that the data was safe with me and that they could act normally during the meetings. I emphasised the idea of data confidentiality at the end of the July 2022 introductory session, when I explained the research, such as how codes would replace their names and pointed out that they would not be able to be identified in any written form. During the data collection, when I was asked about the opinions of other participants or how the interviews were going, I refused to answer these questions because I needed to protect all the participants’ data. In addition, I never left the notes unattended to show the participants that I paid great deal of attention to the safety of the data.

By exercising these measures, I was gradually perceived as a neutral researcher by the participants. I felt that they were more relaxed and acted more normally; for example, the meeting location for technology meetings changed over time, from a conference room (10 August 2022) to a shared office room (20 August 2022). The participants met in a small office, sitting on sofas rather than office chairs (3 September 2022). Although the influence of being perceived as an outsider who was close to the senior management might negatively affect the occurrences of team improvisation, since the participants tended to be compliant with the organisational procedures due to my presence, a few team improvisation activities were captured as the participants gradually acted more normally.

This section described how data was collected and how the presence of the researcher might have influenced the data collection. The next section will present how the collected was analysed to achieve the two overall research aims: ‘Scrutinise whether the Study 1

findings can be confirmed by the Study 2 data', and 'Identify whether the Study 2 data provides new findings that differ from those of Study 1'.

5.3 Data analysis

As a way of identifying patterns within data, it was appropriate to apply thematic analysis because this study aimed to identify the action patterns of team improvisation activities and the elements influencing the action patterns (Braun & Clarke, 2022). Unlike the inductive thematic analysis conducted in the Study 1 (see 4.4), Study 2's analysis was deductive because the researcher wanted to examine the previous findings in Study 1. A deductive orientation meant the thematic analysis was conducted using a lens from Study 1's coding framework (see Table 5 in 4.5.2 and Table 7 in 4.5.3). At the same time, the coding framework of Study 1 provided a foundation for coding and theme development (Braun & Clarke, 2022).

A deductive approach can be theory-driven to confirm or revise a theory by using the concepts from theories to make sense of data (Braun & Clarke, 2022). For example, Proudfoot (2023) used a self-determination theory framework and conducted a deductive thematic analysis of teachers' motivations. When the framework applied does not derive from an established theory but from the findings of other scholars, the deductive thematic analysis is viewed as prior-research-driven (Braun & Clarke, 2022; Boyatzis, 1998). For example, Dawn and Willig (2023) used a category of uncertainty in healthcare developed by Han et al. (2011) as a coding manual to seek examples of their participants' experiences of perceiving uncertainty.

Given that improvisation scholars (e.g., Macpherson et al., 2022) have pinpointed the concern that self-reported data might be biased due to people's social desirability, the deductive thematic analysis of this study aimed to test the validity of the microprocesses that

emerged from the self-reported data of Study 1 existed in the real-time data of Study 2. In practice, before engaging in deductive thematic analysis, it was necessary to identify team improvisation activities. The same criteria for identification were applied as in Study 1, derived from the definition of team improvisation (see 2.2). The criteria were: a) the actions needed to be team actions, b) the team actions had to deviate from written procedures, c) the time interval between the composition of a new idea and its execution had to be quick (how a team idea was determined as executed quickly is explained in the following paragraphs). A table template was created to list the deviated team actions identified in chronological order in a Word document (see Figure 10).

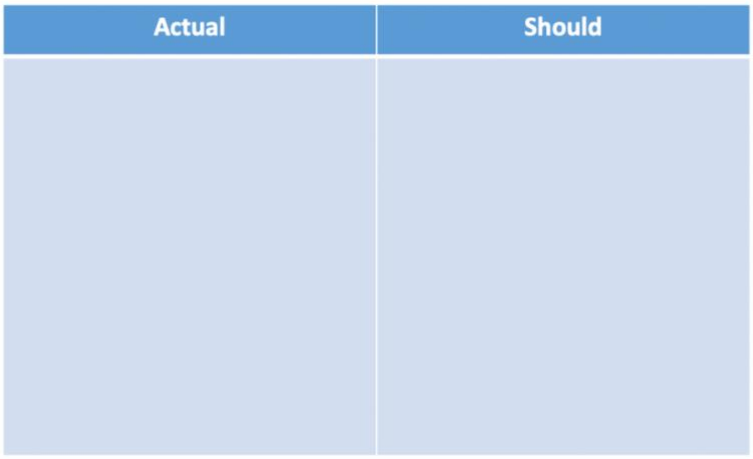


Figure 10: Table for the data from team meeting observation to record deviated team actions

The left-hand column 'actual' depicts the listed team actions that were observed; the right-hand column 'should' represents what the team should do. Then, the researcher needed to determine whether or not a new idea proposed in the team meetings has been executed quickly.

It was necessary to note how a team activity was composed as there were many field notes. A team activity was composed in two ways to fully capture team members' plans and the actions for executing those plans. Firstly, a team activity could be composed of the data gathered during a meeting, such as a team activity involving blade designing: members talked

about their designing ideas and ran simulations on computers (Example N; FN9, 9/9/2022); in such a circumstance, a team activity was composed of only one field note. Secondly, given that team members often implemented the improvised plan after a meeting, the composition of team activities needed two field notes because, at the beginning of a meeting, the researcher asked team members to share what they had done for the project during the previous week (see 5.2 for Study 2 data collection process). For example, in Example E, the researcher observed in a meeting on 10 August 2022 that the team interpreted a mould designing detail as an innovative feature which could be used for selling to the client, while the data for the actual execution occurred in another meeting on 20 September 2022.

In practice, two criteria were used to identify team improvisation activities. Firstly, if a newly-formed idea (which deviated from written procedures) agreed upon by team members in a meeting was put into action during that meeting, the team actions were considered to be a team improvisation. Secondly, the participants explicitly stated that a team plan was executed quickly during the meetings when they were asked to share what they had done for the project, for example, using words such as ‘immediately’, ‘quickly’, ‘in a short time’, ‘as early as we got the chance’ to demonstrate a team plan entering the execution stage.

When all the researcher’s field notes were completed and scrutinised and he had identified the team improvisation, the relevant field notes were used for deductive thematic analysis. This was conducted following the guidelines provided by Boyatzis (1998): a) refining a coding manual, b) testing a coding manual, c) applying the coding manual and additional inductive coding, d) connecting codes and reframing the coded themes.

It was necessary to pinpoint the reason for conducting additional inductive coding. When a coding manual was refined based on the Study 1 coding framework, and its themes and second-order codes were applied, the themes contributed to the predetermined codes’ “definition” (see step one, Table 14 as an example), the second-order codes composed the

"description" of the coding manual. As a result, when the researcher was coding the texts using the coding manual, the "definition" allowed him to identify data which might not be included in the circumstances presented in the "description", since the former was more abstract than the latter. In addition, a summary was provided at the end.

5.3.1 Step one – Refining a coding manual

A coding manual is important because it can work as a data management tool for organising segments of similar related texts to help interpretation (Crabtree & Miller, 1999). For this study, the researcher used a coding manual based on Study 1, which was generated inductively from the 19 semi-structured interviews, to analyse the texts from my field notes. It was necessary to refine the coding manual before commencing an in-depth analysis of the data by stating the names of the codes, defining what the codes were about, and providing descriptions of how to know when a code had occurred (Fereday & Muir-Cochrane, 2006). The coding manual the researcher used in this study comprised two parts. Firstly, the microprocesses framework of improvisation, which represented the action patterns of team improvisation, including four themes of team improvisation microprocesses: (1) making 'temporary' devices, (2) interpreting written procedures and introducing new ideas, (3) asking for help from outside teams, and (4) arguing and verifying to construct solutions. Tables were created to show themes' names, definitions, and descriptions. The "names" were the highest level of the codes, i.e., the themes from the coding framework of Study 1; the "definition" showed the intentions of the themes regarding capturing relevant data; the "description" demonstrated the circumstances that the researcher would observe in Study 2 data to indicate when the relevant data would appear, each circumstance represented a lower level microprocess (i.e., second-order code under the theme). The numbering used was the same as in Study 1.

Table 13. *Theme A of the coding manual for deductive thematic analysis*

Theme A	
Name	Making ‘temporary’ devices
Definition	The intent is to find data about members creating physical structures to get the job done. This may show the attitude of treating the method of creating a device as a permanent solution. This will often appear in factory settings, where members find creative ways to assemble nearby materials to create devices to get by.
Description	It is indicated when team members . search/gather materials/tools (e.g., go to the warehouse to find a duct); . fabricate devices using nearby materials (e.g., assemble a duct and a valve into a diverter pipe); . amend devices (e.g., strengthen a physical structure via welding).

Table 14. *Theme B of the coding manual for deductive thematic analysis*

Theme B	
Name	Interpreting written procedures and introducing new ideas
Definition	The intent is to find data about members’ interpretations, they might interpret the organisational procedures/rules/regulations and how they normally apply or give new meanings to plans/ideas of improvisation. The purpose may be to prevent new plans from being suppressed by the procedures. This will often appear when members want to make room to develop a new idea that they know they are not allowed to execute.
Description	It is indicated when team members . twist the meanings of a specific procedure/company rule; . add new meanings to a new idea (e.g., a new idea brings additional advantages); . weaken the enforcement of a specific procedure (e.g., claim following a rule can be optional by highlighting the importance of a local situation).

Table 15. *Theme C of the coding manual for deductive thematic analysis*

Theme C	
Name	Asking for help from outside teams

Definition	The intent is to find data about members to reach someone from other teams, departments, or another company for all kinds of help, maybe for solving a problem or making things easier, quicker. This often appears when the knowledge about how to solve a problem is beyond members' abilities or an expert member is absent.
Description	It is indicated when team members . reach out to all kinds of helpers via various channels (e.g., make a video of a machine making abnormal sounds and send it to a technical expert); . ask helpers for insights on a specific problem; . ask favours (e.g., give small gifts to jump the waiting queue for quality testing).

Table 16. *Theme D of the coding manual for deductive thematic analysis*

Theme D	
Name	Arguing and verifying to construct solutions
Definition	The intent is to find data about members discussed within the team to find a solution, the purpose might be urgent problem-solving. The team members may argue with each other and verify each other's proposals/ideas with various actions during the team discussion. This will often appear when members have opposite views on something; they can become emotional to prove themselves right or that the other person is wrong under time pressure, leading to a disorganised discussion of solutions.
Description	It is indicated when team members . express different opinions to analyse situations such as finding a cause of a specific problem with actions to check those opinions; . generate new ideas via arguing (e.g., proposing different ideas or comparing each other's ideas to reach a team consensus); . show evidence or state certain limitations to convince each other.

Secondly, the five themes identified as influences on team improvisation from Study 1 were considered as another part of the coding manual: a) location distance, b) power, c) worry, d) time pressure, and e) team climate. The same type of tables was created as follows. The numbering used was the same as in Study 1.

Table 17. *Theme 1 of the coding manual for deductive thematic analysis*

Theme 1	
Name	Location distance
Definition	The intent is to find data about the physical distance. For example, the physical distance between members and the physical distance between members and the materials. This is to judge whether such a distance could be a component that influences team improvisation.
Description	It is indicated when the data shows team actions are . shaped due to a closer/further physical distance between team members (e.g., a member chooses to improvise with another who is physically closer); . shaped due to a closer/further physical distance between members and materials/tools (e.g., a member chooses to use materials on a sliding stand next to him/her).

Table 18. *Theme 2 of the coding manual for deductive thematic analysis*

Theme 2	
Name	Power
Definition	The intent is to find data about people's power. Power might come from hierarchical positions and seniority in the company. This is to examine whether the power of members could be a component that influences team improvisation.
Description	It is indicated when the data shows team actions are . shaped due to the organisational rank in a certain way (e.g., a senior manager instructs an employee to break rules of mould management regulation to return a mould directly to the factory); . shaped due to people's length of service in a certain way (e.g., a member asks an expert outside the company for advice because the expert has experience and skills).

Table 19. *Theme 3 of the coding manual for deductive thematic analysis*

Theme 3	
Name	Worry

Definition	The intent is to find data about members' anxious feelings. The feeling of anxiety can be caused by the project management system in the Avatar Group and the rectification mechanism. This is to see whether members' anxiety has an impact on team improvisation.
Description	It is indicated when the data shows team actions are . shaped due to the anxiety about falling behind other teams (e.g., members speed up the workflow in a certain way because they hope to finish the project sooner to have a better project record); . shaped due to the anxiety about being punished in the future (e.g., members feared the rectification movement, so they interpret their actions as an opportunity).

Table 20. *Theme 4 of the coding manual for deductive thematic analysis*

Theme 4	
Name	Time pressure
Definition	The intent is to find data about elements that cause time pressure for members. This is to examine whether time pressure influences team improvisation.
Description	It is indicated when the data shows team actions are . shaped by approaching deadlines caused by tight production/job task schedules or ever-changing clients' demands; . shaped by urgent field situations (e.g., surprises).

Table 21. *Theme 5 of the coding manual for deductive thematic analysis*

Theme 5	
Name	Team climate
Definition	The intent is to find data about how team actions of improvisation are protected, justified and encouraged by team climate.
Description	It is indicated when the data shows team actions are . shaped by colleagues showing a positive attitude toward improvisation

	a. shaped by leaders showing a protective attitude over team improvisation (e.g., a leader helps cover up a team improvisation, changes report); . shaped by employees' tolerant attitude towards unpredictability; . shaped by the company value of the client is king (e.g., members claim they improvise to provide better service or products to a client).

5.3.2 Step two – Testing the coding manual

A vital step in developing a useful coding manual for deductive thematic analysis is to judge the applicability of the coding manual to the raw data (Boyatzis, 1998). Two field notes were selected as test pieces: a technology meeting observed on 10 August 2022, labelled as 'FN2, 10/8/2022', and a management team meeting on 15 August 2022, labelled as 'FN3, 15/8/2022'. Following the process of coding the field notes using the coding manual predefined earlier, the relevant data could be matched with the predetermined codes while examining the field notes, showing how the coding manual works. Table 22 shows examples of how the codes matched the data from the field notes.

Table 22. *Testing on match between the coding manual and the raw data of field notes*

Predetermined theme	Data from the selected field notes
Theme A Making 'temporary' devices	For size comparison, Susan asked Kevin to use a 3D printing machine to produce a VS60 blade using aluminium alloy material, so the team did not need to measure a sample every time it was manufactured (FN2, 10/8/2022).
Theme B Interpreting written procedures and introduced new ideas	The technology team noticed the old model of the blade used liquid nitrogen cryogenic technology to replace traditional quenching treatment … Susan: "Let's just use a low-temperature quenching method, we don't have a piece of equipment, and we are not explicitly required to produce it as the same way as the old model" … Kevin: "if we manage to refine the quench process to improve ductility of the blade, it will be better than using cryogenic equipment, we need to prioritise the development of our existing technologies rather than blindly applying new ones" (FN2, 10/8/2022).

	When discussing how the mould processing of the handler part would be on the computer, Kevin, a technical team member, introduced the mould design of handler products ... The mould release was designed in a rotating mode, which caused the handler's surface to take on a spiral shape, the member kept explaining that such design was technically convenient for demoulding … Susan (the technical leader) interrupted: "we might describe this as a new product shape innovation, the client will be impressed" (FN2, 10/8/2022). Susan explained the reason for using the existing quenching method: "the purpose of a method is more important than the process; using the existing quenching method can reduce internal stress and brittleness, so we should refine it (the quenching method) to guarantee an improvement on abrasion resistant quality" (FN3, 15/8/2022).
Theme C Asking for help from outside teams	The team shared how they produced samples… Susan asked some senior engineers and resident machinists to stay late and help the team out when producing the samples because they had to wait until all daily production was finished (FN2, 10/8/2022). The team was discussing the problem of not having cryogenic equipment… Linda: "There is not enough time to buy liquid nitrogen cryogenic equipment, and we don't have a budget of over 50,000 RMB" … James pulled out the budget sheet and shared the concern that the team may not have enough money if it decided to spend on new equipment. Carl pinpointed time would also be a concern because the team was only given two months… Carl: "I know another company with a small cryogenic equipment should be enough for us to make some samples; maybe we can borrow it for a month" … James asked Carl to make some calls meanwhile also asking for prices for renting a proper one (FN3, 15/8/2022).
Theme D Arguing and verifying to construct solutions	The team discussed refining the heat treatment in this meeting… Susan suggested raising the temperature to 850 degrees after the blade was stamped out, then raising it by 10 degrees if it did not show good results. Mike suggested another cooling method rather than wind cooling, as it may not be effective if the temperature increases. Carl agreed with Mike and proposed water cooling. Mike used computer software to run a simulation that showed that water cooling would quickly reach its limit. Susan suggested

	using oil cooling, and others agreed. Carl made a call to the scheduling office asking about the current schedule of the oil cooler; the scheduling office responded by saying 'it was impossible to completely set the oil cooler for one project, although it was prioritised, but would try to make the oil cooler available if the team made an appointment one day before'. At the same time, the team talked about the concern that the blade may crack if the cooling was taking place in a short time. Carl suggested combining the air, water, and oil cooling as a phased cooling, considering the oil cooler may be unable to be used. Susan still preferred to use oil cooling if considered a phased cooling. The team agreed to use oil cooling at 180 degrees and test the phased cooling method (FN2, 10/8/2022).
Theme 1 Location distance	The resident engineers would be there (at the factory), so the team assumed they could ask them for help (FN2, 10/8/2022). Susan said: "I do not want to walk to the executive building every time a version of the blade is manufactured to do a simple measurement so the data could be recorded properly" (FN3, 15/8/2022).
Theme 2 Power	The plan of testing oil cooling was determined by the leader, Susan (FN2, 10/8/2022). Susan suggested that James instruct the factory people to cooperate fully because the project was more important (FN3, 15/8/2022).
Theme 3 Worry	The technology team was worried about the plan to use new equipment and decided to report the expected over-budget for buying equipment to James (the team leader) in the next management meeting (FN2, 10/8/2022).
Theme 4 Time pressure	The time was limited; the client only gave the team two months (FN2, 10/8/2022) The team decided to try the oil cooling method as the first attempt since the oil cooler was not always available, and the team had to make requests in advance (FN2, 10/8/2022).
Theme 5 Team climate	James told Susan to leave the testing reports and focus more on how to make things work (FN3, 15/8/2022).

	James told Susan and Linda that he would defend the project if the top management asked about being over budget (FN3, 15/8/2022).

5.3.3 Step three – Applying the coding manual to the entire sample and additional inductive coding

The coding manual was applied to the texts from the field notes with the intention of identifying meaningful units of text. The field notes were entered into NVivo; the themes from the coding manual were entered as nodes, and the researcher coded the text by matching the themes with segments of data. It is important to state that at this stage the analysis of the text was guided by, but not confined to, the coding manual. During the coding of the field notes, inductive codes were assigned to any segments of data that described a new phenomenon in the text (Boyatzis, 1998; Fereday & Muir-Cochrane, 2006). Therefore, the deductive thematic analysis in this study was combined with deductive and inductive coding in a more hybrid approach (Boyatzis, 1998; Fereday & Muir-Cochrane, 2006; Rishi, Jauhari & Joshi, 2015). Some scholars – such as Pearse (2021) – have asserted that additional inductive coding should be viewed as an exception, rather than normal practice. However, other scholars (e.g., Yukhymenko et al., 2014) have argued that it is necessary to include additional coding to ensure important information is not missed out, as long as researchers distinguish the 'added' codes and show how they are connected to the original coding manual (Yukhymenko et al., 2014; Fereday & Muir-Cochrane, 2006). In this study, the additional codes either expanded a code from the coding manual, or ones which were separated from the coding manual.

5.3.4 Step four – Connecting codes and reframing the coded themes

The reframing of the coding manual, i.e., the original coding framework from Study 1, was conducted by connecting the newly-generated codes into the coding manual (Crabtree

& Miller, 1999). In practice, the newly-generated codes were clustered with the second-order codes of the original coding framework from Study 1 to reframe the themes (Fereday & Muir-Cochrane, 2006). Similarities and differences between the separate groups of data emerged at this stage, indicating areas of consensus in response to the research questions and areas of potential conflict (Fereday & Muir-Cochrane, 2006).

In summary, with guidance provided by Boyatzis (1998), a deductive thematic analysis was conducted in Study 2 by applying the coding framework from Study 1. Firstly, the coding framework from Study 1 was refined into a coding manual to match texts in Study 2 data. Secondly, the coding manual was tested as useful using two samples from the Study 2 dataset. Thirdly, the coding manual was applied to the entire dataset of Study 2; at this stage, additional inductive coding was conducted to capture what emerged from Study 2 data and which was not covered by the coding manual. Fourthly, the newly-generated codes were connected to the original second-order codes, resulting in reframed themes.

5.3.5 Reflexivity on data analysis

Additional inductive coding was conducted in this study, indicating there was a degree of difference between the data from Study 1 and that from Study 2. It was important to reflect on why the two studies showed such differences. During the semi-structured interviews in Study 1, I focused too exclusively on the action details regarding how team improvisation unfolded but failed to capture information regarding what the team members did after the improvisation, which should have been a part of the team improvisation episode. When observing the team meetings over a period of time, I was able to note the changes of team actions with regard to a specific aspect. For example, Study 1 data did not show team members interpreting the improvisation after it happened, while Study 2 data demonstrated how technical members justified their improvisation in front of managers in later

management meetings. In addition, a direct observation of team meetings did allowed me to notice some aspects which were not be captured during the semi-structured interviews. For example, Study 2 captured more emotional elements by observing members' speaking tones and body language.

Moreover, participants might not have been aware of some aspects which were captured by me via observation. This might have been because the participants had been in a familiar organisational environment for a long time and were not aware of some of the elements that continued to influence their behaviours. For example, in Study 2, I observed that team members had extra power to mobilise resources and manpower because the project they were engaged in was identified by top management as a "priority" project. The priority of the project within the company as a source of power for team members was not captured in Study 1. Besides, being engaged in a "priority" project, it became difficult to determine whether or not the team had bypassed company rules since the team operated under the project management system (which allowed members to do things beyond their original job responsibilities).

Furthermore, the team discussion regarding constructing a team plan was different in the two studies. In Study 1, the team discussion was described by the interviewees as a chaotic, sometimes emotional process in which team leaders often made the final call. However, the team discussion observed in Study 2 had a clear team goal, and the leaders showed a degree of compromise with those who held opposing opinions. Such differences may be attributed to three reasons. Firstly, they might have been due to my presence: it may have been that the team members wanted to show me that they were professional, so the meetings were more purposeful than they would normally be, and there was no emotional language. The team leaders probably did not want to give me the impression that the meeting was dominated by one person since they were being observed. Secondly, it was possible that

the interviewees withheld information due a desire for impression management; by describing the team discussion as chaotic and dominated by leaders, members showed their frustration as they recognised that the improvisation was not a good thing since it deviated from organisational procedures. Thirdly, it might be because of the differences in the nature of their work. The team improvisation activities shared by interviewees occurred in the day-to-day operation of the factory where everything was predetermined. However, the observed team was operating an NPD project which needed to be more organised and took all the members' opinions into consideration since the leaders were not omnipotent regarding many technical aspects. For example, in Study 2, the technical leader, Susan, had a technical background in heating treatments, without much experience in terms of blade stamping and grinding, which forced her to listen to other members. Besides, more urgent situations were likely to occur in a factory setting. In such a setting, members were under a great deal of time pressure caused by a tight production schedule, so the leaders tended to be more dictatorial.

This section described how the data in Study 2 was deductively analysed in order to achieve the first research aim, i.e., scrutinise whether Study 1 findings could be confirmed by the Study 2 data; and how an additional inductive analysis was conducted in terms of Study 2 data in order to achieve the second research aim, i.e., identify whether Study 2 data provides new findings that differ from those of Study 1. The next section will present the findings with regard to the data analysis.

5.4 Findings

Using a total of 17 sets of field notes as texts to conduct the deductive thematic analysis, a considerable degree of data was coded by relying on the coding manual. However, it was found Study 2 data was different from Study 1 findings to a degree. By conducting additional inductive coding, some data needed to be represented by new codes which could

not be coded out based on the coding manual. These new codes were connected to the coding manual via the researcher's interpretations, resulting in a reframed coding framework which represented the study's findings. It was necessary to note that all new codes ended up imported into the predetermined themes as a result of the researcher's interpretations, as the new codes were not strong enough to form a completely new theme.

The next section will start by offering an overview of team improvisation examples found in Study 2, then present the confirmation of the existing themes from Study 1. It will present the new codes and indicate how they reframe the predetermined themes.

5.4.1 The descriptions of team improvisation examples

Firstly, by listing 'actual' and 'should' columns as shown in Figure 10 in 5.3 and reading the field notes many times, relying on the definition of team improvisation: *one (on behalf of a team) or more team members deviating from written procedures to compose and quickly execute a new solution in order to achieve a shared team goal*. 15 team improvisation examples were summarised from the 17 field notes.

In this section, Table 23 provides an overview of the team improvisation examples due to fact that the full detailed descriptions of all examples would use up a lot of pages which might hinder the narrative of the presentation. Consequently, two full examples are offered to demonstrate the level of detail included, while the remaining full examples are provided in Appendix 9.

Table 23. *An overview of the team improvisation examples (Study 2)*

Example number	Involved field note	Summarised team improvisation activity
A	FN2, 10/8/2022	The team improvised to use a 3D printer to print a model of the blade for comparison in anytime.
B	FN9, 9/9/2022 & FN10, 13/9/2022	The team improvised to create a simplified rust inhibitor and a motor pump to improve the blade cutting system.
C	FN15, 11/10/2022	The team improvised to create round metal locks to cover some insufficient injected areas of the handle product.

D	FN2, 10/8/2022 & FN3, 15/8/2022	The team improvised to not follow the procedure given by the client but deciding to use a technology the members more familiar with.
E	FN2, 10/8/2022 & FN12, 20/9/2022	The team improvised to interpret the handle shape as a new selling point.
F	FN8, 3/9/2022 & FN11, 15/9/2022	The team improvised to break an item with a large cost into a number of items (mostly was disposable material) with smaller cost to obtain the former's budget approval.
G	FN4, 20/8/2022 & FN7, 2/9/2022	The team improvised to replace lab measuring of a steel material with naked eye observing.
H	FN15, 11/10/2022 & FN16, 14/10/2022	The team improvised to explain the use of a metal lock on the handle product as a new feature of quality improving.
I	FN1, 3/8/2022 & FN2, 10/8/2022	The team improvised to ask a resident engineer's help to manufacture some samples products out of working hours.
J	FN2, 10/8/2022	The team improvised to ask help from other companies to borrow a small liquid nitrogen cryogenic device.
K	FN5, 25/8/2022 & FN6, 31/8/2022	The team improvised to ask help from an experienced grinder to narrow down the machining error.
L	FN10, 13/9/2022	The team improvised to ask the other team for help in order to temporarily borrow an oil cooler.
M	FN2, 10/8/2022 & FN5, 25/8/2022	The team improvised to test water cooling methods on the site in order to replace original plan of using oil cooler.
N	FN9, 9/9/2022	The team improvised to develop the blade as a more balanced product, instead of pursuing a higher level of sharpness, so the team decided to set the grinding wheel speed as a range between 35-48m/s.
O	FN13, 22/9/2022	The team improvised to make a decision of improving the resistance to wear, so the team improvised to add a number of new steps into the machining process.

In Table 23, the left-hand column shows the number of the example, the middle column presents the series numbers of the field notes and the dates of their observations, while the right-hand column presents the summarised team improvisation activities from the field notes. The following paragraphs relate to the two full examples.

Example A

Since the client specified the dimensions (size/thickness) of the blade, the new product (the vs80 model) needed to be the same size as the old product (the vs60 model). Consequently, the team needed to ensure that the blade size was in line with the client's requirements. The Avatar Group also mandated that the team should retain the sample data (such as dimensions, metal characteristics) during development to trace the development process. As a result, the team was required to submit blade samples to the testing centre throughout the development of the product. Since the team needed to wait one to two days (longer if there are many measurement items) for the measurement results to come through, and the team faced a short product development cycle, the members improvised by using a 3D printer to print a blade model for an old product which they could use for visual size comparison purposes, so that they could still progress the project while waiting for the exact size measurement data.

Example B

To improve the rust resistance of the cutting fluid (a liquid that lubricates the blade's cutting process), the team added a boron hydrochloric acid rust inhibitor. This increased the concentration of the mixture of emulsifiers and water. However, the team found that the increase in concentration meant that the cutting fluid was unable to enter the filter smoothly through the sewage tank, so the team temporarily installed a motor pump in the pipeline to absorb the cutting fluid stored in the sewage tank and changed the position of the filter by putting it under the pump to ensure that the cutting fluid could enter the nozzle for recycling.

By reading Table 23, the reader already has a sense of what team improvisation in Study 2 looked like. Consequently, it is appropriate to move on to present the confirmation of the existing themes from Study 1.

5.4.2 The confirmation of the existing themes from Study 1

Table 24 and 25 were created to show the matched data between Study 1 and Study 2 in terms of microprocesses and influences.

In order to achieve a balance between the parsimony and richness, the two tables presented the confirmation of the coding manual regarding the themes and the second-order codes, instead of the first-order codes as they were too many.

Table 24. *The matched themes and second-order codes between the coding manual and Study 2 data regarding the microprocesses*

Theme	Matched second-order code & Study 2 data example
Theme A Making 'temporary' devices	**Gathering materials** **Example A** … aluminium alloy material was obtained within the 3D-printing section (FN3, 15/8/2022) **Example B** The team obtained several small motor pumps from the factory equipment storage … get a metal plate for bracket base (for the motor pump) … some necessary tools (e.g., screw, screwdriver, screw key) were obtained within the factory, to assemble the motor pumps and disassemble the cutting fluid filter (FN9, 9/9/2022 & FN10, 13/9/2022). **Example C** … metal locks were originally manufactured for a water pipe products' tightness, Mike saw some (the metal locks) when he walked through the factory to deal with the defects of the handler product … (FN13, 15/9/2022). **Fabricating devices** **Example A** The 3D printer could automatically produce some samples when the team members entered the size data (FN2, 10/8/2022). … Mike: "we attached the pumps to the waste sink (of the cutting fluid system) there" (FN10, 13/9/2022). **Example C** The team measured the length of the metal strip (could be bent into round shape as a lock) … measured the inner circle of the metal lock for selection … then fixed it with the handler products with a bending machine (FN13, 15/9/2022).

	Amending devices **Example B** .. additional mounting holes were drilled … strengthened the waste sink (FN9, 9/9/2022). **Example C** … reinforced it with pressure (to ensure the metal lock attached to the handler products) (FN13, 15/9/2022).
Theme B Interpreting written procedures and introducing new ideas	**Twisting meanings** **Example D** Susan: "I guess we don't have to exactly follow the blueprint of the old model, it was an old version after all" … other members talked about the time of adjusting and testing new equipment … (FN2, 10/8/2022). **Adding meaning to new ideas** **Example G** The technical members were confident about their judgements in terms of the quality of the blades' embryos. They hesitated to send the embryos for materials quality testing but decided to trust their empirical judgements because they reckoned the differences were explicit regarding which was better (FN4, 20/8/2022). **Weakening the enforcement** **Example F** … the technical members reviewed the reimbursement procedure for requesting a budget over 50,000RMB … they complained about the time for getting it done (e.g. Five persons' signatures were needed) … Carl: "it was so unreasonable, they (referring to the top management) should give the money in advance if they expected us to meet the deadline" … the technical leader suggested separating the amount of money to other items to make it even … others agreed (members started to review the budget claiming paperwork which was not yet submitted) … (FN8, 3/9/2022).
Theme C Asking for help from outside teams	**Different methods for reaching out to helpers** **Example I** The technical leader called the HR department for help to check for resident engineers' availability … then called three engineers for help to ask them to work off-duty time with the team to produce the blade sample (FN1, 3/8/2022 & FN2, 10/8/2022). **Example L** The team reached out to another team that was using the oil cooler for help … asking to borrow the oil cooler for a few days (FN10, 13/9/2022). **Example J** Mike: "… we may want to ask some friends (referring to other companies, see if they have equipment available, even a small one, we could use for sample testing" (FN2, 10/8/2022).

	Bringing insights to solve problems **Example K** … the helper (i.e., the experienced grinder] showed the team how to better control the machine and how to roughly judge the grinding speed … the helper further suggested the team to increase the speed because the helper noticed spindle was a little unstable, and the speed needed to be faster to operate stably… (FN6, 31/8/2022).
Theme D Arguing and verifying to construct solutions	**Finding cause** **Example M** The team reviewed the original manufacturing process and determined several key points for further developing … hardness was one of them … Susan: "We urgently need to increase the hardness of the blade, it was an important aspect raised by the client" (FN2, 10/8/2022)… the team talked about current developing item: the cooling method … the issue was phased water cooling could not maintain a stable/high degree of hardness, the team agreed on it was due to the temperature dropped too fast… a more gentler method was needed… (FN5, 25/8/2022). **Example N** Sharpness was agreed as an aspect the team should focus on to improve the blade … members reviewed the current equipment's status and predicted the highest level of accuracy … (FN9, 9/9/2022). **Generating new ideas** **Example M** … Suan (the technical leader) proposed to use oil cooling as a way of bringing down the blade temperature slowly with cutting point protection … Mike, and Carl argued that phased water cooling or special water cooling would achieve the same effect … the team talked about the possibility of not having an oil cooler on time … at the same time, technical members used computer software to run the simulations … oil and phased salt bath cooling were chosen as plan A and B, other methods such as air, water cooling were agreed as not preferable (FN2, 10/8/2022). **Example N** Susan … the granularity of the sandpaper should be reduced, and the grinding speed of the grinding wheel should be increased to more than 50m/s … Mike … that excessive speed of the grinding wheel would lead to easy bending of the blade … (Mike) started to enter speed data into a simulation model … Carl … "We may not be able to guarantee the speed of the grinding wheel…" … Kevin … the grinding wheel speed should be around 30m/s to ensure that the blade can be used for a longer time … (FN9, 9/9/2022). **Convincing each other** **Example M**

	Susan said: "can we agree on using oil cooling first?" when Mike was not answering her question and moved on to talk about his idea, Susan stopped him by raised her hands and insisted Mike to declare where he stands and kept persuading him. **Example O** Susan tried to convince Mike by highlighting the cost and convenience of simply dipping the blade into oil, Mike did not show any sign of agreeing, so Susan kept saying "We should always try a simple step first, then move to more complicated steps, besides, it can have a high degree of completeness"

Table 25. *The matched themes and second-order codes between the coding manual and Study 2 data regarding the influences*

Theme	Matched second-order code & Study 2 data example
Theme 1 Location distance	**Physical distance between team members** **Example A** The technical team was separated from other managers, the former was travelling between the factory and the office upstairs, the latter was based in the executive building for most of the time (FN2, 10/8/2022). **Example K** The technical leader sat on the one side of the sofa … other technical members sat on the other side (FN6, 31/8/2022). **Physical distance between team members and the tools/materials they needed** **Example A** Susan said, 'I do not want to walk to the executive building every time a version of the blade is manufactured to do a simple measurement so the data could be recorded properly' (FN3, 15/8/2022). **Example G** The testing centre was a long way from the grinding factory and the technology department office (FN4, 20/8/202). **Example I** The resident engineers would be present at the factory, so the team assumed they could ask them for help (FN2, 10/8/2022).
Theme 2 Power	**Position ranks in the organisation** **Example A** The plan for testing oil cooling was determined by the leader, Susan (FN2, 10/8/2022). **Example E** Susan was the leader of the technology team, and she needed to explain the new features of the handler design to the client (FN12, 20/9/2022).

	Seniority **Example D** Susan had the most extensive technical work experience, which made her feel justified in her response when James (the project leader) asked why she had not used the liquid nitrogen cryogenic cooling recommended by the client (FN3, 15/8/2022). **Example G** The technology department had a great deal of say with regard to how the blades should be developed, since James, the project leader, came from something other than a technical background (FN4, 20/8/2022). **Example K** The team sought the help of the grinder to operate the machine because he was the most experienced employee in the factory (FN6, 31/8/2022).
Theme 3 Worry	**The worry about falling behind** **Example D** Kevin commented that the time was limited because the client had only given the team two months (FN2, 10/8/2022). **Example L** Team members expressed concern that the previous work to improve the cutting fluid could be lost if the silting problem in the sewage tank was not addressed (FN10, 13/9/2022). **Example M** … the team worried that the booked time would be wasted if they did not do something … the technical leader suggested the team take on what was available to do some experiments (FN5, 25/8/2022). **The worry about being punished in the future** **Example C** The team shared the worry of being held accounted for using the metal lock to cover up the product defects, if the client found out about it, the team could lose the order … in the end, the members agreed on it was a had-to-do measure, best option at that time, it was more important to hand it over on time.
Theme 4 Time pressure	**Approaching deadlines** **Example B** Kevin, a technology department member, believed it would be too late to find a suitable company to improve the cutting fluid pipeline since the inspection, design, and plan took at least a week (FN9, 9/9/2022). **Example C** Delivery was due in four days; it was too late to check where the problem came from or how to correct it. The team decided to find a way to remedy this injection moulding defect (FN15, 11/10/2022).

	Urgent field situation **Example B** … Carl reported: "we found excessive remaining in the [waste] tank when the grinding was going on, and kept producing wasted fluid" (FN9, 9/9/2022). **Example M** … the scheduling office failed to assign the oil cooler to the team … (FN5, 25/8/2022). **Example N** Not enough grainy sandpaper could be found on site … (FN10, 13/9/2022).
Theme 5 Team climate	**Positive attitude toward improvisation** **Example B** … the team members were proud of handling the on-site emergency of wasted liquid (FN9, 9/9/2022). **Example F** Team members had no objection to a rule-breaking proposal to hide reimbursement amounts for the rental of new equipment (FN8, 3/9/2022). **The protective attitude of leaders** **Example D** James told Susan to leave the testing reports and focus more on how to make things work … James told Susan and Linda that he would defend the project if the top management asked about being over budget (FN3, 15/8/2022). **Example F** The team members had done something similar before, that was spreading a larger amount of reimbursement into other smaller amounts and not being penalised. Consequently, the team thought it would not be penalised this time given the importance of the project (FN8, 3/9/2022). **High tolerance with regard to unpredictability** **Example M** The technology team was prepared for the possibility that the scheduling office might not be able to coordinate the oil cooler (FN5, 25/8/2022). **Client is King** **Example B** The team believed that the purpose of blade quality improvement was to make the client feel that it was an improvement on the original (VS60) (FN10, 13/9/2022).

	Example C The team worried that the client might think it was not professional enough of a high enough quality because of a minor defect, (i.e., the injection defect of the handler front end) (FN15, 11/10/2022).

In Tables 24 and 25, the left-hand column represents the highest-level theme for microprocesses and influences match. The right-hand column shows matched results, containing the matched second-order codes (shown in bold font), and the data example from Study 2. Bold font was applied to identify which team improvisation activity the data was supporting.

The next section shows the new codes regarding the microprocesses and the influences with regard to team improvisation; the process of reframing the predetermined themes is also presented by adding the new codes into the coding framework.

5.4.3 The new codes and corresponding reframing

In this study, eight new codes were identified with the use of additional inductive coding. Four new codes were found to be related to microprocesses, while the remaining four new codes were about influences relating to team improvisation. Tables 26 and 27 were created for clarification purposes.

Table 26. *The new codes regarding microprocesses of team improvisation*

New code	Meaning	Why new?	Example text
Justifying the new ideas	Team members interpreted their new ideas of improvisations after the new ideas were executed, to make them more acceptable to the managers	This one new code was most relevant to the predetermined Theme B because they were about members interpreted something verbally. However, the predetermined theme 2 only involved that team members interpreted procedures and new plans before their executions, the new code indicated members interpreted a new plan after and during its execution.	… the team created space for the new plan of cancelling the quality tests of steel materials (FN4, 20/8/2022) … the technical members explained they did not want to disturb the regular operation of the testing centre … and they explained the situations of the steels (Carl showed James some pictures of the blade embryos) and reassured to the project leader that their judgement was correct (FN7, 2/9/2022).
Shelving the dispute	Team members decided to temporarily put aside a dispute (often due to opposite opinions on how to develop the product) to push forward the meeting.	These three new codes were most relevant to the predetermined Theme D because they were all about the team discussing to form a team plan. However, the predetermined Theme D was mainly about team members argued with other each and simultaneously verified the proposed ideas to convince each other to reach a team plan. It was unknown about what exactly the 'convince' looked like. The new codes showed team actions	Technical members disagreed with each other on how to combine the three cooling methods … They stopped talking and the leader asked whether they all agreed that the oil method was the best option ideally from a pure technical perspective, other members agreed (FN5, 25/8/2022).
Compromising by reducing each other's opinions	Team members compromised in order to agree on a plan that none of the members would reject outright		… the team was discussing the plan for improving blade's sharpness via grinding improvement … Susan (the technical leader) proposed the granularity of the sandpaper should be reduced and the speed of grinding should be increased to more than 50m/s … Mike (a former grinder) thought that excessive speed of the grinding wheel would lead to easy bending of the

		of shelving a dispute and compromising in two different ways.	blade… another member, Carl joined the discussion by saying "We may not be able to guarantee the speed of the grinding wheel to continuously produce qualified products under such circumstances" … Kevin believed that the team needed to make a product that pursues balance, and the grinding wheel speed should be around 30m/s to ensure that the blade can be used for a longer time … all other members (Mike, Carl, Kevin) wanted a more balanced blade which against Susan's idea, the speed of the grinding wheel was compromised by determining a speed range: from 35 to 48m/s (FN9, 9/9/2022).
Compromising by building on each other's opinions	Team members compromised by adding each other's ideas together to arrive at a team plan that could be agreed on by every member.		When the team was discussing how the blade's resistance to wear could be improved … the team decided to do something after the grinding step … the team agreed on adding an additional heating treatment process after the main grinding … Susan (the technical leader) wanted to dip the blade into oil then cool it down to room temperature to put a layer of antirust coating on the blade's surface … However, Mike and Carl disagreed, they asserted the oil dipping would increase the likelihood of scratches on the blade surface … then they (Mike proposed with Carl nodding on the side) proposed the idea of cooling the blade into quartz sand … Susan agreed to take their idea into the plan of oil dipping … the blade would be immersed in oil, boiled again, then buried in quartz sand and cooled to

			room temperature as a finished product (FN13, 22/9/2022).

Table 27. *The new codes regarding influences of team improvisation*

New code	Meaning	Why new?	Example text
"Priority" project	The team worked on a "priority" project which allowed members to mobilise manpower and resources.	This new code was most relevant to the predetermined Theme 2 Power because team members could obtain additional power because the project they worked on was recognised as "priority" by the top management. This code was new because the predetermined theme 6 only involved rank and seniority as the power sources.	The team members decided to manufacture some blade samples via the heating treatment process they normally conducted … Susan: "It will be better if we don't disturb the normal production because we might need more than two hours to do it" … Mike suggested asking the HR department to assign some resident engineers as extra manpower and do the sample manufacturing after 6 pm: "we can do this right? We got this important project" … Susan quickly made a call and asked the HR manager to allocate at least three engineers on the project for some overtime work … Susan picked four resident engineers she trusted and informed them the overtime work via WeChat message … the team members were allowed to do this because the project was "priority", recognised by the top management (FN2, 10/8/2022).
Location type	The meeting location was changed over the period of observing team meetings, which might affect the way people interacted.	This new code was most relevant to the predetermined Theme 1 Location because this new code was about locations. However, the predetermined Theme 1 Location did not include locations about team meetings.	Meeting location: Executive conference room in the executive building (FN1, 3/8/2022) Meeting location: Susan's office (the technical leader) (FN4, 20/8/2022). … the meeting location was changed from a big conference to a technical member's office room (FN5, 25/8/2022).

Confidence	The team members showed a level of confidence regarding team improvisation	These two new codes were most relevant to the predetermined Theme 3 Worry because they were all about people's emotions. However, the predetermined Theme 3 Worry did not include confidence and excitement.	… the team members believed their empirical judgements … it was thus discussed that the quality tests of the steels were not necessary … (FN4, 20/8/2022). … the team believed the top management would not find out, and even if they did, they would not care … (FN11, 15/9/2022). Susan took the lead and further explained the metal lock could be a new feature with different colours (FN16, 14/10/2022).
Excitement	Team members showed a level of excitement during team improvisation activities.		Mike seemed to give Susan a look of surprise when she was talking about why the technical team used metal lock … When other department managers and team leaders left, members of the technical team complimented each other on their performance in front of the managers … Mike [standing up] said to Susan: "How can you think of that, that was brilliant" (FN16, 14/10/2022). The team members were still excited when the reviewed how they solved the block of the sink (FN10, 13/9/2022).

In this section, Tables 26 and 27 present the new codes generated as a result of the additional inductive coding. The far-left column represented the names of the new codes; the middle-left column showed the meanings of the new codes; the middle-right column explained why the codes were new and also indicated the relevance between the new codes and the predetermined themes, while the far-right column showed examples of texts that matched with the new codes as examples. The following paragraphs will show how the new codes are connected to the coding manual.

As shown in Tables 28 and 29, the new codes were relevant to the predetermined themes in the coding manual, while different from the original second-order codes of the predetermined themes (this was why the codes were new). To reframe the coding framework, the original second-order codes and the new codes were put together to examine whether the predetermined themes needed to be reframed. The reasons for the reframing were explained.

Table 28. *Reframing the predetermined themes of microprocesses with the new codes*

New code	Original second-order code	Reframing
● Justifying the new ideas	● Twisting meanings ● Adding meanings to new ideas ● Weakening the enforcement	● Predetermined theme B: Interpreting written procedures and introduced new ideas  ● Reframed Theme B Interpretation
● Shelving the dispute ● Compromising by reducing each other's opinions ● Compromising by building on each other's opinions	● Finding causes ● Generating new ideas ● Convincing each other	● Predetermined theme D: Arguing and verifying to construct solutions  ● Reframed Theme D Team plan construction

Table 29. *Reframing the predetermined themes of influences with the new codes*

New code	Original second-order code	Reframing
● Location type	● Physical distance between team members ● Physical distance between team members and the tools/materials they needed	● Predetermined Theme 1 Location distance  ● Reframed Theme 1 Location
● "Priority" project	● Position ranks in the organisation ● Seniority	● Predetermined Theme 2 Power  ● Reframed Theme 2 Power source
● Confidence ● Excitement	Worry about falling behind Worry about being punished in the future	● Predetermined Theme 3 Worry  ● Reframed Theme 3 Emotion

In Tables 28 and 29, the left-hand column shows the new codes, the middle column shows the original second-order codes of the predetermined themes, while the right-hand column shows the changes of the predetermined themes resulting from the addition of the new codes. The predetermined themes were changed to a more general name to ensure the meanings of the added new codes could be represented.

To summarise, the results of the data analysis were the reframed themes. For microprocesses, firstly, the title of Theme B was changed to 'Interpretation' because the new code represented a microprocess that happened after a new idea had been executed, while the original title of Theme B highlighted the microprocesses prior to the implementation of new ideas. Secondly, the title of Theme D was changed to 'Team plan construction' because the original title – Arguing and verifying to construct solutions, focused on the argumentative nature with regard to how a team plan was constructed, whereas the new codes highlighted

the fact that a team plan could be built up through compromise. The title of 'Team plan construction' was thus found to be more appropriate for the Theme D as it was more general.

In terms of influences, firstly, the reframed Theme 1 Location involved contextual information that affected team improvisation. It was about the physical distance between team members and the resources they needed for improvisation, and the types of meeting locations. Secondly, the reframed Theme 2 Power source was seen as an element that could influence team improvisation. It was demonstrated that it could result from members' position ranks, seniority, and being a "priority" project. Thirdly, the reframed Theme 3 Emotion was seen as a possible component that could influence team improvisation as the participants demonstrated confidence, excitement, and worry about falling behind and being punished in the future.

The next section shows the codes that exist in Study 1 but were not found in Study 2.

5.4.4 The not-confirmed code

One code regarding microprocesses was not confirmed – offering an incentive to bypass rules. It might be because the observed team was engaged in a "priority" project involving a new product development. Consequently, the observed team did not need to ask people's help to bypass rules in that they were not restricted by the rules in the first place, and because they were aware that other departments would voluntarily make things easier for the observed team.

As team improvisation examples and confirmed/new codes/missed-out codes regarding the microprocesses and influences of team improvisation were presented in the previous sections, the following section presents the findings with regard to microprocesses relating to Study 2 in order to show the similarities and differences between Study 1 and

Study 2 in more detail. In the following section we compare the findings of the two studies concerning the influences on team improvisation.

5.4.5 Microprocesses of team improvisation

In this section, similarities between the two studies in terms of microprocesses of team improvisation are described, as well as pinpointing some nuanced differences between the two studies with an explanation of why they were different.

Theme A Making 'temporary' devices

Similar to the findings in Study 1, the observed team also improvised by creating temporary devices (e.g., Examples A, B and C) with similar lower-level microprocesses (the second-order codes), i.e., the observed team also gathered necessary materials and tools, then fabricated the devices by assembling or straightforward manufacturing, and sometimes altered the created devices by strengthening them. However, there were two nuanced differences. Firstly, the observed team tended to actively create a temporary system for experimental purposes, with a clear team goal, while Study 1 examples indicated that the temporary devices were often passively created for purpose of expediency because team members were facing high degrees of time pressure due to tight production schedules. For example, in Example B (FN9, 9/9/2022 & FN10, 13/9/2022), the team was aiming to refine the cutting fluid system, with the improvement involving conducting tests and dealing with the side effects resulting from by the experiments. When the members found the increased cutting fluid concentration caused excessive accumulation in the sewage tanks, the team built a temporary system for moving the cutting fluid by installing motor pumps in the pipes and changing the position of the filter. Secondly, Study 2 data showed temporary devices could be made to hide a problem when it was too late to be fixed. In Example C (FN15, 11/10/2022), the team found out that the handle's front end was insufficiently formed by

plastic injection moulding four days before the sample delivery was due. The team realised that it was too late to inspect the mould or examine the injection moulding machine, so they chose to make a round metal lock to wrap around the handle front-end to hide the problem and explained to the client that it was a special design for a new feature.

> The team members began to discuss how to find a way to cover up this injection moulding defect... Kevin proposed a rubber ring cover, Carl proposed a plastic lock, Mike agreed with the idea of a lock, but thought it should be changed to metal, because it had a quality texture (FN15, 11/10/2022).

Therefore, although Study 2 examples showed the observed team made temporary devices to deal with a surprise as the Study 1 data suggested, the purpose was to test something new, or solve the side-effect problem brought by the new idea's implementation.

Theme B Interpretation

Similar microprocesses were confirmed as those in the Study 1 findings. Data in Study 2 featured team members weakening written procedures and coming up with new ideas before improvisation via various methods (e.g., twisting meanings of procedures), to allow it. For example, in Example D, the team interpreted the blueprint provided by the client as a reference instead of a must-follow procedure for new product development. Hence, the team abandoned the use of the liquid nitrogen method and chose to improve the existing quenching procedure (FN2, 10/8/2022). Another example was Example G, where the team devalued the testing procedure on the ground by claiming that the results of the quality tests were often the same as empirical judgements made by team members, so the team had the space to improvise – cancelling the quality test of the steels used (FN4, 20/8/2022). Similarly, Example F shows the team weakened the enforcement of a procedure by directly denying its use (FN8, 3/9/2022 & FN11, 15/9/2022). When the team learned that it was impossible to

borrow liquid nitrogen cryogenic equipment from other companies, they planned to rent one, but the rent was too high, so they needed to apply for a special budget. During the discussion, the team members interpreted the company's reimbursement procedure as a strict and unreasonable system. The team then decided to hide the rental cost and spread the required amount over other items. In these examples, when members determined a procedure could not be followed (e.g., due to resource shortage in Example D), the observed team often reviewed an organisational procedure to analyse its applicability to the team's current situation. Being involved in a new product development project, and one recognised as a "priority" by top management, puts the observed team in a rule-based environment. Members were expected to be innovative based on the rules, but not restricted by them. Although it seemed the observed team interpreted the procedures in a somewhat direct and reckless way (e.g., denying a procedure in Example F), the team was not anxious about being punished because the company assured the team members that progress was more important than the rules. However, the team members in Study 1 operated in a factory where many actions were predetermined. Employees perceived that the procedures were obviously more important than them. Such a rule-saturated environment made Study 1 participants interpret the procedures in a more subtle way (e.g., twisting the meaning of a procedure) if they wanted to improvise. Therefore, it reflected the fact that the working environment – regarding of how rules were expected to be applied by employees – could shape their improvisation activities.

Differently from the Study 1 findings, the Study 2 data found that microprocesses involving interpretation (i.e., members' conversations aiming to interpret things) did not only work as a way of contributing to improvisation but also could be an improvisation in itself. In Example E, when the team found the mould of the handle product was designed to be rotatory demounted, which would result in a thread shape, the team interpreted this as an

innovative highlight when they contacted the client to report progress (FN2, 10/8/2022 & FN12, 20/9/2022).

> A technical team member introduced the mould design of handler products ... The mould release was designed in a rotating mode, which caused the handler's surface to take on a spiral shape, the member kept explaining that such design was technically convenient for demoulding … Susan (the technical leader) interrupted: "we might describe this as a new product shape innovation, the client will be impressed" (FN2, 10/8/2022).

In this example, the interpretation of the mould design was brought up by the technical leader, rather than by the technical team members, which may have been due to differences in job responsibilities between technical team members and the technical leader. In the process of developing a new product, the former was more concerned with whether a technical design would be feasible/useful from an engineering point of view, while the latter had the additional responsibility of selling the new product to the client. This was due to the fact that the observed team had not signed a long-term contract saying there would be a large number of orders, meaning that the observed team needed to come up with innovations in as many aspects as possible (including shape design) to convince the client.

Another difference between the Study 1 and Study 2 data was that the latter demonstrated a microprocess of justifying the improvisation after it had occurred, which was not found in the former. In Example D, on being asked to explain the reason for not following the provided blueprint of the last-version blade model, the technical team stressed a shortage of equipment and argued that the result would be better with an improved quenching method (FN3, 15/8/2022). The technical team stated that the blueprint was the design for the previous generation of products with some process details being outdated … then, the team pointed to

the current situation: “Although liquid nitrogen refrigeration technology can perfectly eliminate thermal stress while cooling, we do not have the relevant supporting equipment” [by Susan] … the technical team stressed they were confident the improved quenching method could compete with the liquid nitrogen refrigeration technology regarding heating treatment … Mike: “If we force our way into unfamiliar technology, it is likely to backfire” (FN3, 15/8/2022).

To make it more acceptable to the non-technical managers, the technical team reassured the management team that the improvisation was a better approach after it had occurred. It might not be intuitive that a team in a rule-based environment will perform more interpretation actions after improvisation than teams in a rule-saturated environment, because it seems to make more sense if the latter was asked by managers to explain the reasons for improvisation after it occurred. The reason could be what follows. In Study 2, during management meetings, the technical team was obliged to justify their choices with regard to new product development to the team leader, so that the result of the improvisation could remain. In addition, the reasons for the improvisation were explained to the non-technical members to ensure their support in future product development. However, in Study 1, the teams were in a working environment with strict rules for their behaviours. They decided to perform improvisations when they were confident that their leaders would protect them (e.g., the leader had tolerated similar improvisations previously), or they carefully probed a leader’s attitude toward team improvisation after it had occurred to ensure that they were safe (the reasons for two studies being different were also reflected in 5.3.5).

To summarise, what was similar to the findings of Study 1 was that the team also showed microprocesses of interpretation actions with regard to procedures before the execution of a new plan to make room for it. On the other hand, Study 2’s data showed many microprocesses of interpretation actions undertaken to make the improvisation more

acceptable to a broader audience after the new plan's execution: to the team leader to prevent the improvisation from being removed, to non-technical managers to ensure future support. Interestingly, the observed team showed that a microprocess of interpretation can itself be an improvisation.

Theme C Asking for help from outside teams

The subjects in Study 2 who sought help from outside the team were similar to those in Study 1, such as when they used the microprocess of seeking help from other team experts at the work site. In Example I, because of the lack of manpower, the team members sought the resident engineer's help in manufacturing samples after work (FN1, 3/8/2022 & FN2, 10/8/2022).

Moreover, because of a shortage of equipment, the team asked other teams within the company or even other companies for help. In Example L, the team asked the team that was using the oil cooler for help and obtained its use for a week (FN10, 13/9/2022). In Example J, the team submitted a loan request to a company with liquid nitrogen cryogenic devices (FN2, 10/8/2022).

A slight difference from Study 1 is that the team the researcher observed asked for help from experienced people due to the lack of capability with their own team. In Example K, the team sought help from an experienced grinder, to ensure that the speed of the spindle was as close as possible to 0.249m/s, which was found to be the best speed for grinding the blade (FN5, 25/8/2022 & FN6, 31/8/2022).

To summarise, the data in Study 2 was consistent with the findings in Study 2 to a moderate extent.

Theme D Team plan construction

Similar to the findings in Study 1, the team made use of the microprocess of generating ideas and verifying them at the same time. For example, in Example M (FN2,

10/8/2022 & FN5, 25/8/2022), when the team members generated ideas for improving cooling methods, they verified these ideas by running computer simulations as supporting proof. Similar actions were presented in another technical meeting (i.e., Example N, FN9, 9/9/2022) when members entered different speed data into some computer software to examine the quality results of the blade being ground at different spindle speeds.

More differences were found between the two studies. Firstly, Study 2 data showed that members used various microprocess approaches for achieving team consensus. For example, the team members would shelve the disputes to search for common ground; in Example N (FN9, 9/9/2022), when the members struggled to agree on the spindle speed for blade grinding, a technical member pointed out fact that the speed range was going to appear eventually, due to the tolerance of the machining process, so it would be better simply not to talk about an ideal speed, but focus on an acceptable speed range from the manufacturing aspect. Then, with the agreed common ground, team members combined ideas to arrive at a team plan via compromise. For example, in Example O (FN13, 22/9/2022), the team members split into two groups. Susan suggested that dipping the blade in oil after grinding and cooling it to room temperature could increase the wear resistance of the blade's surface, while Mike and Carl both thought that the blade should be cooled in quartz sand. The team decided to add one idea to another. As a result, the team plan was that the blade would be dipped in oil, boiled again, buried in quartz sand and cooled to room temperature.

In summary, similar to the Study 1 findings, microprocesses were found in the form of team members putting forward ideas based on existing information and verifying these ideas where possible (e.g., using software to run simulations during meetings). On the other hand, if the opinions were conflicting and deadlocked, members shelved the disputes; by doing so, a member could calm down after a fierce confrontation in terms of opinions and take a step back, to think about what common ground there was between the members, which

would help make the team discussion more constructive. Moreover, the common ground ideas were combined through mutual persuasion (similar to Study 1) and a compromise was achieved to produce a team plan.

Summary

To summarise, to a degree the findings in Study 2 were consistent with those in Study 1, albeit with more nuances added, which led to reframed themes. First, similar to the Study 1 findings, the observed team experienced microprocesses in terms of gathering materials, and fabricating and amending devices to create physical structures. However, the Study 2 data showed another microprocess involving the team creating a temporary system for experiments, or sometimes hiding a problem that members did not have sufficient time to solve.

Second, besides the microprocesses of interpreting written procedures and new ideas to allow for team improvisation before it occurred (similar to the Study 1 findings), Study 2 revealed many microprocesses involving interpretative actions on the part of the technical members following the team improvisation, with the intention of justifying the improvisation and making it more acceptable to the team leader (for the purpose of making the improvisation permanent) and to other non-technical managers (for the purpose of ensuring future support). It was also found in Study 2 that interpretation itself could be a form of improvisation.

Third, consistent with the Study 1 findings, the observed team showed the existence of microprocesses involving asking help from outside teams, but it was not found that the team asked for favours to bypass rules.

Fourth, the microprocess of team plan construction in Study 2 was similar to that in Study1 because the observed team showed that microprocesses involved proposing opposing ideas and performing actions simultaneously to verify these proposed ideas in such a way as

to convince each other, so that team consensus could be achieved. In addition, Study 2 showed more microprocesses with regard to how to achieve a team consensus: shelving disputes and compromising.

5.4.6 Structural, social, cognitive influences of team improvisation

In this study, five themes were identified as influences on team improvisation: 1) location, 2) power source, 3) emotion, 4) time pressure, and 5) team climate; a total of 17 field notes were coded. Similarities and differences between the two studies were described by presenting the findings, and the reasons why the findings of the two studies were different were explained. An analysis was then presented to show how the identified themes affected the microprocesses.

Structural influence: Theme 1 Location

Theme 1 Location was considered as a *structural* influence in Study 1 because it involved the physical environment.

Similar to the findings in Study 1, Study 2 data also showed that team members would consider the physical distance between them when improvising, particularly during team discussions that led to arriving at a team plan. For example, it was observed that a member showed more disagreement with another member who sat farther away, and the member changed his seat as a nonverbal communication signal to demonstrate his opinion during the team plan discussion (e.g., FN9, 9/9/2022; FN6, 31/8/2022). As indicated by the data, members who expressed their views through the layout of seats or the behaviour of changing seats in meetings may be affected by their opinions later on in the meeting. For example, in situations in which members strengthened their opinions by changing seats during a meeting, the fact of changing seats may have prevented them from changing their views again as the meeting progressed (e.g., Example N). Moreover, it was shown that the physical distance

between team members and the resources could be a component that influenced team improvisation, i.e., out of convenience, team members chose the resources that were physically closer for improvisation (e.g., FN2, 10/8/2022; FN3, 15/8/2022).

What was different from the Study 1 findings? The Study 2 findings showed that the type of location of the meeting might have an impact on the interaction of team members. As the meeting locations were changed from a conference room of the executive building (e.g., FN1, 3/8/2022), to the technical leader's office (e.g., FN4, 20/4/2022), and further to the technical member's shared office (e.g., FN9, 9/9/2022), the members' interactions became more relaxed as the meeting location became more informal.

Social influence: Theme 2 Power source

Theme 2 Power source was considered as a *social* influence in Study 1 because power could not have impact without people.

Similar to the findings in Study 1, power was identified as a component that had an impact during team improvisation. Study 2 showed that power could be distributed according to members' hierarchical rank. The observed team showed that members with higher organisational rank tended to dominate the design process of a team plan, reflecting how dominance during meetings is a way of controlling the direction of product development (FN2, 10/8/2022; FN5, 25/8/2022). Powerful leaders interpreted written procedures very directly before improvisation (e.g., FN4, 20/8/2022; FN7, 2/9/2022; FN2, 10/8/2022) because the higher-ranking members believed the organisational rules did not apply to them since they had the power to interpret those rules. Moreover, the more powerful leaders performed actions which weaker members would not perform (FN2, 10/8/2022 & FN12, 20/9/2022). This might be due to the higher-ranking person having more job tasks and he/she would try to use the power of interpretation to complete those tasks (e.g., Example E, FN2, 10/8/2022). In addition, interestingly, Study 2 data showed that when a leader's opinion was opposed by the

majority, the leader tended to be more dictatorial in some irrelevant matters, reflected in the leader not even giving a chance to others to speak, by announcing the meeting was over immediately (FN9, 9/9/2022).

Seniority was confirmed as another source of power (FN5, 25/8/2022 & FN6, 31/8/2022), reflected in members seeking help from senior members with experience and expertise. Moreover, in Study 2, it was found that the power of seniority and the power of rank would fight against each other during a meeting regarding how a team plan involving improvisation should be composed and executed (FN9, 9/9/2022; FN13, 22/9/2022).

Compared with Study 1, what was found to be different in Study 2 was that being in a "priority" project (see the project management system of the Avatar Group in 3.5.2) could bring additional power to the observed team, as being in a "priority" project meant that all the needs of the team members should be prioritised by other supportive departments; for example, the testing/measurement centre should give priority to processing the test requests from a "priority" project (FN7, 2/9/2022), the logistics department would prioritise the need for the deployment of the requested equipment (FN13, 22/9/2022), and the HR department would urgently coordinate available engineers to support the "priority" project if requested by project members (FN2, 10/8/2022). In such an organisational system, members of the "priority" project assumed that they had additional power to mobilise the equipment and personnel they needed, and other departments had no choice but to cooperate. By enjoying such a privilege, the "priority" team members could exercise control over other members who worked on normal projects to give up equipment and time slots.

Cognitive influence: Theme 3 Emotion

Theme 3 Emotion was considered as a *cognitive* influence in Study 1 because this theme involved people's feeling.

Study 2 showed that team improvisation activities were influenced by members' emotions, both positively (e.g., in terms of confidence and excitement) and negatively (e.g., in terms of anxiety). Similar to Study 1, the observed team expressed concerns about falling behind in the product development process (e.g., FN2, 10/8/2022), which may have been caused by the limited time given by the client. It was also found that the team had concerns about falling behind other teams (e.g., FN5, 25/8/2022), which might relate to how the team's overall performance would be determined (see 3.5.2 for the project management system). In short, in the Avatar Group, a team's performance would be evaluated based on the quantity and quality of project completion and would be compared against the work of all other teams. Throughout the observation period, the observed team expressed concern about the quality of their development projects due to a lack of sophisticated equipment (FN2, 10/8/2022) or technical capability to machine the products (FN10, 13/9/2022). These matters caused the team's anxiety. Team members were put in a state of anxiety during work. Similar to Study 1, the unpredictable rectification movement initiated by top management (see 3.5.2 for the research context) existed in the garden equipment division; such a system encouraged employees to expose each other's wrongdoings, with top management using fear to prevent any violations. The existence of this organisational arrangement might make the observed team, which was already facing work anxiety (e.g., FN3, 15/8/2022; FN11, 15/9/2022), likely to fall into continuous anxiety in daily activities because they might assume they could not trust each other, as others might fabricate stories to frame them for self-interested reasons (given that there was internal competition between teams due to the project management system). Taken together, the company-wide prevalence of anxiety could leave members with a vague sense of danger. The members might want to prepare for the worst during daily operations, although they may not know where the danger lay, and when it might occur.

Unlike Study 1 findings, Study 2 showed that team members had a high level of confidence when they decided to deviate from organisational procedures (FN4, 20/8/2022). Moreover, Study 2 data showed more positive emotion on the part of the observed team when their improvisation worked, and they would review the process of a team improvisation to relive it. Excitement was also observed when they relived an old improvisation experience (FN10, 13/9/2022; FN16, 14/10/2022). These findings with regard to emotion suggest that the joy and excitement brought by team improvisation may be the reason for team members choosing to improvise in a work environment that creates constant anxiety for them.

Cognitive influence: Theme 4 Time pressure

Theme 4 Time pressure was considered as a *cognitive* influence in Study 1 since no new second-order code was added.

Similar to the findings in Study 1, time pressures existed due to deadlines and urgent field situations were found to be a component that influenced team improvisation, although the time pressures perceived by the observed team in Study 2 were not as strong as those on the teams from Study 1 based on data from the semi-structured interviews. This might be because the interviewed participants were located in the factory environment, where a tight production schedule was in place on a daily basis, while the observed team was working on a new product development project which was constrained by a two-month deadline for prototype delivery. In Study 2, the team improvising by giving up conducting the normal procedure of grinding machine repair (including pipeline inspection and redesign) because the members believed there was not enough time to follow the procedure: "… it was too late to do it … since the inspection, design and plan took at least a week" (Example B, FN9, 9/9/2022).

Moreover, when an urgent field situation occurred, the team was forced to deal with it by improvising; for example, in Example M (FN5, 25/8/2022), the team was told by the

scheduling office that the oil cooler could still be unavailable when they wanted it. The team improvised and conducted experiments with water-based cooling methods. A quick decision was arrived at on site and executed immediately because if a surprise occurred, the work had to go on.

In addition, linking back to the influence of emotion (see the previous theme 3: emotion), because surprises happened suddenly on site, this created a great deal of temporal urgency for team members. They responded to such surprises on the spot, experiencing the same levels of excitement as in the process of using improvisation. It should be noted that team members actively chose to improvise, in that they also had non-improvisation options, such as stopping the workflow. Consequently, the excitement experienced in the process of improvisation might be the reason why the team indulged in such firefighting improvisations.

Cognitive influence: Theme 5 Team climate

Theme 5 Team climate was considered as a *cognitive* influence in Study 1 since no new second-order code was added.

Similar to the findings in Study 1, Study 2 data suggests that the team's improvisation was protected. The two obvious components reflecting such protection were: a) team members' positive attitude, and b) the team leaders' protective attitude towards improvisation. The fact the team members had a positive attitude toward improvisation might protect members from being reported and obtaining necessary support for improvisation. Moreover, the leaders had a protective attitude towards team improvisation; similar to the findings of Study 1, examples in Study 2 also showed that leaders covered the observed team's improvisation, such as not reporting to changes to top management (e.g., Example D, FN3, 15/8/2022).

Both team members' positive and leaders' protective attitudes towards improvisation were based on past experience of improvisation. This means that if the leaders acknowledged

an improvisation that solved a problem at the cost of breaking a procedure, members would assume that improvisation could be an option in their daily work without fear of penalty. For leaders, members' successful improvisation in the past kept leaders' expectations protective, even for improvisation with unknown consequences. However, team improvisation may not always be successful. Study 2 showed that the occurrence of team improvisation could disrupt the normal operation of a department; for example, temporary experiments on-site might disrupt the arrangement of materials/equipment and other resources (FN5, 25/8/2022, FN2, 10/8/2022 &), or lead to negative consequences in the long-term, such as an inability to operate temporary equipment over the long term (FN16,14/10/2022); similarly, in Study 1 there was an example where team improvisation led to negative consequences in the long term (e.g., Example 2). As a result, there should be more about the organisational considerations which exist behind the team members'/leaders' attitudes, which allow team improvisation to persist. Such organisational considerations are reflected in the high tolerance of unpredictability on the part of company members in general (e.g., FN5, 25/8/2022). One possible component that inclined the company to be highly tolerant of unpredictability could be the influence of the zero-COVID policy in China (see 3.5.2 for research context). Being influenced by the zero-COVID policy, as a manufacturing company, the Avatar Group could not employ the normal number of employees in its factories and offices. The company changed from traditional hierarchical management to project management in 2021 to make the company operational with fewer employees on the premises. Such a change made the employees who were used to doing things by the book become members of projects, carrying KPIs assigned to them.

The environment was constantly changing in an unpredictable way, in ways which were determined by the local government for pandemic control reasons. Top management could find setting procedures and protocols to manage ineffective and feel that they were

losing control of the company, since an emphasis on following procedures might cause team members to be unable to keep up with changes in the environment. To deal with unpredictability, the company established a group of positions such as resident engineers/machinists who were responsible for helping the project teams deal with various engineering and mechanical problems occurring in the factory. Top management introduced a project management system and allowed employees to improvise whenever they felt they needed to keep the workflow going. In this context, employees who were able to improvise and deal with unpredictability in such a way as to solve problems, become heroes. Thus team improvisation was positively accepted by team members and proactively protected by team leaders.

Furthermore, similar to Study 1, the Study 2 data showed that the observed team valued the client more than the company's procedures. Such an observation might be a side effect of the unpredictable environment. Due to the impact of COVID and the zero-COVID policy on manufacturing industry such as the inability to full staff factories, the possibility of having to stop work at any time, and the loss of foreign clients due to the cancellation of international transportation, the Avatar Group had been engaged in regular layoffs, which may have led to team leaders being focused solely on pleasing their clients and gaining their recognition, meaning that teams would do whatever it took to get results in the short term to ensure job security.

Summary

In general, by using the coding manual, to a large degree Study 2 confirmed the findings from Study 1 regarding the influence of team improvisation, albeit with several differences being found. Five themes were identified: 1) location, 2) power source, 3) emotion, 4) time pressure, and 5) team climate. Firstly, theme 1 location confirmed that the physical distance between team members could influence improvisation by having an impact

on team interaction (such as using seat changing to improve nonverbal communication). Besides, team members improvised with regard to using physically closer materials and tools. Unlike in Study 1, by comparing members' behaviour during meetings in formal and informal environments, this study found the type of meeting location might be a component influencing improvisation.

Secondly, theme 2 power source confirmed position or rank as a component which could influence team discussions, reflecting leaders' dominance and additional interpretations. In addition, the power of seniority was also confirmed, since members would seek the support of senior members when their rank or power was insufficient, as a leading strength for composing a team plan. An interesting observation was that the power of rank would seek a sense of illusory authority by instructing on irrelevant matters when those with rank were opposed. Unlike in Study 1, being in a "priority" project was found to be a source of power, which gave the team the opportunity to mobilise resources.

Thirdly, theme 3 emotion confirmed that team members' anxiety could be a component influencing improvisation by causing continuous anxiety. It was further indicated that such anxiety could be mixed with confidence when a team improvised. In fact, the emotion of excitement might be the underlying element that team members experienced during improvisation, which they viewed as an emotional outlet in an anxious working environment.

Fourthly, theme 4 time pressure confirmed that team members improvised due to the time limitations caused by deadlines and surprises. The sense of temporal urgency perceived by the team could work as a trigger for members to seek emotional outlets, as the time pressures might not only cause temporal tension but also excite the feelings of members who indulged in improvisation.

Fifth, theme 5 team climate confirmed that the team's improvisation was justified by the team's beliefs, such as members' positive attitude (in terms of obtaining necessary support) and leaders' protective attitude (in terms of the improvisation to occuring and remaining) with regard to team improvisation. The high tolerance of unpredictability and also the value of 'The client is king' were influential components that might result from the working in an unpredictable environment during the observation period. As COVID and the zero-COVID policy in China caused a great deal of uncertainty and difficulties to the Avatar Group as a manufacturing company, top management might find it ineffective to refine and insist that employees stick to procedures/rules/protocol, allowing members to improvise in order to keep the company operational. As the company changed to a project management system (which caused high levels of internal competition) in response to the epidemic and strict local policies, most employees joined project teams to undertake KPIs. Team members' emphasis on improvisation seems to make sense. Even though improvisation might have negative effects in the long term, they were introduced in the search for short-term benefits to ensure job security, while top managers were concerned about whether the company could survive the crisis.

Next, an analysis of the outlined themes with regard to influences using the microprocesses of team improvisation will be presented, and the similarities and differences of the analysis between Study 1 and Study 2 will be included.

5.4.6.1 Analysis of how the microprocesses of team improvisation are affected by the influences regarding the similarities and differences between Study 1 and Study 2

This section shows how Study 1 and Study 2 are similar or different in terms of how the microprocesses of team improvisation were affected by the influences. The analysis involves the themes and second-order codes of the microprocesses and influences in order to

maintain a balance between parsimony and richness. Figure 11 was therefore created to offer an overview with regard to such a comparison.

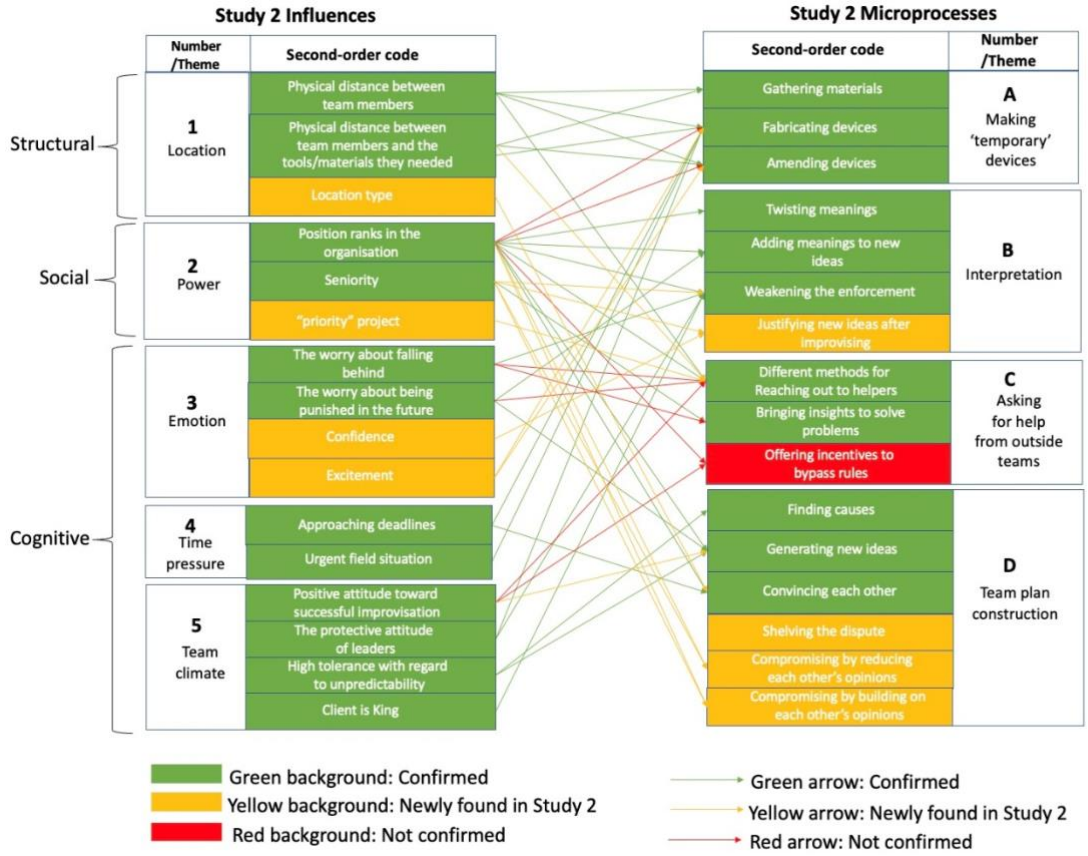


Figure 11: An overview of how the microprocesses are shaped between the two studies

In Figure 11, on the left-hand side, there are themes of influence (numbered 1, 2, 3, 4, 5) and the corresponding codes. The themes are classified as structural, social, and cognitive in accordance with Ciuchta et al. (2021). On the right-hand side, there are themes of microprocesses (numbered A, B, C, and D). Since Figure 11 aims to offer a comparison between the two studies, different colours have been used in order to show which was confirmed (green), not confirmed (red), or newly found (yellow). As a result, the boxes under the second-order codes with green background mean that the codes which existed in Study 1 were confirmed in Study 2; the red background means that the code from Study 1 was not found in Study 2; the yellow background means these second-order codes are newly found in Study 2. Moreover, the arrows all originate from the influences and pointed to the

microprocesses, indicating that the former have an impact on the latter. The same logic of using the colours was applied with regard to the arrows, in that green arrows mean that the relationships between the influences and the microprocesses were found in Study 1 and confirmed in Study 2. The red arrows mean that the relationships were not confirmed, while the yellow arrows mean that there were new relationships found in Study 2.

The following paragraphs will analyse the similarities and differences between Study 1 and Study 2. As the entire analysis would require a large number of pages, this section included two examples, i.e., analysis of how Theme A Making 'temporary' devices was influenced by Theme 1 Location, Theme 3 Emotion, Theme 4 Time pressure, and Theme 5 Team climate and was not influenced by Theme 2 Power source. This is followed by the analysis of how Theme B Interpretation was affected by Theme 2 Power source, Theme 3 Emotion, and Theme 5 Team climate. The rest of analysis can be found in Appendix 10. In each section, the similarities between the two studies will be analysed at the beginning, followed by the differences which might be nuanced differences within the similarities, the parts which do not matched between the two studies, or newly found relationships. A summary is included at the end.

Theme A Making 'temporary' devices as influenced by Theme 1 Location

Similar to the findings in Study 1, physical distance between the team members and the materials/tools they needed was a component that affects teams making 'temporary' devices. In Example A (FN2, 10/8/2022), the testing centre was located at a distance from the grinding factory and from where the technology was being undertaken: 'the measurement centre is 20 minutes' walking distance from the gear grinding workshop and the office of the technology department respectively … especially we were already quite far away in this building' (FN2, 10/8/2022). For convenience, the team members printed the blade model using a 3D printer and always carried it with them for size comparison.

Theme A Making 'temporary' devices as influenced by Theme 3 Emotion

Although Study 1 did not find a relationship between emotion-related influences and the microprocesses of making temporary devices, Study 2 found that a feeling of excitement might drive the team to improvise by making devices, as members enjoyed the excitement during the microprocesses of fabricating and amending devices. In Example B (FN9, 9/9/2022 & FN10, 13/9/2022), the team members initially increased the concentration of the cutting fluid to improve its corrosion resistance. However, when the cutting fluid sewage tank began silting up due to the increased cutting fluid concentration, the team improvised by adding motor pumps and retrofitting filters to create a temporary system to solve the problem. Moreover, the team members spent around ten minutes talking about how they had created a new management system for cutting fluid waste and the members were very excited when they talked about it (FN10, 13/9/2022). Such an observation indicates that members might enjoy the team improvisation process although it caused trouble and chaos. Given that team members discussed the improvisation after it occurred, and showed excitement, it is reasonable to assume that team members would have a similar emotion when performing the improvisation. It is possible that the members wanted to improvise because it generated the excitement associated with successfully dealing with the unknown.

Theme A Making 'temporary' devices as influenced by Theme 4 Time pressure

Similar to the findings in Study 1, the observed team created temporary systems to solve problems due to the time pressure resulting from approaching deadlines and urgent field situations. In Example C (FN15, 11/10/2022), the most influential component affecting the team was the impending sample delivery date, causing team members to improvise a round metal lock to hide the injection defects of the handler's front end,: 'Delivery was due in four days; it was too late to check where the problem came from or how to correct it' (FN15, 11/10/2022).

Moreover, team members built makeshift systems in response to emergencies that arose on-site. In Example B (FN9, 9/9/2022 & FN10, 13/9/2022), when the team members used the more concentrated cutting fluid, its deposition in the sewage tank was noticed. Consequently, the team members needed to come to a decision in a relatively short space of time because the continuous deposition in the sewage tank would soon lead to wastewater overflow and stop the cutting process. Apart from anything else, this was not a good idea since it would be necessary to scrap the valuable blade material. The team members were under a lot of time pressure dealing with this unexpected situation, and they chose to overcome the problem for the moment by improvising a temporary system involving adding a motor pump to the pipeline and changing the position of the filters.

Theme A Making 'temporary' devices as influenced by Theme 5 Team climate

Similar to the findings in Study 1, the leaders' protective attitude towards team improvisation might be one of the reasons the team was not afraid of improvisation, since there would not be any negative consequences. In Study 2, this protective attitude was reflected in the leaders' recognition of team improvisation, influencing the microprocess of fabricating devices. In Example B (FN9, 9/9/2022 & FN10, 13/9/2022), the technical members improvised a temporary sewer drainage system to solve the siltation problem. In a follow-up management meeting, the project leader, James, acknowledged the team's improvisation. He also asked the team members how they would continue to improve the cutting fluid line management system. The technical members mentioned the use of water level sensors and a numerical control to control the flow of cutting fluid, a suggestion that James appreciated. To some extent, such recognition from the team leader would encourage team members to continue to solve problems by improvisation in the future. As for why leaders tended to be protective of team improvisation, the reason may lie in the unpredictability of the external environment. During the observation period, the COVID

pandemic and China's zero-COVID policy meant that the company was facing a great degree of unpredictability. The managers' protective attitude toward improvisation may have stemmed from their belief that adhering to corporate rules and procedures was inadequate when dealing with the vagaries of the environment.

Theme A Making 'temporary' devices as NOT influenced by Theme 2 Power source

In Study 1, it was found that position ranks had an impact on the microprocesses of fabricating devices and amending devices. However, such relationships were not found in Study 2. The reason could be that there were fewer team improvisation examples involved in making a temporary device for the researcher to work on, and the observed NPD team might perceive less influence from the hierarchy of rank because the members at lower rank were also senior employees in technical roles, which made them more confident to not defer to the leaders (such a confrontation of different sources of power has been found to affect how teams compose a plan later on).

Theme B Interpretation as influenced by Theme 2 Power source

Similar to Study 1, leaders with rank power were straightforward when it came to creating space for team improvisation by interpreting written procedures, reflecting on twisting meanings of procedures and weakening their enforcement of them. For example, Susan was originally the technology department leader and had the most experience in blade manufacturing. In Example D, she directly claimed that the drawings provided by the client did not apply to the team and that the drawings were a type of reference, rather than compulsory requirements (FN2, 10/8/2022). This example also showed that power from different sources could be antagonistic. Susan convinced James, who had a higher rank within the company, to accept her behaviour based on her greater experience in technical matters, i.e., not to use the drawing design provided by the client (FN3, 15/8/2022). It may

have been that James did not have Susan's strong technical background, so he could not argue with her from a technical perspective.

Another similarity between the two studies was that higher ranked employees would interpret what was going on as an improvisation by adding new meanings. For example, in Example E (FN2, 10/8/2022 & FN12, 20/9/2022), the technical leader was the first person to note that the design of the de-moulding could be explained as a new feature of the handler product because the technical leader had the power (as stipulated by the leader's job responsibility and determined by the organisational hierarchy) to interpret the results of the product development, whereas the technical members did not have such power.

Differently, the data from Study 2 revealed something new, i.e., that seniority power also played a role in shaping the microprocesses of weakening the enforcement and justifying new ideas after improvising. First, in Example G (FN4, 20/8/2022 & FN7, 2/9/2022), team members with technical backgrounds, including Susan, Mike, Carl and Kevin, were dismissive of the company's material testing procedures. They thought they could judge the quality of the embryo of a cast blade in different materials with their own eyes since they had a great deal of experience in this area. Consequently, they decided not to send all the embryos for testing, saying that it was unnecessary. Second, when the technical members were questioned in a management meeting by the project leader, James, they responded light-heartedly/jokingly, 'they did not want to disturb the operation of the testing centre too much' (FN7, 2/9/2022). Such a collective response reflected the power of interpretation that members with extensive technical experience had. These outlined examples in Study 2 showed that powerful individuals (those with seniority) cared little about the compliance of with the rules. They perceived that they were above the organisational procedures, and the awareness of being restricted by such rules was dispelled when he/she had a high degree of seniority power.

Theme B Interpretation as influenced by Theme 3 Emotion

Similar to the findings in Study 1, the worry about falling behind schedule had an impact on the microprocess of weakening the enforcement of rules and procedures, as reflected in Example D (FN2, 10/8/2022 & FN3, 15/8/2022). The observed team was worried that developing a new type of technology might cause the team's overall development process to fall behind the delivery schedule, so the team weakened the enforcement of the product design drawing provided by the client, turning to focus on refining the existing technology to achieve a same level of quality.

Another similarity was that concern about being punished in the future was also identified as a component that influenced the microprocess of adding meaning to new ideas. In Example H (FN15, 11/10/2022), when the observed team noticed that the front end of the handler product was inadequately moulded, they came up with the new idea of improvising a metal lock to wrap it up as a form of temporary covering. The members talked about how the improvisation of wrapping a metal lock around it improved the brightness of the handler and made it stands out. By adding meanings to the new idea of improvising a metal lock, the team mitigated the worry of future punishment (e.g., such an improvisation might be perceived as unprofessional by the client which might lead to complaints) because team members opened reasonable room for improvisation.

Differently, Study 2 found that the emotion of confidence had an impact on the microprocess of justifying new ideas after improvising. In Example H (FN16, 14/10/2022), during a management meeting when the technical members were questioned by the project leader about the improvisational use of the metal lock to hide a product defect, the technical members responded by justifying the team improvisation with a set of reasons including adding new features, the high possibility of passing the client's product inspection, and a lack

of time of re-manufacturing. The technical members believed that the improvisation was the best option at the time.

Theme B Interpretation as influenced by Theme 5 Team climate

Similar to Study 1, in Study 2, the leaders' protective attitude influenced the microprocess of weakening the enforcement of rules and procedures. This was confirmed at a management meeting after the technical team had skipped the size testing of the blade embryo (Example A). James, the team leader, told the technical team to 'leave the testing reports and focus more on how to make things work' (FN3, 15/8/2022). Such a commitment on the part of the leader protected the team to the extent that, in Example F (FN8, 3/9/2022 & FN11, 15/9/2022), the team members dared to improvise by weakening the enforcement of the budget regulation, with the team modifying and hiding a budget item – the rental of liquid nitrogen cryogenic equipment – although it required a special large expense declaration. This rule-breaking improvisation was later explicitly protected by the team leader, James, the project leader, and Linda, the purchasing department manager, by accepting the technical team's violation of the reimbursement rules by altering items to hide the rental cost of the new equipment (FN11, 15/9/2022). The acceptance on the part of the leader was reflected in the fact that the leader did not punish or scold the technical team for violating the reimbursement procedures. Rather, the leader expressed his wish that the rented equipment would be effective.

Another similarity found was the team's belief in the mantra 'Client is King' influenced the microprocess of weakening the enforcement. In Example E (FN2, 10/8/2022 & FN12, 20/9/2022), the team was upset that the product had not changed much in appearance when the client asked for a new feature in appearance which could stand out. To satisfy the client's demand, the technical members improvised by determining the shape of the handler product was threaded. They did this without the management approval, and then notified the

client. In doing so, the team weakened the enforcement of project management regulations which stipulated that a team should ask the management for approval when it came to contacting clients or proposing alternatives.

Summary

By mapping out the five themes of influences mapped out on the four themes of team improvisation microprocesses (see Appendix 10 for the rest of the analysis), it was found that Study 2 confirmed the Study 1 findings to a large degree. In fact, approximately 76% of the relationships between influences and microprocesses were confirmed, with the addition of a number of newly-found relationships. The following paragraphs summarise the similarities and differences between the two studies regarding how the microprocesses of team improvisation were affected by the influences.

Firstly, it was confirmed that teams tended to improvise by making 'temporary' devices when a) the necessary resources/materials/tools were physically close to hand, b) they perceived time pressure, and c) they believed the improvisation could be justified and would be protected. However, it was not confirmed that the team improvisation in terms of creating devices were influenced by power. In addition, with regard to Study 2 a new finding was that the teams enjoyed the excitement of improvising by creating and amending physical structures to solve urgent problems.

Secondly, it was confirmed that powerful leaders tended to be more reckless and creative in terms of interpreting procedures or new ideas when leading the teams in terms of improvisation. Study 2 also found new evidence that members with greater seniority would behave similarly to those of higher rank as they all tended to see themselves as being above the rules. Moreover, it was confirmed that teams would improvise by interpreting procedures or new ideas when they perceived anxiety; while Study 2 found that teams tended to justify their improvisation when they felt confident. In addition, it was confirmed that team

improvisation involving interpretation was more likely to occur when the team believed that their improvisation would be accepted by other members, protected by leaders, or justified by demanding clients.

Thirdly, it was confirmed that teams tended to improvise by asking for help from outside teams when a) they had the power to mobilise manpower and b) more senior helpers were accessible. However, Study 2 did not confirm that teams' emotions or beliefs would influence how they improvised by asking for help from outside teams.

Fourthly, it was confirmed that a) powerful leaders dominate how teams construct a new solution, b) feelings of anxiety would make the microprocess of generating new ideas for improvisation more rigorous, c) the perception of time pressure would accelerate the microprocess of attempting to convince one another in order to achieve a new team consensus, and d) the belief of high unpredictability made teams resilient when they repeatedly generated and verified new ideas. What was new was that Study 2 found that teams constructed new plans in a more organised way in formal locations while becoming more chaotic in informal settings. Team members used seating locations or the action of changing seats as a nonverbal signal to express their opinions. Such actions would also restrict the freedom to express opinions if members wanted to change their opinion again. Moreover, Study 2 found new evidence that higher ranked leaders and senior members with technical expertise would make teams compromise (by reducing/building each other's opinions) on the final team plan. Interestingly, leaders would become more dictatorial with regard to details when their authority was challenged by senior members.

5.4.7 Outcomes of team improvisation

As the team improvisation examples were summarised and presented in 5.4.1, the related field notes were carefully read multiple times to allow the researcher to summarise the outcomes of the examples.

This section presents two examples of outcomes of team improvisation. As the full description would require many pages, the full presentation of the Study 2 outcomes can be found in Appendix 11.

Example A

The team improvised a portable metal model of the blade for anytime size comparison to facilitate the NPD process. However, at the company level, the product data for each stage of the blade development process was lost, which was detrimental to the subsequent summary of development experience, and information on technical knowledge was not well recorded and disseminated.

Example K

In a technical meeting aimed at improving the blade's sharpness, the team improvised by asking an experienced grinder to carry out the grinding work on behalf of the team. As a result, the team obtained the best grinding work possible, but this might have negatively influence the helper team's work for a short period.

Overall interpretation of Study 2 outcomes

By carefully reading the field notes for Study 2, the researcher summarised the outcomes into the following types: client satisfaction, company operation disturbance, efficiency, financial loss, learning opportunity loss, machine malfunction, manufacturing improvement, quality, team cohesion, team performance, and well-being.

In general, as with Study 1, the balanced scorecard framework was used to categorise the outcomes (Kaplan & Norton, 1992).

Table 30. *A categorisation of the Study 2 outcomes of team improvisation according to the balanced scorecard*

Perspectives from the BSC	Outcomes
Financial	Financial loss
Customer	Quality, team performance, client satisfaction
Internal	Efficiency, team cohesion, company operation disturbance, machine malfunction
Innovation and learning	Learning opportunity loss, manufacturing improvement

Compared to Study 1, the outcomes with regard to team improvisation in Study 2 confirmed most of the outcomes found in Study 1 (ten out of 12), with two not confirmed – job security and information leak. The reason might be that in Study 2, although the Avatar Group was making redundancies, the observed team was not concerned about job security because they were either managers (i.e., one person was a senior manager, and three people were managers) or had strong technical backgrounds (i.e., five people) which kept them from being earmarked for redundancy. In addition, the team observed in Study 2 was an NPD team, which was particularly conscious with regard to protecting the technical information relating to the project, so no information leak was caused as a result of team improvisation.

In addition, Study 2 revealed a new type of outcome: manufacturing improvement which included the category of innovation and learning. This may be because the teams observed in this study needed to improve manufacturing processes and technology as part of the team's goals, while the Study 1 participants were mostly responsible for production.

To be specific, this section examines the Study 2 outcomes using the same perspectives as Study 1, in order to test whether they are positive or negative in terms of different time scale (immediate-, short-, long-term) and levels (individual, team, organisational). An overview of the Study 2 outcomes is presented in Figure 12, followed by a discussion of similarities and differences between the two studies.

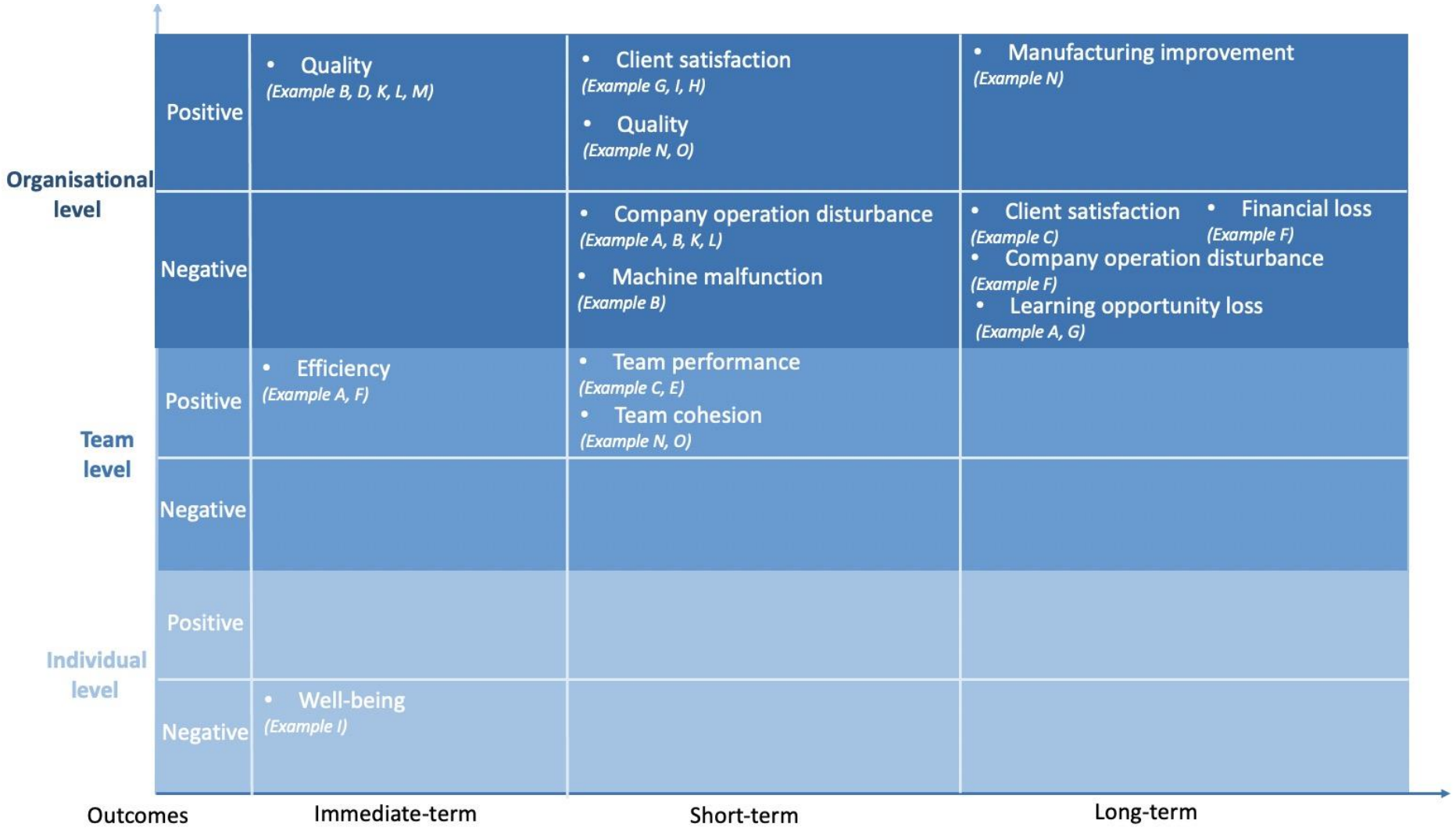


Figure 12: An overview of the outcomes of team improvisation in Study 2

As shown in Figure 12, the tensions previously revealed in Study 1 with regard to positive and negative outcomes at different levels and at different time points, were confirmed. First, when considering time scale, positive short-term outcomes could turn into negative over time (e.g., Example A, C, F, G). For example, in Example A, when the observed team improvised by creating a carry-on metal model of the blade for size comparison, the team did not need to record size data with the testing centre; consequently, the team saved a lot of time and the product development process was made more coherent. However, the company lost the technical data for future reflection and learning.

Second, the tension between positive and negative outcomes at different levels found in Study 1 also existed in Study 2. For example, when the observed team improvised by breaking a large cost into smaller costs for easier budget application (Example F), the team was able to obtain the necessary budget money quickly which facilitated the product development process. However, the company's operation was disturbed as the accounting department had to change the budget registration to cover the team improvisation.

Third, the company still took most of the negative impact from team improvisation, particularly in the long-term.

In addition, although Study 2 also found individual well-being was negatively impacted by team improvisation similarly to Study 1, the researcher identified excitement and increased confidence as two positive emotions during team improvisation which might be positive aspects in terms of wellbeing. However, it is necessary to point out that it is difficult to judge that the team improvisation in Study 2 confirms the insight from Study 1 that when teams improvise they are focusing on their team's interests because, comparatively, the company enjoyed more positive outcomes from team improvisation regarding improvement in product quality, client satisfaction, and manufacturing process. Such differences might be because the observed team was an NPD team. As a result, the team improvisation would

benefit the company as long as the team improvised in such a way as to develop the new product. Another reason why it is difficult to judge whether the insights from Study 1 are confirmed is due to methodological differences. In Study 1, the researcher could directly ask participants how they felt, and there were more team improvisation examples to work with. In Study 2, the researcher could only observe an ongoing project and rely on note-taking to record what participants said to others in the meetings, which limited the data collection to a degree. For example, the researcher could only tell that the participants in Study 2 were stressed when they said so to others, or when they showed unusual body language as signs of them being stressed.

This section described the similarities and differences between the two studies. In the next section, the key findings of Study 2 will be connected to the literature to draw out what kinds of theoretical contributions this study could make in addition to those made in Study 1.

5.5 The additional theoretical contribution

Study 2 contributes to the improvisation literature by highlighting a particular reason why people improvise – team members want to improvise to experience positive emotions. In the extant literature, although a small number of studies have focused on the relationship between emotion and improvisation, negative emotions receive more attention because employees are often fearful as improvisation is generally discouraged in organisations and leads to tiredness as employees constantly have to cope with surprises (Mirvis, 1998; Hatch, 1999; Fisher & Barrett, 2019)). Therefore, there is relatively little research on the role of positive emotions during improvisation (Hadjimichael, 2024). Study 2 finds that team members are confident and excited during improvisation, and demonstrate an intention to repeat the improvisation process when they talk about the improvisation after it has been put into place.

Relatedly, in the extant literature, a study by Roy (1956) suggests an explanation for the reason why people want to improvise. By observing machine operators in a manufacturing factory, Roy (1956) found that the workers interspersed monotonous work with break times which allowed them to relax and to fight against boredom. Through two months of participatory observation, Roy (1956) found that workers engaged in work which involved the repetition of very simple operations over an extra-long workday. Consequently, they organised a series of breaks during their daily work, such as coffee time, peach time, banana time, fish time, and coke time. During these breaks, workers would have a series of informal conversations, with making jokes found to be a common feature of these conversations. As a result, Roy (1956) believes that these breaks exist for the pure pleasure of countering the deadly boredom of repetitive work.

In this study, although the observed team was responsible for developing a new type of blade, the new product development project was not the only job task the team had at the time. Team members were also responsible for their own production tasks. Moreover, the manufacturing process of some features of the new product development project was strictly not allowed to be changed. The team needed to carry out repeated process experiments to meet the requirements under the framework provided by the client. Therefore, team members wanting to improvise to experience positive emotion might be because they want to relieve boredom.

5.6 Limitations

This study was based on observing a series of team meetings. Team members' actions regarding implementing team plans agreed upon during meetings were orally reported in a subsequent meeting, which might provide information that might be inaccurate or incomplete. Moreover, there was no audio recording of the meetings because one of the

participants did not agree to be audio-recorded. Although the participants were asked to review the on-site field notes to ensure that key information about the meetings was captured, meeting transcripts would do a better job of capturing details, such as by obtaining the exact words spoken by the participants and the speaking tones used, both of which might result in improved findings and insights. Furthermore, by paying attention to the roles of team leader and members, meaningful insights were generated about the relationship between power imbalance and team interaction regarding improvisation. However, the inter-member relationships were not explored. For example, the members at the same rank but with different level of seniority/experience might influence the way members interact when they are constructing a team plan for improvisation.

The next chapter is the concluding chapter, offering summaries of the key findings, theoretical contributions, and practical recommendations. Summaries of the limitations of this research and suggestions for future research are also included.

Chapter Six Conclusion

The phenomenon of improvisation is pervasive as organisational members often need to somehow adjust their actions to cope with a local situation (Cunha et al., 2017), but it can produce both positive and negative outcomes in terms of many aspects such as performance (Vera et al., 2016), machine breakdown (O'Toole et al., 2020), and organisational learning (Macpherson et al., 2022). Therefore, it is important to study the role of improvisation.

The literature has mainly relied on three approaches to developing improvisation theory. These are: microprocesses exploration (e.g., Weick, 1998a), metaphor translation (e.g., Vera & Crossan, 2004), and improvisation involved causality testing, mainly using the scales developed by Moorman and Miner (1998a) and Vera and Crossan (2005) in order to understand what improvisation means, and when/how/why improvisation happens (Cunha et al., 1999).

Scholars have argued about the limitations of using metaphors and testing causality involving improvisation using current measurement scales. The former approach is limited by metaphorical concepts because they only seek elements that fit within the analogical transitions situation while leaving out components that did not (e.g., Kamoche & Cunha, 2001). Consequently, the context-dependent knowledge might be black-boxed (Hadjimichael, 2024). The latter approach has been criticised for using measurement scales that were too minimalistic, making it difficult to identify specific improvisation processes (Ciuchta et al., 2021). Similarly, as the quantitative work on improvisation reached a plateau, scholars have called for conducting more microprocesses studies on improvisation to explore different ways of unfolding in such a way as to develop the core of improvisation theory (Vera et al., 2024; Hadjimichael, 2024).

Team improvisation is an area that currently lacks attention, which makes it necessary to conduct microprocesses research into the phenomenon (Hadida et al., 2015). In such research, team improvisation has been defined as *one (on behalf of a team) or more team members deviating from written procedures to compose and quickly execute a new solution in order to achieve a shared team goal*. In the improvisation literature, scholars have relied on metaphorical explanations of synchronisation (Marotto et al., 2007) and yes-and (Crossan, 1998) to understand what team improvisation is like in organisations (Hadida et al., 2015). However, they are limited in terms of understanding team improvisation in organisations. The former was first noted in jazz music, referring to instruments creating a continuous synchronised rhythm; however, it was difficult to judge whether synchronisation occurs even in jazz, since everyone is likely to have a different criteria when it comes to making a judgement (Hadida et al., 2015). The latter was a theatrical notion, referring to theatre performers accepted the creation of others and building on it (Vera & Crossan, 2004). However, it is hard to believe that team members in manufacturing situation would do the same under time pressure leading to improvisation. Therefore, team improvisation was chosen for conducting a microprocesses research because metaphors were not enough to understand team improvisation in an organisational context; the overall research aim is thus to *understand how different types of microprocesses are shaped during team improvisation*. The following definition of the microprocesses of team improvisation has been offered: *action patterns undertaken/demonstrated by one (on behalf of the team) or two team members when deviating from written procedures to compose and quickly execute a new solution in order to achieve a shared team goal*.

In this research, in order to achieve the research aim, four specific research questions have been proposed to explore the key microprocesses, influences, and outcomes of team improvisation, and to probe how the microprocesses were shaped during team improvisation.

To answer the research questions, two studies have been conducted in a manufacturing company in China during the COVID epidemic. Study 1 was carried out using semi-structured interviews, and inductive thematic analysis was used to analyse the self-reported data. Study 2 was carried out using a team meeting observation method, following which deductive thematic analysis was employed to test the validity of the Study 1 findings and to generate additional insights. The following section summarises the key findings across the two studies.

6.1 Summary of findings and theoretical contributions

This section summarises the key findings and their theoretical contributions. To facilitate the summary, Figure 13 was created to present the findings, including details of the microprocesses, influences, and different types of outcomes found in the research context. In order to achieve a balance between parsimony and richness in terms of the findings, only the highest-level codes (i.e., the themes), and the second-order codes are demonstrated in the presentation of Figure 13.

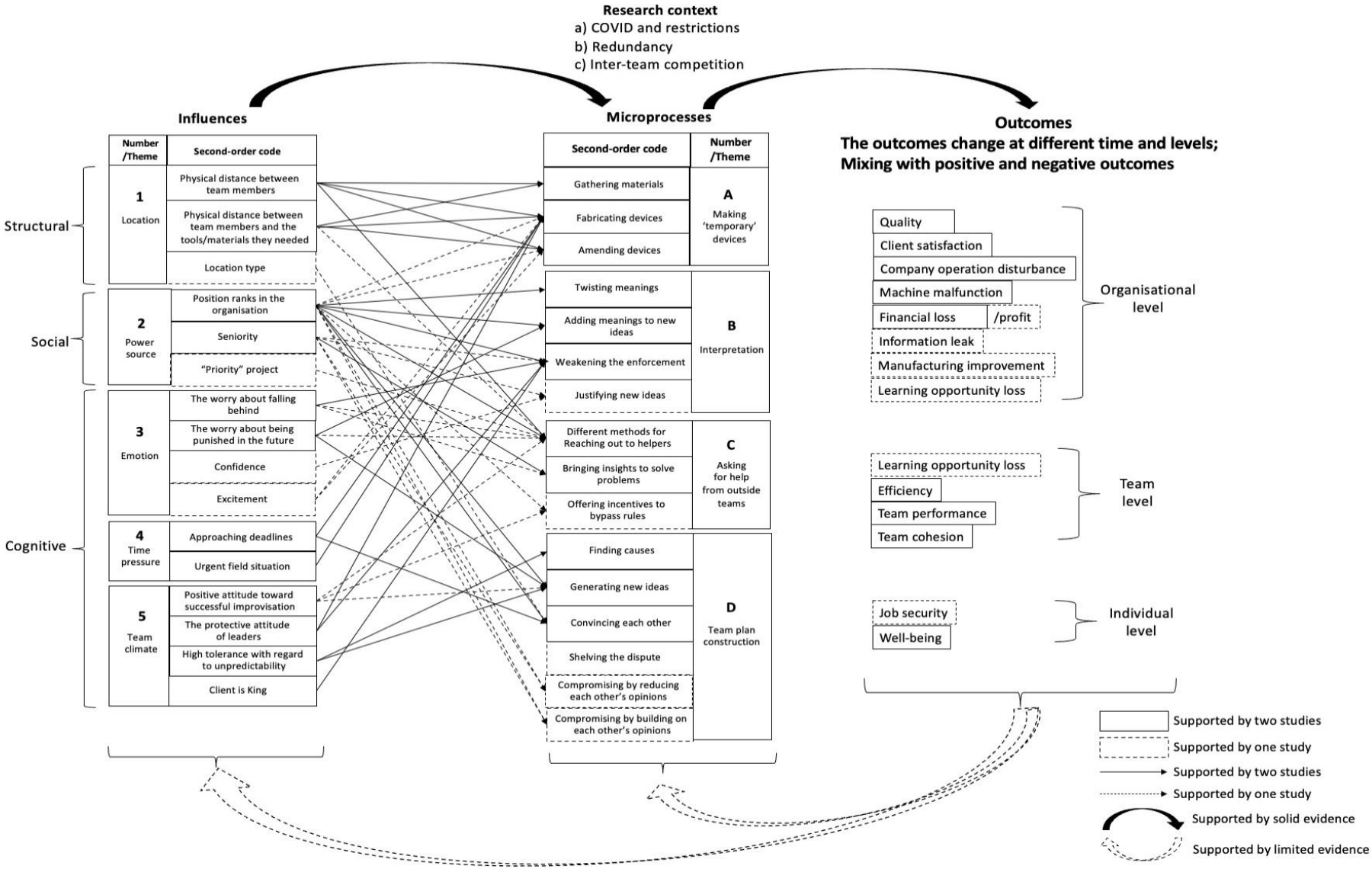


Figure 13: The summary of the relationships between the microprocesses, influences, and outcomes across Study 1 and Study 2

According to this figure, the research findings relate to a particular context which was characterised by uncertainty, given that the participants in China faced strict restrictions related to COVID, company redundancies and inter-team competition. In general, the findings can be seen as involving three connected parts - microprocesses (presented in the middle of Figure 13), influences which could be viewed in terms of structural, social and cognitive aspects (presented on the left-hand in Figure 13), and outcomes which could change at different time and levels (presented on the right-hand in Figure 13).

The following sub-sections summarise the key findings and their theoretical contributions respectively.

6.1.1 The microprocesses and their contributions

Across Study 1 and Study 2, 45 first-order codes were identified, from which were obtained 12 second-order codes (11 of which were validated) while four new second-order codes were identified, leading to the confirmation of the four highest themes (three of which were refined after incorporating the new second-order codes). The four highest themes represented a categorisation of team improvisation microprocesses. These are: Theme A, making 'temporary' devices. This refers to team members improvising in such a way as to gather, create, and use temporary equipment to keep the workflow going. To improve work efficiency, these temporary physical structures would be repeatedly used as they were treated as permanent solutions for specific problems. Theme B, interpretation. This comprises four second-order codes: twisting meanings, adding meanings to new ideas, weakening the enforcement and justifying new ideas after improvising. Theme C, asking for help from outside teams. This refers to team members improvising by seeking help from people outside their own team/company to solve problems and bypass rules via different channels. Theme D, team plan construction. This refers to team members improvising in order to interact on the

analysis of encountered problems and their associated solutions, whilst also performing actions to validate each other's ideas, as well as compromising or temporarily shelving disputes in order to create a consensus in order to arrive at a final team plan.

The thesis contributes significantly to the improvisation literature by empirically identifying a much more richly-detailed range of action patterns involved in team improvisation episodes compared to past research. The categorisation of microprocesses of team improvisation consequently provides an organising conceptual framework in which to categorise the different sets of microprocesses. These microprocesses have received limited attention because most discussion focuses on the individual or organisational level (Weick, 1993a; Bingham & Eisenhardt, 2011), and attends to the effectiveness of improvisation by focusing on the connections between improvisation and the variables that underpin the decision of when to improvise rather than how to improvise (Miner & O'Toole 2020; Ciuchta et al., 2021; Hadjimichael, 2024). This research aligns with that of another group of scholars (Vera et al., 2024; Miner & O'Toole, 2024) who argue that the microprocesses in a specific context can advance the core theory related to the improvisation process. In this way, the categorisation of the microprocesses of this research therefore enriches our knowledge regarding improvisation processes by providing details of different ways in which teams improvise (Vera et al., 2024).

Transferability of the microprocesses

In addition, in the extant literature, although scholars have explored team improvisation in the micro-world – for example, the types of improvisation at the micro-level (e.g., classification of what triggers improvisation, as in Cunha et al., 2017), or how a team improvises in a specific crisis situation (e.g., Roud, 2021; Aage & Meisiek, 2024), the literature still lacks a consideration of the microprocesses of team improvisation with regard

to their transformability. Thus, it is necessary to present what the microprocesses will look like when transferred into a context different to manufacturing.

Three different contexts are selected: firefighting, legal, and policy-making, as they were all research contexts that have appeared in the improvisation literature (see Table 31).

Table 31. *Examples of how the microprocesses may look like in other contexts*

Other contexts/the microprocesses	Theme A: Making 'temporary' devices	Theme B: Interpretation	Theme C: Asking for help from outside teams	Theme D: team plan construction
Firefighting	Firefighters' equipment might be damaged in a fire, so they can improvise to use materials and tools near at hand to make a temporary replacement and get the job done.	Firefighters can come up with an improvisation which is more appropriate due to a local situation, in order to protect the crew from being punished or allow the improvisation to be learned by the organisation (e.g., Macpherson et al., 2022).	A crew of firefighters can improvise by asking for help from other teams. For example, when the forest fire team finds the fire is too large, they can improvise by requesting help from the national park to use patrol planes to spray water from the air and control the fire. Or a firefighting team can improvise by requesting help from other rescue teams (e.g., the police) to remove trapped civilians.	A firefighting crew may encounter different opinions when formulating firefighting strategies. Under time pressures, the crew can improvise to reach consensus by a) quickly verifying each other's ideas as they are proposed, b) shelving disputes, c) compromising.
Legal	Although lawyers are unlikely to create physical devices, they sometimes need to add supplementary provisions to deal with special situations when composing legal documents, which can also be regarded as creating temporary devices.	In international law firms, lawyers from different countries have different understandings of the law, which might result in conflict. When writing legal documents, they need to explain to each other how laws are applied locally (to persuade each other) and promote progress. These	A company's legal team might improvise by seeking the help of employees from other departments or administrative employees to understand how a legal practice may affect them.	When conflicts arise in a group of lawyers regarding how a specific matter should be handled legally, the lawyers can improvise to resolve the conflicts by persuading each other, shelving the dispute, or compromising.

		interpretations might be improvisational between the lawyers (e.g., Smet et al.,2012).		
Policy-making	After a major unexpected event, such as an earthquake, the government usually needs to build houses quickly, but private construction companies may not be enthusiastic about reconstruction. The government can improvise by temporarily authorising municipalities to plan and execute social housing projects to jump-start the real estate market (e.g., Farias, 2014). The policy of issuing temporary licenses can be seen as a form of making 'temporary' devices in the area of policy-making.	In the process of policy-making, bureaucracy may make administration and implementation difficult. Policymakers may need to improvise to interpret the responsibilities of some government departments or reduce red tape in order to implement a policy.	When formulating a policy, the government needs to gather evidence to support the process of policy-making. Policymakers can improvise by requesting help from specialists in think tanks and universities to obtain data and conduct certain investigations.	The policymaking process often requires regulating conflicts among multiple stakeholders. In order to build consensus as quickly as possible to advance the policy-making process, the policymakers can improvise to a) propose ideas and simultaneously verify these ideas; b) persuade each other; c) compromise; d) temporarily shelve disputes to facilitate discussion of other items on the agenda.

6.1.2 The influences of team improvisation and their contributions

Across Study 1 and Study 2, five themes were identified. Firstly, theme 1, location, highlighted that team members would tend to improvise when they were physically separated from supporting resources, provided they were near to handy tools and materials which they could use, and were located in an informal environment in which they felt relaxed. Secondly, theme 2, power source, highlighted that power could not have an impact without people. This theme indicated that team members' power derived from their rank, seniority, and 'priority' projects. It was found that having these types of power enabled team members to improvise; that said, not having power could also lead to team improvisation because members would be emotionally motivated to improvise when they perceived that they were being treated unfairly due to differences in rank. Thirdly, theme 3, emotion, referred to the emotions (including anxiety, excitement, and confidence) felt by members during team improvisation. Theme 4, time pressure, highlighted that temporal urgency was felt by team members, caused by approaching deadlines with regard to particular job tasks, and the possibility of urgent field surprises. Theme 5, team climate, showed how teams believed that improvisation could be justified and protected/accepted in the company. It was suggested that organisational members' high acceptance of team improvisation was largely associated with the disruptive effect of the Zero-COVID policy on the leadership of the company.

In general, the classification of structural (Theme 1), social (Theme 2), cognitive (Themes 3, 4, and 5) over influences of improvisation as proposed by Ciuchta et al. (2021) is appropriate in this research. However, the emotion perspective found in this research was significant, reflecting the emotions such as worry, excitement and confidence experienced by team members. Similarly, it has been pointed out in the literature that practitioners experience emotions during improvisation such as fear (Fisher & Barrett, 2019) and fatigue (Miner &

O'Toole, 2024). These affective influences should be considered as an individual category to study how improvisation is influenced.

Specifically, this study contributes to the literature by highlighting a type of team climate that aligns with the metaphorical concept of experimental culture. It shows that team improvisation is widely accepted by employees, supported by leaders, and tacitly promoted by the organisation. The concept of experimental culture, conceptualised in three dimensions — action promotion, error tolerance, and organisational support (Vera & Crossan, 2004; Yao et al., 2017)—has been discussed in the literature, with scholars suggesting a positive link to improvisation (Cunha et al., 1999; Vera & Crossan, 2005; Su et al., 2022). However, few studies have provided empirical evidence of its existence within organisational contexts. This study fills that gap by offering empirical support for the concept of experimental culture within teams.

Furthermore, by analysing how the microprocesses were affected by various influences, this research contributes to the improvisation literature by highlighting two reasons for why people improvise. This is a relatively under-researched area as most studies focus on when and how improvisation occurs (Cunha et al., 1999; Ciuchta et al., 2021; Miner & O'Toole, 2024). Firstly, this research has found that teams want to improvise to reduce their anxiety because they can produce an immediate positive outcome by improvising achieve certainty. Although the existing literature has noted that employees experience emotions such as fear and exhilaration during improvisation (Mirvis, 1998; Fisher & Barrett, 2019), the literature has tended to ignore emotions as a variable causing improvisation (Ciuchta et al., 2021; Hadjimichael, 2024). Secondly, this research finds that teams want to improvise in order to produce positive emotions. Although a small number of studies have noted the relationship between emotion and improvisation (Mirvis, 1998; Hatch, 1999; Fisher & Barrett, 2019), negative emotions have tended to receive particular attention because

employees are often afraid of improvisation, given that it is generally discouraged in organisations, and leads to exhaustion as employees constantly have to deal with surprises (Batista et al., 2016; Baker & Nelson, 2005). As a result, there has been limited research regarding the role of positive emotions in improvisation (Hadjimichael, 2024). In attempting to redress this balance by analysing how different emotions influence different team improvisation microprocesses, this research contributes to the improvisation literature by providing an emotional perspective on why people choose to improvise in the first place.

6.1.3 The outcomes of team improvisation and their contributions

In past literature, scholars have often focused on improvisation outcomes from only one perspective, making such improvisation outcomes a relatively simple good/bad story; such a perspective might be from a certain level, related to a certain timeframe, or might be positive or negative (Vendelø, 2009; Ciuchta et al., 2021; O'Toole et al., 2020). Many studies have explored how improvisation can be positive. Such explorations mainly focus on the individual (e.g., Weick, 1993a; Magni et al., 2009) or organisational levels (e.g., Bingham & Eisenhardt, 2011). However, across Study 1 and Study 2, using the time and level dimensions proposed by Ciuchta et al. (2021), this research illustrates a whole set of outcomes over different levels and times which are positive and negative. The findings highlight the tensions between the levels and across different timeframes. For example, although immediate/short-term positive outcomes were predominant at the team level (e.g., team performance), they appeared along with negative outcomes at the individual (e.g., well-being) and organisational level (e.g., company operation disturbance) over the longer term. Therefore, by highlighting the complexity of outcomes, this research contributes to the improvisation literature by further emphasising the tensions between positive and negative results at various levels and with regard to various time points.

6.2 Practical recommendations

This research offers three significant implications for managerial practices, particularly through training programmes designed for managers and employees. The former should be conducted first to prepare the organisational environment for the latter.

To create an organisational context conducive to improvisation training, the company should first conduct executive briefings to ensure that leadership understands its objectives and benefits. These briefings should equip leaders with the knowledge and strategies to oversee implementation, track progress, and address challenges throughout the training process. Additionally, the company should introduce a cultural transformation policy that explicitly promotes trust, experimentation, and openness to mistakes as integral to learning. For example, leaders could establish formal recognition programmes or incentives to reward employees who effectively apply improvisation in problem-solving and in collaborative work.

The primary objective of managerial training is to equip managers with the requisite skills and mindset to recognise the pervasive nature of improvisation, provide support to employees to facilitate successful improvisation, and mitigate the risks associated with improvisational activities that may lead to adverse outcomes. To achieve these aims, firstly, trainers should introduce the concept of improvisation using illustrative examples from popular media, such as the Apollo 13 film, where mission controllers employed creative problem-solving to address an urgent challenge. Further evidence from the academic literature may reinforce the prevalence of improvisation, such as the example of R&D teams developing circuit boards to accommodate unexpected cable specifications (Miner et al., 2001). Trainers should then guide managers in terms of examining the circumstances under which improvisation typically arises, such as during periods of time pressure (Abrantes et al., 2018), in response to unexpected events (Yanow & Tsoukas, 2015), or in the pursuit of new

opportunities (Suarez & Montes, 2019). Managers should be encouraged to reflect on and share their personal experiences with improvisation, fostering a deeper understanding of its practical implications. Furthermore, trainers should present this research's microprocesses framework, enabling managers to comprehend the nuances of improvisational processes and the complexities of their associated outcomes. By adopting a levels/timescale perspective, managers can be better positioned to evaluate the broader implications of improvisational activities. Trainers should also facilitate discussion by posing questions such as: 'Should improvisation ever be entirely prohibited?', 'Which types of improvisation should be encouraged or discouraged?', and 'What strategies can managers employ to maximise the success of improvisational efforts?'

Furthermore, the research advocates for an internal communication campaign to encourage employees to participate in improvisation training. These sessions should begin with an introduction to the concept of improvisation, supported by examples from real-life scenarios and academic literature. To cultivate practical skills, employees may engage in group activities that simulate work-related challenges necessitating immediate problem-solving (e.g., developing action plans within a five-minute timeframe). Trainers should emphasise the importance of collaboration, encouraging participants to listen actively, observe attentively, and build constructively on the ideas of their peers (Balachandra, 2019; Mannucci et al., 2021). The microprocesses framework can be presented as a decision-making tool, with its four thematic components serving as strategic options for employees to employ when improvisation is required. Trainers should elaborate on the detailed action streams (second-order codes), which serve as practical guidelines for undertaking improvisational activities.

In addition, employees should be encouraged to evaluate the potential positive and negative outcomes of various improvisational approaches and to develop strategies to

mitigate associated risks. For example, employees might consider how their improvisation might impact the workloads of other teams, and propose proactive solutions, such as redistributing tasks. Trainers should also highlight specific behaviours identified in this research as being directly linked to negative outcomes, such as distorting procedural meanings or seeking assistance from competitors, and provide explicit guidance to avoid these practices. In addition, employees should also be advised to report any potential risks associated with improvisational activities to management in a timely manner, particularly in cases where the consequences are uncertain. Such an approach aims to enhance employees' capacity to balance the benefits of improvisation against its inherent risks. To reinforce the knowledge imparted during the training sessions, a concise one-page summary (e.g., Figure 14) consolidating key points should be distributed to participants. This summary would serve as a readily accessible reference tool to support ongoing learning and application.

Improvisation you can choose	Positive outcome	Negative outcome	Heads-up
Option One: Temporary devices *You can improvise by creating physical structures to cope with surprises and solve problems. See following points as action guide.* ❑ **Gather materials** ▪ You can look around or go somewhere close to obtain necessary materials/tools. ❑ **Fabricate devices** ▪ You can use the gathered materials and tools to make a temporary device, equipment or component. ❑ **Amend devices** ▪ You can change the structure, components of the physical structure you created for adjustments.	➢ Team performance *(the most common)* ➢ Efficiency ➢ Quality	➢ Machine malfunction	○ Try to keep the created devices detachable, so they can be removed after a problem is solved. ○ If you want to create a non-removable device or not intend to remove, you should report to management.
Option Two: Interpretation *You can improvise by oral interpretations, to protect your alternatives and yourself. See following points as action guide.* ❑ **Add meanings** ▪ You can add meanings to a new idea to show its an opportunity to make room for improvisation. ❑ **Weaken enforcement of a procedure** ▪ You can use a local situation to argue a procedure is not suitable to apply. ❑ **Justify a new idea** ▪ You can justify a new idea after its execution if you worry about being punished.	➢ Job security *(the most common)* ➢ Team performance	➢ Company operation disturbance *(the most common)* ➢ Financial loss	○ Do not improvise if a procedure is twisted, follow the procedures. ○ Try to have a quick internal discussion to obtain team consensus if you believe an alternative is better. ○ You should be able to justify your improvisation.
Option Three: Asking help from outside teams *You can improvise by asking help from outside teams on the site to solve problems when your team is understaffed or lack of expertise. See following points as action guide.* ❑ **Reaching out to helpers** ▪ You can reach out to other colleagues through various channels such as phone call, video call, email, text message, going to the person's office, inviting a helper over to your place. ❑ **Bringing insights to solve problems** ▪ You can ask others to help you solve problems, such as analysing a cause, finding solutions, or providing resources.	➢ Quality *(the most common)* ➢ Well-being ➢ Financial profit ➢ Team performance	➢ Company operation disturbance ➢ Information leak	○ Do not ask help from outside the company as it can lead to information leak. ○ Do not ask others to bypass rules for you.
Option Four: Team plan construction *You can improvise by proposing different ideas, and simultaneously verify them where possible to compose alternative team plans. See following points as action guide.* ❑ **Finding cause** ▪ You can perform necessary actions to find a cause of a problem on the site. ❑ **Generating new ideas** ▪ You can freely propose ideas within your teams if you believe your idea is better or others have flaws. ❑ **Shelving dispute** ▪ You can shelve a dispute if you can not reach an agreement with other members. ❑ **Compromising** ▪ You can compromise with others by giving up parts of your ideas which disagreed by others or try to build on each other's ideas to compose a new plan.	➢ Efficiency *(the most common)* ➢ Quality ➢ Job security ➢ Team cohesion ➢ Team performance	➢ Company operation disturbance ➢ Learning opportunity loss	○ Do not disturb other teams' normal operation, if so, efforts should be made to coordinate. ○ Ensure an afterwards reflection to record a new plan, so the knowledge created by team improvisation can pass on.

Figure 14: An example of the categorisation of microprocesses as training material

According to social learning theory, people's behaviours are learned by observing and imitating role models (Bandura, 1977), with people tending to learn from role models around them via observation. In turn, the role models respond to team members with positive actions, attitudes, or emotions when the team members imitate the leaders' improvisation, which works as reinforcement for the team members to imitate in the future (Bandura, 1977). In organisations, team members' role models are likely to be their leaders and higher-ranking managers. When the leaders and management introduce improvisation into a training session and try to teach employees how to improvise, the employees will receive the message that the company has accepted that improvisation will happen and the workforce will be supported if improvisation is a reasonable option, so they do not need to hide improvisation activities anymore, since improvisation without organisational support can have negative consequences (Nisula, 2015).

In addition, scholars such as Miner & O'Toole (2024) have pointed out that not knowing when to stop improvising can have negative consequences. It is therefore important to inform the employees during the training session when they can or cannot improvise. In the extant literature, scholars (e.g., Cunha et al., 2017; Ciuchta et al., 2021; Yanow & Tsoukas, 2009) have roughly divided improvisation into two categories: the first is basic improvisation, where practitioners fill in the details of an original plan without changing its core features, making minor adjustments according to the local context, while the other type of improvisation involves a major change to the core of the original plan. This research makes the reasonable suggestion that the company relies on its employees' discretion in terms of basic improvisation. That is to say, they can choose to improvise on site once they have evaluated any negative results and formulated coping strategies. However, if the employees feel that their desired improvisation will significantly change the original plan or organisational procedures, the practitioners must stop and report the situation to management.

6.4 Limitations of this research

First, the conclusions drawn in this research could be limited by the researcher's own ability when it comes to understanding technical terms and processes in auto-parts manufacturing. The microprocesses of team improvisation often involve technical problems, procedures, and solutions. Consequently, there were time when the researcher had difficulty understanding what the teams were doing and why they were doing it. Although the researcher sought help from the participants in terms of explaining the technical jargon and processes as far as possible, microprocesses research could have been improved if the researcher had shared the same/related (technical) background with the participants, which would have made the interviews and observation more effective, as well as easing the analysis of the collected data.

Second, although two methods were used in this research to collect data (including both self-reported and real-time data) (semi-structured interview for Study 1 and team meeting observation as Study 2), the backgrounds of the respondents for the two methods were different: the semi-structured interviews involved participants from a production-related or operation projects background in auto-parts manufacturing, while the participants in the team meetings observation were technical experts and managers working on a new product development project regarding gardening equipment. Such a difference made the comparison between the two studies difficult to a degree, so the researcher relied on contextual information to explain the differences that appeared.

Third, the constraints imposed by COVID-19 and the extreme weather (flood caused by typhoons) in China at the time of gathering the data severely restricted the time that the researcher had on site to carry out the empirical research related to Study 1, the findings regarding the outcomes of team improvisation were used as additional materials to feed into the analysis of how microprocesses of team improvisation could be shaped. Although the

positive and negative outcomes with regard to team improvisation were both noted in this research, how they might be shaped in order to be positive or negative was not systematically analysed with regard to the microprocesses of team improvisation. This could be considered to be a post-PhD research area that would benefit from further research.

6.5 Suggestions for future research

First, following the call by Vera et al. (2024) that microprocesses studies should be conducted to deepen the understanding of the core theory of improvisation, this research suggests that future researchers should test the microprocesses framework, i.e., the microprocesses framework in different contexts and also different countries, in order to see how transferable that is. For example, a future qualitative study can start with exploring microprocesses of improvisation in a specific context such as services and healthcare using semi-structured interviews, then use the collected data to test the microprocesses framework.

Second, future research might also explore the role of emotion in shaping improvisation, because there is little research on this aspect (Hadjimichael, 2024). For example, more attention should be paid to the emotions experienced by organisational members. In this research, it was noticed that when organisational rules were designed from the top down, members were required to abide by a lot of organisational rules and technical procedures which they did not have a voice into, organisational members might become dissatisfied and emotionally motivated to improvise. This research found hints in this regard, but there was insufficient evidence to support this assumption. Future researchers can focus on collecting improvisation events that occur as a result of employees' dissatisfaction with procedural and technical rules, as well as exploring what types of emotions employees experience during the unfolding of these improvisation activities, in order to investigate how emotions shape the improvisation process.

Third, this research follows Hadjimichael's (2024) suggestion that more attention should be paid to what happens when there is conflict between individual and organisational values. In this research, team members had values that resulted in a conflict. Members from technical backgrounds believed that the pursuit of product quality was the most important, but this was challenged by the organisational value of client is King; when a client required a product to be developed in a way that technical members disagreed, it was found members might improvise during such a circumstance. This suggests the role of value may play a role in team improvisation. Since this study only found one such example and did not deeply explore how the conflicting values shaped improvisation, future researchers can further explore the role of the conflict of values in the improvisation process to further understand the improvisation phenomenon.

Fourth, the role of power as a variable needs further exploration regarding improvisation. Because although the improvisation literature widely mentioned having power/autonomy is positively associated with improvisation, less is known how lack of power shapes improvisation. This research found team members improvised to seek more power, i.e., creating local knowledge only they know, so they can increase their irreplaceability in order to strengthen job security. Moreover, this research noticed team members compromised to reach team consensus for improvisation, the compromise might be due to the power dynamics within the team (members had different types of power, such as rank and seniority). Future research might want to explore how power dynamics within a team shapes team improvisation by looking deeper at participants' background in social, organisational, and technical aspects.

In addition, in terms of data collection and analysis, one recommendation is to include unwritten procedures (e.g., custom and practice) into the definition of improvisation. This research primarily relied on written documents to identify team improvisation episodes,

which may have excluded forms of improvisation embedded in custom and practice. Employees may initially improvise by deviating from established written procedures, yet over time, such deviations can become routine practices that are seldom documented in updated procedures. Future research could further examine diverse forms of improvisation and alternative microprocesses by focusing on the role of unwritten rules in shaping improvisational behaviours. Another suggestion is to collect data regarding long-term outcomes to better understand whether/how improvisation may cause risks in the long-term or how the outcomes might feed back to the microprocesses/influences. Therefore, future researchers might want to follow up improvisation periods over a longer period of time.

6.6 Concluding remarks

This chapter concluded the thesis by revisiting previous chapters and summarising important components of this research. This includes the key findings across the two studies and the theoretical contributions. Subsequently, practical recommendations were discussed. In the end, summaries of limitations of this research and suggestions for future research were presented.

Managing the whole process of designing this research, obtaining ethical approval, conducting interviews and team meeting observation during COVID pandemic in China where people were often restricted from travelling due to constant lockdowns, and analysing the data to draw out findings, linking to literature to draw out this research's contributions, has improved my skills and resilience.

It is also acknowledgeable that microprocesses of team improvisation is a crucial avenue to advance improvisation theory in this research's context, considering the unpredictable environment businesses face in these uncertain times. Specifically, this research examined how team members interacted to improvise which provide evidence to

improvisation literature regarding nuances underneath the basic definition of improvisation. By laying microprocesses of team improvisation as a foundation, this research was able to analyse the how these microprocesses were influenced to generate insights with regard to the reasons that underpin the decision surrounding how to improvise, which revealed the reasons for choosing improvisation; as well as contributing some insights to practitioners.

To conclude, the microprocesses of team improvisation should not be seen as independent from the social environment of the participants, this requires researchers to have a thorough understanding of the worlds of the participants. In addition to focusing on how improvisation can be effective, examining the tensions which implied by improvisation might also be a route to develop useful insights for practitioners.

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Appendices

Appendix 1: Distress protocol

Data collection methods	Interview/focus group	Team meeting observation
Precautions	• Provide information sheet and consent forms to all participants. • Pilot interviews to test the appropriateness of the questions • Have meetings with supervisors to discuss any ethical considerations.	• Provide information sheet and consent forms to all participants. • Be unobtrusive in dress and actions. • Become familiar with the setting before beginning to collect data. • Keep the team meeting observations short at first to keep from becoming overwhelmed. • Be honest, but not too technical in explaining to participants
Identify distress	• Participants indicate they are experiencing a high level of stress or emotional distress. • Participants exhibit behaviours suggestive that the discussion/interview is too stressful such as uncontrolled crying, shaking etc. • Facial expressions indicate anxiety, nervousness, and worry.	
Stage 1 response	• The discussion/interview will be stopped, any recording will be stopped. Access mental status: • ⇒ Are you ok? • ⇒ Do you want to take a break/end the	• Recording/notetaking will be stopped. Access mental status: • ⇒ Tell me what thoughts you are having? • ⇒ Tell me what you are feeling right now? • ⇒ Do you feel safe?

	interview/discussion/continue talking – participants' decision will be final.	• ⇒ Do you still wish me to take notes about your work? - participants' decision will be final.
Review	• If participants feel able to carry on. ⇒ Resume interview/discussion/team meeting observation, and I will commit to providing participants with an opportunity to talk and ensure the participants are not visibly distressed when leaving the interview/discussion, or when team meeting observation finishes. • If participants are unable to carry on. ⇒ Go to stage 2	
Stage 2 response	• Discontinue interview/team meeting observation, or participants will be removed from discussion/team meeting observation and accompany to quiet area. • With participants' consent, contact a member of the health care team within field company, treating them at for further advice/support. • I will ensure that participants have all contact information to my supervisors and remind them they are free to contact if there is anything further they would like to discuss. • I will offer to provide the participants with some local contacts, such as Ningbo psychological counselling and treatment centre, phone number: 57487258693; with the participants' consent, I will help them to contact their local community doctor. • Situation will be reported to my supervisors via mobile phone, and seek for guidance (due to time difference between China and UK, supervisors may be unable to answer in time, I will then write an email to them)	
Follow up	• Follow participant up with courtesy call (if participant consents) • Encourage the participant to call either if he/she experiences increased distress in the hours/days following the interview/focus group/team meeting observation. • I will debrief the incident with supervisors (if necessary) to discuss what happens next.	

Appendix 2: Participant information sheets (English Chinese Translation)

Participant Information Sheet

1. Research project title

A qualitative study of ways that team members work together to achieve team goals.

2. Invitation paragraph

You are being invited to take part in this study. Before you decide whether to participate, it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully and discuss it with others if you wish. Ask us if there is anything that is not clear or if you would like more information. Take time to decide whether you wish to take part. Thank you for reading this.

3. What is the project's purpose?

The aim of this project is to explore the micro-processes of team activities, specifically, this study aims to investigate how individual team members join together to accomplish team goals. To deal with day-to-day situations or surprises, team members need to work together to get things done; such processes can result in organisational learning and innovation.

Therefore, it is important to find out how team members go through different levels of processes to achieve team goals, how it connects to certain outcomes, and what/how social and cultural components are being influential.

To answer the questions outlined, the research topic namely, micro-processes of team activities, referring to the interaction of lower-level processes within a team that contribute to the team goals' accomplishment.

As a result, this study needs a detailed description of team activity; a mixture of observation and interview as data collection methods is involved.

4. Why have I been chosen?

You have been invited to take part in this study because your company agreed to support this research project, and your team leader showed the interest to participate. Moreover, the reason for choosing you is that your position and responsibilities in organisation fit with the demand of this project.

5. Do I have to take part?

No, you do not. It is up to you to decide whether to take part. If you do decide to take part, you will be given this information sheet to keep (and then be asked to sign a consent form), and a small amount of payment will be given to you as a way of showing respect and appreciation, at the end of the research project field work.

Moreover, normally, you can still withdraw at any stage of the research project, and you do not need to give a reason; however, considering this qualitative study only has limited participants and focuses on team activities, one person withdrawing may cause irreversible negative influence on the research project. Therefore, it will be ideal if you do not withdraw after you sign up the informed consent. If you wish to withdraw from the research, please contact the organisational contact (i.e., Mrs. Chen, phone number: +86 15888547702, email address: 903729243@qq.com) or the lead researcher (i.e., Mr. Zhang, contact number: +86 15300731438, email address: jiachengzhang0301@163.com).

Please note that by choosing to participate in this research, this will not create a legally binding agreement, nor is it intended to create an employment relationship between you and the University of Sheffield.

6. What will happen to me if I take part? & What do I have to do?

Observation

Some of your team members will be observed by the researcher and audio recorded during a particular new product development project duration, specifically, your team meetings will be audio recorded, and the researcher will be there in the meeting room to take notes. Moreover, you might be shadowed by the researcher from time to time for observing your work (e.g., when you execute a task that was agreed in a team meeting). Your action will be kept as jots then transferred into field notes, and you may be asked to provide further details as to your thoughts and actions during the observation period.

Interview

You will be asked to attend an individual interview which will last around 1 hour, and happen at your workplace on a working day. Specific individual interview date and time will be later double confirmed with you.

Before the interview, you will receive an email to ask you to prepare a team scenario based on the examples, definition, and a measurement scale provided by the researcher within the email. You will be asked to reply to the email with a brief description (less than 250 words) of the team activity you prepared and present the reasons for choosing, and your rating results.

During the interview, the team activity that you pick will be discussed, you will be asked to talk about your thoughts, describe and explain your action, other members' action, and the communication among members (e.g., conversations), and the outcomes in detail.

Focus group

You will be asked to join a focus group, specific group interview date and time will be coordinated among members and double confirmed with you.

You will be asked to compare with each other's' experiences and opinions during the focus group because focus group aims to build team consensus about the sequence of events and collective responses.

Firstly, you will be asked to take turns to share your impression on a term. Secondly, you will be asked to discuss with each other to recall a most recent situation, share thoughts on motivations, traditional procedures. Thirdly, you will be asked to discuss with each other about team responses to the situation, sort out the sequence of events, compare opinions about outcomes. Fourthly, you will be asked to reflect on just-experienced the focus group to relate to your own work; and you will be given a summary of the discussion, you will be asked whether the summary is good enough to capture the key content.

7. Will I be recorded, and how will the recorded media be used?

Yes. The study will record using audio recording devices. The audio recordings will be used only for academic purposes and for data analysis. No other use will be made of them without your written permission, and no one outside the research project will be allowed access to the original recordings. All data gathered will be kept confidential and stored in a password-protected file on the shared drive of the University network. Moreover, the physical copies of the data will be kept

in a digital lock protected box at the researcher's house, the password will be only known by the research alone.

8. What are the possible disadvantages and risks of taking part?

Whilst there are no immediate disadvantages or risks associated with participating in the research project, it is possible that you may become aware that the ways that team activities may lead to negative outcomes under certain situations through this work.

9. What are the possible benefits of taking part?

Whilst there are no immediate benefits associated with participating in the research project, it is possible that via this work, you may become aware how team activities can lead to positive outcomes such as organisational learning or resulting in efficiency improvement.

10. Will my taking part in this project be kept confidential?

All the information that we collect about you during the research will be kept strictly confidential and will only be accessible to the researcher. You will not be able to be identified in any reports or publications. To assuage your concerns on this, you can ask the researcher to show you the transcripts before the analysis starts, to ensure there is no identifiable data involved.

11. What will happen to the data collected, and the results of the research project?

The results will be used to shape a wider research program as part of a PhD which is due for completion in September 2024. The data will be only used for data analysis purposes, and the

researcher will be the person who analyses it. You will be kept anonymous and not personally identified in the PhD thesis and any resulting journal publications or conference presentations. Moreover, due to the nature of this research, it is very likely that other researchers may find the data collected to be useful in answering future research questions. We will ask for your explicit consent for your anonymised data to be shared in this way.

12. Who is organising and funding the research?

This study is not funded by any organisations, the researcher is self-funded.

13. Who is the data controller?

The University of Sheffield will act as the Data Controller for this study. This means that the University is responsible for looking after your information and using it properly.

14. Who has ethically reviewed the project?

This project has been ethically approved via the ethics review procedure at the Institute of Work Psychology which forms part of the University of Sheffield Management School. The University's Research Ethics Committee monitors the application and delivery of the University's Ethics Review Procedure across the University.

15. What if something goes wrong and I wish to complain about the research or report a concern or incident?

If you wish to make a complaint, this should be done in the first instance to the HR section manager of the company, i.e., Mr. Li, contact number: +86 13916484954, who can also be reached via

dialling 220 from company internal line from 9am to 5pm. If the concerns or complaints cannot be solved satisfactorily, you can further escalate the complaint to the organisational contact, or you can directly contact the lead researcher. At the same time, you can also choose to contact the research ethics coordinator for this research project within the field organisation, they can be contacted on email at mgt.research@sheffield.ac.uk.

16. Contact for further information

Lead researcher

Name: Jiacheng Zhang

Email: jzhang246@sheffield.ac.uk

Contact number: +86 15300731438

First supervisor

Name: Dr. Kamaljit Birdi

Email: k.birdi@sheffield.ac.uk

Contact number: +44 114 222 3288

Second supervisor

Name: Dr Sarah Brooks

Email: s.brooks@sheffield.ac.uk

Contact number: +44 114 222 3218

Chinese translation（中文翻译）

参与者信息表

1. 研究项目名称

定性研究：团队成员实现团队目标的方式

2. 邀请您参与

我们邀请您参加这项研究。在您决定是否参与之前，了解这项研究的重要性是十分必要的，包括这项研究将涉及什么。请花时间仔细阅读以下信息，您可以与他人讨论。如果有任何不清楚的地方，或您想获取更多的信息，请询问研究负责人。请花些时间决定是否参与。首先谢谢您的阅读。

3. 此项研究的目的是什么？

本研究的目的是探索团队活动的微观过程，即单个的团队成员们如何一起实现团队目标。为了处理日常事务或应对意外情况，团队成员们常常需要一起来完成目标，诸如协调合作的工作方式会对组织学习或创新产生积极影响。理清团队成员如何通过不同方式实现目标因此十分重要，包括这些方式如何导出特定的结果，以及不同社会或文化因素是如何影响团队工作方式的。

为了回答上述研究问题，研究主题关注于团队活动的微观过程，具体指的是团队活动中不同过程之间的相互作用，如何有助于团队目标的实现。

因此，本研究需涉及团队活动十分细节的描述，观察法和采访作为数据收集方法也因此被包含在本研究中。

4. 为什么我被选中了？

您被邀请参与这次研究，是因为贵公司同意支持这个研究项目，选择您的原因是您在组织中的职位和职责与这个项目的需求相匹配。

5. 我必须参加吗？

是否参加由您决定。如果您决定参加，您将在之后被要求签署一份知情同意书。

通常来说，您可以在任何时间提出退出本研究，并且不需要给予任何理由，关于您的数据也会随之被删除。但是考虑到本项研究仅有较少的数位参与者，并且本研究主题是团队活动，所以团队中任意一人的退出，会对本研究造成负面影响。因此，我们希望您只可以在数据收集（即观察或采访）正式开始之前提出退出，希望您能理解。在签署知情同意之后，如果您想要退出本研究，请联系本研究的组织联络人，陈女士：15888547702，或本研究的研究员：张先生，联络电话为：15300731438。

请放心，您参与到这项研究中并不意味着您将签署任何具有法律效力的协议，也不会建立与英国谢菲尔德大学之间的任何雇佣关系。

6. 如果我参加，会发生什么？我必须做什么？

您或许不会涉及到所有的数据收集方法。

1. 在观察法中，研究人员将在现场观察您团队的讨论或会议，并且将录制音频，同时记录笔记。此外，研究人员会不时地随行您的工作（例如：当您去进行团队会议中商定的工作任务时），您的行动会被记录下来。您也可能会被问及您做事时的想法，原因和一些细节。
2. 在独立采访中，您将被要求参与一次个人采访，约持续一小时，具体日期与时间会提前与您联系并确认。在采访开始之前，您会被要求根据研究人员提供的相关案例，定义和量表，准备一个团队工作的场景。您会被要求回复这封邮件，并对您准备的团队活动进行简要描述（少于 250 字），并陈述选择原因，以及您根据量表的打分结果。在采访中，您选择的团队活动将被讨论，您将被要求谈论您的想法，描述和解释您在该团队活动中的行动，团队成员之间的沟通(例如：对话)，以及详细的结果。
3. 您将被要求参加一个焦点小组，具体的小组面试日期和时间将在成员之间协调，并与您再次确认。

   在焦点小组期间，您将被要求相互比较彼此的经验和意见，因为焦点小组旨在就事件的顺序和集体反应探索建立团队共识的过程。

   首先，您将被要求轮流分享您对某个概念的印象。其次，您将被要求与其他人互相讨论，回忆最近发生的一个团队活动情境，分享想法关于团队改变计划和工作常规

的想法。第三，您会被要求讨论团队成员们各自对情况的反应。第四，您将被要求反思刚刚经历过的焦点小组，并将其与您自己的工作联系起来；您在最后会得到一个总结，您会被问到这个总结是否捕捉到了本场讨论的关键内容。

（关于产生的数据如何被保护将在本信息表之后部分列出）

7. 我会被录下来吗？录下来的材料会被如何使用？

会的。本研究将使用音频记录设备（如录音设备）进行记录。本次研究期间您活动的音频记录将仅用于学术目的的数据分析。没有您的书面许可，我们不会使用它们，研究项目之外的任何人都不被允许访问原始录音或录像。所有收集到的数据将被保密，电子版的将存储在英国谢菲尔德大学的共享驱动器上，将有密码保护的所在文件，密码只会被本研究的研究员知晓。此外，数据的物理副本将保存于一个有数字锁进行保护的箱子中，密码也将只有研究员知晓。

8. 参与这项研究会有什么不利情况或风险？

本研究没有直接的不利或风险，通过这项工作，您或许可以意识到某些团队活动在特定情况下会导致负面结果。

9. 参与这项研究会有什么有利情况？

虽然参与研究项目并没有直接的有利情况，但通过这项工作，您可能会意识到团队活动可以带来积极的结果，如组织学习或提高效率。

10. 我参与这个研究项目产生的数据会保密吗？

研究过程中收集到的关于您的所有信息将严格保密，仅供研究人员查阅。您将无法在任何报告或出版物中被识别。为了减少您的担心，在数据收集后，您可以向研究人员要求检阅数据转录后的具体文件，来确保任何可以识别您的信息都被匿名化或删除了。

11. 收集到的数据和研究项目的结果会最后会怎么样？

数据将被用于研究项目的完成，会被作为 2024 年 9 月研究员博士学位项目的一部分。数据将仅仅被用于学术目的的研究，本项目的第一研究员将是分析它的人。如果研究项目的结果在任何类型的期刊或学术会议上展示，任何关于可以识别您的数据都将会被匿名化。另外，出于推动学术发展的目的，其他研究人员或许在未来会想要分析本研究收集到的数据，但是我们将会为此再来取得您的同意，没有您的书面同意，您的数据将不会被与本研究项目无关的研究人员获得。

12. 谁在组织和资助这项研究？

本研究不受任何组织或个人资助，研究人员是自费的。

13. 谁会是数据的控制者？

英国谢菲尔德大学将担任本研究的数据控制者的责任。这意味着英国谢菲尔德大学有责任好好照顾您的信息，并正确的使用它。

14. 谁在道德伦理上审查了这个研究项目？

该项目已经通过英国谢菲尔德大学管理学院下属的工作心理研究所的伦理审查程序，并获得道德伦理上的批准。英国谢菲尔德大学研究道德伦理委员会，负责监督整个大学内的研究道德伦理审查程序的申请和执行。

15. 如果有什么地方不对，我想投诉本研究或汇报情况，我该怎么办？

如果您想投诉，您首先应该联系公司的人力资源部门的李经理，联系电话：13916484954。如果您的诉求不能被满意解决，您可以联系本研究的组织负责人，陈女士，联络电话为：15888547702，或本研究项目的研究员：张先生，联络电话为：15300731438。同时，您也可以选择联系本研究项目的研究伦理协调员，他们可以通过该电子邮件联系：mgt.research@sheffield.ac.uk

16. 联系以获得更多信息：

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Appendix 3: Consent forms

How team members work together to achieve team goal

团队如何通过协作来实现团队目标

Consent form (Team meeting observation method)

知情同意表(观察法)

请在适当的方格中加上'是'或'否'	**Yes 是**	**No 否**
Taking Part in the Project 参与项目		
I have read and understood the project information sheet or the project has been fully explained to me. (If you will answer No to this question please do not proceed with this consent form until you are fully aware of what your participation in the project will mean.) 我已阅读并理解项目信息表或项目已向我充分解释。(如果你对这个问题的回答是"否"，请在你完全明白你参与这个项目的意义之前，不要继续填写这份同意书)。	☐	☐
I have been given the opportunity to ask questions about the project. 我有机会就这个研究项目进行提问。	☐	☐
I agree to take part in the project. I understand that taking part in the project will include being observed during team meetings in meeting rooms, and I will be asked to list things that I have done on behalf of the project with a rough date and time, on a weekly basis. 我同意参加这个项目。我知道参与这个项目将包括在在开团队会议时被观察。同时我会每周被要求列出我为实现团队目标做的事情，并标注大致的日期和时间。	☐	☐
I agree to take part in the project, and I agree to be audio-recorded. 我同意参加这个项目，并同意被录音。	☐	☐
I understand that by choosing to participate as a volunteer in this research, this does not create a legally binding agreement nor is it intended to create an employment relationship with the University of Sheffield. 我理解，选择作为志愿者参与这项研究，并不会产生具有法律约束力的协议，也不是为了与谢菲尔德大学建立雇佣关系。	☐	☐
I understand that my taking part is voluntary and that I can withdraw from the study at any time; I do not have to give any reasons for why I no longer want to take part and there will be no adverse consequences if I choose to withdraw. 我明白我的参与是自愿的，我可以在任何时候退出研究;我不需要给出我不想再参加的任何理由，如果我选择退出，也不会有不良后果。	☐	☐
I understand how to report my concerns and incidents to the designated safeguarding contacts (DSCs), and I know the lead researcher is one of my designated safeguarding contacts, and I can directly contact him regarding my concerns, and I know his contact information. 我明白如何向安全联络人去提出不满和担忧，汇报研究相关情况。我知道研究员是我的安全联络人，并且我知道他的联系方式，我可以就我的担忧直接联系他。	☐	☐
How my information will be used during and after the project 我的信息在项目期间和之后将被如何使用		
I understand my personal details such as name, phone number, address and email address etc. will not be revealed to people outside the project. 我明白我的个人资料，如姓名，电话号码，地址和电子邮件地址等，不会透露给研究项目以外的人。	☐	☐

I understand and agree that my words may be quoted in publications, reports, web pages, and other research outputs. I understand that I will not be named in these outputs unless I specifically request this. 我理解并同意我的话可能被引用在出版物、报告、网页和其他研究成果中。我理解，除非我特别要求，否则我不会在这些发表中被提到名字。	☐	☐
I understand and agree that other authorised researchers will have access to this data only if they agree to preserve the confidentiality of the information as requested in this form. 本人明白并同意，其他获授权的研究人员只有在同意按照本表格的要求对资料保密的情况下，才可查阅这些资料。	☐	☐
I understand and agree that other authorised researchers may use my data in publications, reports, web pages, and other research outputs, only if they agree to preserve the confidentiality of the information as requested in this form. 本人明白并同意，其他获授权的研究人员只有在同意按本表格要求对资料保密的情况下，方可在出版物、报告、网页及其他研究成果中使用本人的资料。	☐	☐
So that the information you provide can be used legally by the researchers 这样研究人员才可以合法使用您提供的信息		
I agree to assign the copyright I hold in any materials generated as part of this project to The University of Sheffield. 我同意将我参与者这场研究产生的材料的版权转让给英国谢菲尔德大学。	☐	☐

参与者姓名 Name of participant [printed]	签名 Signature	日期 Date
研究者姓名 Name of Researcher [张佳程 JiaCheng Zhang]	签名 Signature	日期 Date

项目联系方式:

如果您想投诉，您可以联系指定的安全联络人，报告任何问题或事件，他们是:周先生，联系 zhoujun1@shentong.com ，公司内部座机 222; 张先生，联系电话:15300731438,jzhang246@sheffield.ac.uk。你也可以和你的人力资源专家谈谈;他们会代表你通知安全联络人。您的投诉将通过安全保障安排得到解决(详请参与者信息表对第 15 项的回答)。

Project contact details for further information:

If you wish to make a complaint, you can contact the designated safeguarding contacts (DSCs) to report any concerns or incidents, they are: Mr. Zhou, contacted by zhoujun1@shentong.com, and company's internal landline 222; Mr. Zhang, contact by phone number: 15300731438, and jzhang246@sheffield.ac.uk. You can also speak to your HR specialists; they will notify the DSCs on your behalf. Your concerns will be resolved by following the safeguarding arrangements (See the answer for 15 at information sheet).

How team members work together to achieve team goal

团队如何通过协作来实现团队目标 Consent form

(Interview) 知情同意表 （面试法）

请在适当的方格中加上'是'或'否'	Yes 是	No 否
Taking Part in the Project 参与项目		
I have read and understood the project information sheet or the project has been fully explained to me. (If you will answer No to this question please do not proceed with this consent form until you are fully aware of what your participation in the project will mean.) 我已阅读并理解项目信息表或项目已向我充分解释。(如果你对这个问题的回答是"否"，请在你完全明白你参与这个项目的意义之前，不要继续填写这份同意书)。	☐	☐
I have been given the opportunity to ask questions about the project. 我有机会就这个研究项目进行提问。	☐	☐
I agree to take part in the project. I understand that taking part in the project will include individual interview. 我同意参加这个项目。我知道参与这个项目将包括个人采访。	☐	☐
I agree to take part in the project, and I agree to be audio-recorded. 我同意参加这个项目，并同意被录音。	☐	☐
I understand that by choosing to participate as a volunteer in this research, this does not create a legally binding agreement nor is it intended to create an employment relationship with the University of Sheffield. 我理解，选择作为志愿者参与这项研究，并不会产生具有法律约束力的协议，也不是为了与谢菲尔德大学建立雇佣关系。	☐	☐
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I understand how to report my concerns and incidents to the designated safeguarding contacts (DSCs), and I know the lead researcher is one of my designated safeguarding contacts, and I can directly contact him regarding my concerns, and I know his contact information. 我明白如何向安全联络人去提出不满和担忧，汇报研究相关情况。我知道研究员是我的安全联络人，并且我知道他的联系方式，我可以就我的担忧直接联系他。	☐	☐
How my information will be used during and after the project 我的信息在项目期间和之后将被如何使用		
I understand my personal details such as name, phone number, address and email address etc. will not be revealed to people outside the project. 我明白我的个人资料，如姓名，电话号码，地址和电子邮件地址等，不会透露给研究项目以外的人。	☐	☐
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So that the information you provide can be used legally by the researchers 这样研究人员才可以合法使用您提供的信息		
I agree to assign the copyright I hold in any materials generated as part of this project to The University of Sheffield. 我同意将我参与者这场研究产生的材料的版权转让给英国谢菲尔德大学。	☐	☐

参与者姓名 Name of participant [printed]	签名 Signature	日期 Date
研究者姓名 Name of Researcher [张佳程 JiaCheng Zhang]	签名 Signature	日期 Date

项目联系方式:

如果您想投诉，您可以联系指定的安全联络人，报告任何问题或事件，他们是:周先生，联系 zhoujun1@shentong.com ，公司内部座机 222; 张先生，联系电话:15300731438,jzhang246@sheffield.ac.uk。你也可以和你的人力资源专家谈谈;他们会代表你通知安全联络人。您的投诉将通过安全保障安排得到解决(详请参与者信息表对第 15 项的回答)。

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How team members work together to achieve team goal

团队如何通过协作来实现团队目标

Consent form (Focus group) 知情同意表（焦点小组）

请在适当的方格中加上'是'或'否'	Yes 是	No 否
Taking Part in the Project 参与项目		
I have read and understood the project information sheet or the project has been fully explained to me. (If you will answer No to this question please do not proceed with this consent form until you are fully aware of what your participation in the project will mean.) 我已阅读并理解项目信息表或项目已向我充分解释。(如果你对这个问题的回答是"否"，请在你完全明白你参与这个项目的意义之前，不要继续填写这份同意书)。	☐	☐
I have been given the opportunity to ask questions about the project. 我有机会就这个研究项目进行提问。	☐	☐
I agree to take part in the project. I understand that taking part in the project will include focus group. 我同意参加这个项目。我知道参与这个项目将包括焦点小组，即：集体采访。	☐	☐
I agree to take part in the project, and I agree to be audio-recorded. 我同意参加这个项目，并同意被录音。	☐	☐
I understand that by choosing to participate as a volunteer in this research, this does not create a legally binding agreement nor is it intended to create an employment relationship with the University of Sheffield. 我理解，选择作为志愿者参与这项研究，并不会产生具有法律约束力的协议，也不是为了与谢菲尔德大学建立雇佣关系。	☐	☐
I understand that my taking part is voluntary and that I can withdraw from the study at any time; I do not have to give any reasons for why I no longer want to take part and there will be no adverse consequences if I choose to withdraw. 我明白我的参与是自愿的，我可以在任何时候退出研究;我不需要给出我不想再参加的任何理由，如果我选择退出，也不会有不良后果。	☐	☐
I understand how to report my concerns and incidents to the designated safeguarding contacts (DSCs), and I know the lead researcher is one of my designated safeguarding contacts, and I can directly contact him regarding my concerns, and I know his contact information. 我明白如何向安全联络人去提出不满和担忧，汇报研究相关情况。我知道研究员是我的安全联络人，并且我知道他的联系方式，我可以就我的担忧直接联系他。	☐	☐
How my information will be used during and after the project 我的信息在项目期间和之后将被如何使用		
I understand my personal details such as name, phone number, address and email address etc. will not be revealed to people outside the project. 我明白我的个人资料，如姓名，电话号码，地址和电子邮件地址等，不会透露给研究项目以外的人。	☐	☐
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I understand and agree that other authorised researchers may use my data in publications, reports, web pages, and other research outputs, only if they agree to preserve the confidentiality of the information as requested in this form. 本人明白并同意，其他获授权的研究人员只有在同意按本表格要求对资料保密的情况下，方可在出版物、报告、网页及其他研究成果中使用本人的资料。	☐	☐
So that the information you provide can be used legally by the researchers 这样研究人员才可以合法使用您提供的信息		
I agree to assign the copyright I hold in any materials generated as part of this project to The University of Sheffield. 我同意将我参与者这场研究产生的材料的版权转让给英国谢菲尔德大学。	☐	☐

参与者姓名 Name of participant [printed]	签名 Signature	日期 Date
研究者姓名 Name of Researcher [张佳程 JiaCheng Zhang]	签名 Signature	日期 Date

项目联系方式:

如果您想投诉，您可以联系指定的安全联络人，报告任何问题或事件，他们是:周先生，联系 zhoujun1@shentong.com ，公司内部座机 222; 张先生，联系电话:15300731438,jzhang246@sheffield.ac.uk。你也可以和你的人力资源专家谈谈;他们会代表你通知安全联络人。您的投诉将通过安全保障安排得到解决(详请参与者信息表对第 15 项的回答)。

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Appendix 4: Interview schedule

Date of interview	Team	Participants	Duration(hour)
July/2022			
1		A (processing manager)	1
1	Product engineering	B (testing supervisor)	1
2		C (lead designer)	1
3		D (project director)	1
July/2022			
21		C (lead designer)	1
22	Drawing design	E (design supervisor)	1
23		F (drawing designer)	1
24		G (designer)	1
25		H (junior designer)	1
August/2022			
4		I (design manager)	1
4	Sample production	J (design supervisor)	1
5	and testing	K (senior designer)	1
5		L (project manager)	1
August/2022			
18		M (processing manager)	1
19	Mould	N (CNC milling operator)	1
20	manufacturing	O (Cutting operator)	1
21		P (edM)	1
22		Q (engraving machine	1
22		operator)	1
		R (polish operator)	
July/2022			
9		S (configuration operator 1)	1
10	Mould assembly and	T (project supervisor)	1
12	testing	U (configuration operator 2)	1
12		V (assembler)	1

Appendix 5: Full description of team improvisation examples (Study 1)

(See Example 1 and 2 in the thesis in 4.5.1)

Example 3

Ryan's team was once responsible for mass manufacturing a buckle product; members found that the surface of a buckle product had de-carbonisation and that there was severe oxidation. De-carbonisation refers to the phenomenon of reducing the carbon content of steel. According to the heat treatment procedure of metal products, the team needed to refine the heat treatment procedure and conduct experiments of the heat treatment. However, as the team was specialised in mass production, members were not confident in refining heat treatment (such refining usually takes place during mould trial, which is the product adjusting or design team in upstream). Following the procedure s that Ryan's team had to return the project to upstream teams which would negatively affect the team performance. Also, the team believed that optimising the heat treatment was not a good option during mass production period at that time because the delivery date was approaching, and the local epidemic was aggravated which was likely to result in a few days lockdown. After an internal team discussion (where a range of possible solutions were discussed, such as epoxy powder for spraying), the team decided to improvise a protecting system to deal with overheating. Consequently, the team made a screw thread-shaped heat protector to prevent the heat from harming the product. As a result, the team solved the oxidation problem on the same day and shipped the product the next day. However, it needs to point out that, although the team learned a new method of coping metal oxidation and the method allowed the team to finish the day's job, the method was informal and likely to limit to a very small range of similar products, the team could have lost an opportunity for improving their knowledge on heat treatment in a more formal and systematic way which might be more useful for the team to solve metal oxidation.

Example 4

Peter's team was mass producing a pipe fitting product (fuel tank intake pipe). When the main feed port of the injection moulding machine was blocked, the team first carried out several steps in accordance with the feed bucket cleaning process, but found that the blockage of the feed port was very serious (this was due to the machine working for a long time with high intensity, resulting in excessive feeding pressure) and could not complete the standard cleaning process in a short time. Given that production had to go on (the production had already been delayed by a previous breakdown of the machine), in order to unblock the feeding port quickly, the team improvised to build a diverter pipe that would allow the flow of plastic to bypass the main port – basically, this t building a temporary feeding system to share the excessive pressure. After collecting the necessary materials from the warehouse scrap area, the team connected temporary pipes to the main feeding port to share the pressure. However, the team soon realised that the flow rate in the diverter pipe was too high (which would cause injection moulding to overflow), so a manual valve was further installed, and a team member was assigned to manually adjust the flow rate in real time. Although the diverter pipe would have an immediate effect on alleviating the blockage, it should be noted that the source of the blockage (i.e., feeding bucket and port) was still not solved, so the diverter pipe would slowly become clogged over time. In this way, the team successfully completed the production task of the day before the diverter pipe was blocked, and it was removed when the day's production target was completed. However, the feeding bucket and port still needed a proper cleaning, the cleaning task was left to the night-shift team. The team improvisation of making a diverter pipe was likely to interfere the other team's work, because the night-shift team had to take additional time (about 1-2 hours) to clean up.

Example 5

Eric was a manager of a project for manufacturing a mould for a product, an arc core-pulling joint – a small part of the car chassis transmission system. The team was conducting mould trial (mould trial was a step before mass production to test the function of the mould), and found that the mould could not run after being put into the injection moulding machine, so the team improvised to disassemble the mould on the spot (mould disassembly needed to be in the repair zone), and investigated the mould connection structure (such as connecting rod and slider) which was most likely to have problems based on past experience (at this time, the team still followed the mould structure problem troubleshooting procedure). Eventually, the team members discovered that the structure of the two gears was preventing the mould from running. The team members called a mould designer for advice, but the designer did not respond. According to the mould trial procedure, the team needed to report possible changes needed in the drawings to the upstream mould design team, and then entered the mould manufacturing stage to re-manufacture the gears. However, after on-site observation and analysis of the gear structure, the team members found that the mechanical structure only needed one gear, 'this is easy, only takes a few minutes to be done' (Example 5); the team then talked about applicability of the manufacturing procedure, improvised to consider the procedure was optional, rather compulsory. Then, the team members improvised to weld two gears together. This improvisation enabled the mould trial to be completed, and after the mould was proved to run smoothly, it was successfully delivered to the client. However, the participant mentioned that a few months later, the client called to say that the mould was not running smoothly, and the client's engineers could not find what was wrong, so the client asked Eric's team for help (as a favour). This shows that the improvisation of Eric's team was not successful in the long run technically but seems to increase the importance of Eric's team as they are the only people who know how to solve the mould problem. This makes me wonder whether it is possible for team members to deliberately

enhance their irreplaceability through improvisation, to improve their job security in the context of company downsizing.

Example 6

Paul's team was responsible for the production of all small size (plastic) products. Once, the team leader, Paul, was reported by his members that the size of the connector products (a round connector for air conditioning conduits) was incorrectly sized. Team members found wear and loosening of parts inside the mould through visual observation, and thought it was a small problem that could be repaired soon, so immediately after the discovery, the team improvised to do welding work within production zone (this was not allowed, all repairing should be reported and operated in repair zone), but the effect was not good. The team then sent the mould to the repair centre, but the repair staff informed the team that the mould would have to be scrapped because the mould was irreparable. This was because the team's previous welding work had damaged the mould for a 3D imaging which made re-making the mould components impossible. The team searched for the original 3D data of the mould, but it was lost due to software updating some years previously. As a result, the team improvised. Without a full disinfection as required by the regulation for factory disinfection – a regulation established according to Zero-COVID policy, the mould was taken back to the factory and was completely dismantled in the production zone. The team improvised to create a fastening device with steel sticks as supporting levers to weld the mould components together, the mould was repaired, and put back to the injection moulding machine. The team thus successfully met the delivery deadline. The participant mentioned that the same spot of the mould was broken again a few days later, and the team used the same method to repair it again. Therefore, although the team could stumble through the production with the improvisation of making the fasten device repeatedly, the mould was never properly repaired to a decent shape which could make future production in risk because

the mould could get to a point where it could not be repaired with improvisation, the production schedule could be significantly affected since re-making a mould often takes weeks.

Example 7

Andrew's team was required to conduct accuracy measurements on a wheel control joint product, and the team improvised to use the vernier calliper for all components of the product because the members believed the vernier calliper was effective to use because the mobile clamp allowed people to measure any part of the product from any angle, and the vernier calliper was small and easy to carry, members could use it to obtain measurement data from different angles to gather a more comprehensive data regarding sample size. With a quick conversation about how effective the idea (i.e., using only one calliper), the team put the idea into actions. However, the company stipulated that different component needed a specific tool for measurement. The respondent's explanation for the team's improvisation was that 'there was a contradiction between following the measurement procedure and the amount of work we were given' (Example 7). It indicated that another reason for improvisation could be timesaving, the members could save time by not changing tools during measurements, since some required measurement tools might not be put in the correct place which could take time to find. The team thus got into the habit of using only the vernier calliper in work. In this example, a product engineer from another team bumped into the team working site, and noticed the team was not following the measurement procedure, so the product engineer reported to the top management, the latter confirmed what was reported via checking the work surveillance; Andrew's team had to re-do all the work in off-duty time without overtime pay. For the team, the existence of the team improvisation could be considered as positive because the members could finish the job faster while maintaining a moderate degree of the reliability of the measurement results since the members were skillful

workers. However, such a team improvisation in this example can lead to instability in the accuracy of measurement results, when a member was less experienced, or the members came across with a new product they never measured before.

Example 8

Jack's team was responsible for assembly management, the team was once instructed by the top management to improve a product's (multi-ring dimensional chains) assembly process because the delivery of the product was negatively affected by slow assembly. Jack's team asked advice from an employee who had previously worked in assembly about the ideas of improving assembly effectiveness and asked the HR department whether the team could get additional manpower as support. As a result, the team came up with an idea – speed up the assembly process by changing the assembly method. During a small-scale test of the assembly method, the team spotted one assembler working faster than others. After a quick conversation about the idea of promoting the assembler to trainer and take supervisory responsibility, the team then improvised to appoint the assembler to train others, and then promoted the assembler to a supervisory role. The decision to make the assembler a trainer deviated from the assembly procedure and promoting the assembler to a supervisory role deviated from personnel management regulations. The team believed that the assembly process would be improved as a result of such an improvisation. However, there is a negative outcome caused by this improvisation: the HR department's work was disturbed because the improvised promotion was not a decision made through the organisation's promotion procedure. The HR department needed to explain to the top management the necessity of the improvisation of Jack's team and request exceptional management to implement the assembler's promotion.

Example 9

Oscar's team was responsible for the products that needed to be cut (usually metal pipe products), a certain amount of production (i.e., cutting task) would be assigned to the team every day. The members managed five cutting machines and were also responsible for the maintenance of the cutting machines' operation. The team members once noted that one cutting machine positioning reference may not be consistent with the standard, and members observed a certain degree of tilt through the naked eye. In this example, the team can choose to follow the procedures: call the resident machinist or stop the operation of the machine, and report to the factory director. However, the team decided to take matters into their own hands on the spot and immediately analysed the machine's operating status (this was identified as improvisation). After discussing and verifying a series of possible causes of spindle tilt, the team members believed that the environmental temperature should be the main cause. At this time, the team should stop the operation of the machine and report the issue to the factory director; but considering that the deformation of the product was not serious, and it was close to the team's off-duty time, the team decided to let the cutting machine continue to run and informed the night-shift team to pay attention to the tilt. By improvising, the team avoided extra work for their team, members could leave work on time, but the night-shift team had to adjust the positioning to the standard.

Example 10

Miles' team was a team of resident machinists – a firefighting-type job. Usually, the team was on-call based, and responsible for overall machine breakdowns, and mould related problems. The team would also be assigned to follow "priority" projects as a way of special support. The team was once called by another team to help solve a product-related problem. When Miles's team arrived on the scene, the other team left the scene because they rushed to deal with a more urgent situation in another project (a team often handled multiple projects at the same time in the Avatar Group). Miles's team observed honeycomb-shaped holes

appearing inside a pipe product, the team should stop the machine to prevent more defective products being produced. However, the team improvised on the spot to change the percentage of nylon because they suspected that the holes were caused by raw materials. Moreover, when the team noticed the change of nylon percentage did not make a difference, the team improvised to call a consultant from outside the company (which was not allowed). When the consultant (the consultant worked for other auto-parts manufacturers) arrived, along with the two experienced members of the team, they improvised to conduct an on-site dismantling of the mould with the team members (which was not allowed, all repair work should not be conducted in the production zone). After a comprehensive dismantling of the mould, the team found that the holes were caused by uneven injection moulding caused by incomplete assembly of components in the mould, so the team replaced the defective components on site (usually there are multiple replicas of one mould component) and re-installed the mould into the injection moulding machine. As a result, the team successfully ensured the normal production of the product; however, an outside consultant could cause unknown risk for the organisation, because the consultant was informally invited, important technical information could be leaked by letting an expert from a competitor observes the fully dismantling of the mould.

Example 11

Dean's team was responsible for transferring 3D mould drawing into 2D engineering drawing. After a drawing conversion was completed, Dean gave the 2D drawing to another team member (who used to be a member of the internal drawing review team) for double confirming. While discussing the appropriateness of the drawing transfer, the two members found that a code in the modelling of the original 3D drawing could not be understood and could not be run after 2D conversion. The two then improvised to email the code to a friend who was a mould designer on another team to help solve the computer modelling problem

and made a phone call at the same time to this friend and asked him to solve it within an hour. The team members should follow the mould design procedure and send the code back to the original design team, but it would take about two days to get a reply, which Dean's team could not accept, because the subsequent manufacturing team had already urged the team for the drawings. After solving the code modelling problem, the team improvised to skip the internal drawing review process and sent the drawings directly to the manufacturing team. This may be because a member on Dean's team used to be a member of the internal drawing review team, whose expertise was believed to be sufficient to ensure the validity of the drawing transfer, Dean's team thus felt that another review process was unnecessary. However, when the manufacturing team noticed there was no signature from the internal reviewing team on the record sheet (when two teams deliver a project task, the upstream team needs to sign the names of the specific person responsible for the steps on the record sheet). So, since Dean's team had delivered the record sheet and the manufacturing team had already started the manufacturing, the manufacturing team had to request an additional internal review on the drawing for formality purposes (this request would be randomly assigned to a mould design team). As a result, Dean's improvisation eventually resulted in trouble for the downstream team.

Example 12

Wesley's team was a sales team specialised in truck's parts; members were also responsible for providing after-sales service. The team will usually respond directly to a client if the client was asking for general information (such as quotation, delivery date), the team needed to contact the relevant R&D team if the client was asking product quality related questions. The team once received feedback from a client complaining about the wear limit of a brake pad product. Although the normal response time for a complaint was eight to twelve days, Wesley's team urged the R&D team to run some tests as soon as possible by

making phone calls and sending texts. As the R&D team did not respond to Wesley's team on the same day, the team improvised to go over heads of the R&D team to propose metallographic testing requirements for the product to the quality inspection department (such testing requirements should be proposed by a R&D team). The quality control team informed the corresponding R&D team to sign off on test requirements. As a result, Wesley's team received the testing results and got back to the client quicker than usual, however, the R&D team's work was interrupted to a degree. In a longer term, client satisfaction with the Avatar Group may be negatively affected, as clients may not be satisfied with the feedback they received if the sales team often improvised to make technical judgments over the R&D teams regarding product quality.

Example 13

Tanner's team was a logistic team in the factory, responsible for the transportation of goods within the company, loading and unloading goods, and needed to communicate with the freight drivers about the delivery time. The team's goal was to ensure the normal shipment and keep the warehouse in a good capacity of storing goods. Due to COVID restrictions, team members decided to ship as many goods as possible to ease over-stacking in the warehouse, because they had heard a rumour that positive COVID people detected had been identified nearby, resulting in '72 hours of silence'. This '72 hours of silence' was a feature of the Zero-COVID policy China in 2022, designed to reduce the number of positive COVID people by limiting the movement of people, including a ban on cargo shipping. The team improvised to use every forklift and truck available and then members decided to temporarily gather front-line workers (who might not have a forklift operator licence) at lunch break to use a smaller trolley with chopped wood plates to transfer goods. As a result, the team managed to move cargo that had been piled up due to previous travel restrictions imposed by the Zero-Covid policy, but the production activity was negatively influenced

because such a rushing transportation process involving front-line operators lasted around two hours, which took up some time (roughly 30 minutes) for production. Besides, a few front-line workers did not have a forklift operator licence operated the forklifts which caused a degree of risk for factory safety (luckily, no one was injured).

Example 14

A team from the production scheduling office once replaced the production of a hub with an axle with one day's notice. Usually, according to 'Regulation of production arrangement in production workshop', the change of production schedule should have a three-day's notice period. The participant shared how the team interpreted the regulation by stressing the key to the regulation was maintaining the production order, meaning what the team did – shortening the notice period did not result in disorder of overall production. The team improvised to shorten the notice period from three days to one day in response to a request from an important client. The team then went back to the procedure of making rearrangements three days in advance, as the urgent problem had been solved. Although the team's actions still keep the overall production schedule moving forward, such improvisation may be positive at the organisational level, given that important client's requirement was met, but the project team which responsible for producing a hub with an axle had to face sudden time pressure, which could be negative for the well-being of the team members because they would have to work a lot of overtime to meet the delivery time, as well as the front-line operators who involved in the project.

Example 15

Ford's team was a marketing team for interior products, responsible for developing new clients, so the team often went to various trade fair with the newest products and demonstrating the latest technology. In a trade fair of automotive interior accessories, a potential major client unexpectedly asked Ford's team about a new type of sewing process

regarding the Avatar Group's current interior leather products. The client did not confirm or disagree with the team's answer, the team thought the client was not satisfied. So, the team improvised to talk about a sewing technology (this technology was still unstable and under developing) to please the client. When the team obtained the client's recognition, an intention contract was signed for a large order (such contract did not include liquidated damages and was usually signed by the most senior manager at the site of the conference). Then, the team asked the R&D team to add this special technology to the development of the current interior leather product. It should be noted that, it was usually the R&D team that gave lectures to the marketing team members to help them grasp the new technical characteristics to promote products, not the other way around. In order to get the R&D team to agree, the marketing team continued to improvise, the team reported to the top management (including the signing of the intention contract and a market report), suggesting that the R&D team should speed up the commissioning of the new sewing technology. At the same time, the team was also secretly giving gifts (cigarettes, alcohol) to ask favours from the R&D team. As a result, the top management said yes to the team's request, and R&D agreed to help. Several months later, a formal supply contract was signed for two years.

Example 16

Shepherd's team was an apprentice's team. The team was assigned welding work as training, members should follow the welding procedure to operate for mould repair. Team members have done about three hours of non-stop repetitive work, they felt bored: 'We were already like machines… we didn't know what we were doing, didn't know why' (Example 16). It was approaching 5.30pm (the time for off-work), a new batch of broken moulds were just-arrived, asked for an urgent welding, the team improvised to try different ways of welding, such as leaving the corners of a liner area as the last spot to weld (when it was a liner area, corners should be the first spot to weld, according to the welding procedure).

However, during the team's welding work, a machinist – the person who delivered the batch of the broken moulds (he should be the person who was responsible for the moulds) corrected the team's welding sequence after a quarrel. The team's improvisation might make the welding work less boring, however, the quality of the team members' welding work would decrease (i.e., the quality of the welding).

Example 17

A welding team (Shepherd's team) always found that the use of a welding protection mask hindered welding work as one hand was needed to hold the mask. A few weeks ago, the company issued a batch of headgear masks, but did not equip Shepherd's team, because the team was still in an apprenticeship and needed to be certified in two months before they can be treated as regular employees. Considering the workload of the team, when heard the team would not receive the headgear masks, Shepherd's team self-made a rubber-covered steel shelf and welded it inside the welding mask. Welders could use their teeth to bite on the shelf when they needed to use both hands to work. As a result, Shepherd' team could free their hands to do the welding work which would speed up the welding and possibly better welding quality (e.g., the members would have their both hands to keep a mould steady). However, it might be bad for the members' teeth and jaw since they needed to bite on the shelf to hold the welding mask.

Example 18

Mike's team was a team specialised in blade improvement, worked in the technology department. The team once wanted to test out different steel materials for refining a blade for a weeding machine. Given the team needed to test the metal performance of more than a dozen different steel materials (such as hardness, wear resistance, rust prevention), the tested outcomes needed to be registered at the testing centre and recorded at the quality control department. Mike's team needed the testing certificates to complete their job. According to

the testing submission procedure, each test can only contain one object with only one testing purpose; the team thus needed to make at least two dozen requests of testing. Although the testing centre followed a first-come-first-served order, when a team submitted more than ten requests at once, the testing centre would delay them and prioritise those that required less time. Mike's team thought it was likely that their requests would be delayed since their project was a regular one (not a 'priority' project). Therefore, after a quick conversation about how well the procedure was being followed within the company – it was common that members asked each other to submit testing request on each other's behalf, Mike's team then improvised to ask an employee from another team for help, asking him to submit the testing requests of Mike's team on his behalf, and Mike also asked the staff of the testing centre for favour (by giving gifts, such as cigarettes and fruits) to priorities the team's requests. To ask for favours, the team bought some gifts such as fruits and snacks, giving to the people the team asked help for. As a result, Mike' team successfully completed the testing within two days. However, the team's improvisation reflected a fact that many employees did not take the testing submission procedure seriously. Team members' favour asking on the basis of personal relationships could easily bypass the procedure which was designed to keep an order in submitting testing requests; such team improvisation would result in chaos since the employees tend to find ways to bypass company procedures to speed up their own teams' projects.

Example 19

Carl's team once faced a situation when an injection moulding machine made an explosive sound. By following the machine inspection procedure, the team could not find what caused the abnormal sound, so the team improvised to record a video and send it to an employee from the technology department (according to regulation on project teams, teams were not allowed to bring other employees to their projects). With their help, the team

diagnosed the abnormal sound as being caused by an obstructed air exhaust. Instead of following mould repair procedure to replace the relevant mould parts, the team discussed on the site then decided to improvise a grip handle, to ensure the production catches up with the schedule. By connecting a steel tube and a pothook, the team made a grip handle to the operating mould, so an operator could use the handle to pull out a piece of the mould to let the air out when the explosive sound occurred. The grip handle's capacity to bear was pre-tested before attaching to the mould. The grip handle existed for several weeks until the company launched a rectification movement about working site safety, the team removed the grip handle for a few days until the inspectors finished their job, then put the handle back to the mould.

Example 20

Nick's team was responsible for handling company documents/contracts in the gardening equipment division, the members worked in the HR department because the majority of the team's work was to handle employees' entry/exit contracts and documents and labour litigation. The top management once required the Nick's team to negotiate the shipping costs with a freight company as the contract renewal date was approaching. However, the team was aware that the freight company had suffered from COVID restrictions, and that any negotiations on price reduction would be highly unlikely to be successful. The team thought: 'we could put more products in each box to reduce shipping costs because they [the freight company] charged on box numbers' (Example 20). As a result, the team did not try to negotiate prices but improvised to change how products were packed.

Example 21

Bob's team was responsible for blade product packaging, such as daily product packaging, packaging design and packaging plan improvement. The team was once tasked with improving the de-plasticised packaging solution for domestic (Chinese) goods. De-

plasticised packaging was originally only a packaging requirement for products exported to Japan, because Japan requires inbound goods not to have any plastic packaging. Avatar Group wanted to implement the de-plasticisation standard for the packaging of the whole production line, in order to cope with the increasing environmental protection requirements in China, and also facilitate the collective packaging of goods within the company. After receiving the task of de-plasticising from the top management, Bob's team began looking for alternative materials, such as wood pulp. In terms of the final encapsulation, the team used a combination of wooden stickers and wooden packing belts. However, in the packaging of a batch of metal buckle products, the team found that such packaging was not waterproof enough since the batch was delivered to Yaan, Sichuan province – a city famous for its constant rain. So, the team improvised to use plastic tape as the waterproof layer inside the packaging box, which was deviated from the de-plasticisation procedure, the team thought it would not be noticed. The team's explanation for the improvisation was: '… domestic (Chinese) clients themselves do not require de-plasticisation … and the government does not require 100 percent plasticisation … reaching a 90 percent de-plasticisation is already a high standard' (Example 21). However, this practice was found by the quality inspector in the final inspection before shipment, and the team improvised to adopt the wooden sealing solution (wooden sealing box is usually a packaging standard for international shipping) to replace it – directly put the packaged product box into a large wooden box. It was necessary to mention that the team bought two packs of cigarettes to the quality inspector afterwards. As a result, the team did not receive any punishment from the top management. However, it should be note that, although the team improvisation of using a large wooden box as water-proof method solved the problem (i.e., the improvisation meets the demand of de-plasticising and waterproof packaging), this method would result in increased packaging costs for the company if the team kept use it for a permeant solution.

Appendix 6: The rest of analysis of how the microprocesses of team improvisation are affected by the influences (Study 1)

Theme C Asking for help from outside teams as influenced by Theme 1 Location distance

Due to the physical location between team members, the team members were often insufficiently knowledgeable to solve an emergency, so team members might have to ask people (who were outside the team) on the scene for help face-to-face. For example, Peter's team asked two machine operators to help install the diverter pipe when there was a blockage of the feeding port, and the injection moulding engineer was unavailable: 'We asked two operators face to face, they were just next to us … to hold and adjust it [the diverter pipe] … to match the size of the feeding port because he [the injection moulding engineer] was not here' (Example 6).

Theme C Asking for help from outside teams as influenced by Theme 2 Power

Firstly, due to rank power, a senior manager on Ford's team, in order to please the client, the senior manager promised the client that a new technology would be used in an interior product. With the support of this manager, Ford's team asked the R&D team for help by directly giving order to speed up the development of the new technology.

> 'At that time, he [the senior manager on Ford's team] asked me to call the R&D people, and said that the new sewing technology must be put on, I was a little hesitant, but he [the senior manager] asked me to tell the R&D people, just say that was an order from him' (Example 15; Ford reported).

Secondly, team leaders could ask help from employees in lower ranks to bypass rules by offering incentives. For example, the leader, Paul (Example 6) asked an employee in the

repair centre to help remove the mould without disinfection as was required by COVID restrictions and proposed the employee could ask for a favour from him next time.

> 'I'm sure he [the employee in the repair centre] listens to me … I said you can call me if you need something next time … I have been with the company for many years, and I'm managing the whole small-scale product line … In fact, I don't have to go personally; just make a phone call [will be enough]' (Example 6).

Thirdly, due to seniority, team members would ask help from an expert who was outside the company, to seek advice. For example, when the pipe products showed discolouration and honey-shaped holes inside the pipes, Miles' team suggested Miles call his teacher (who was an expert and not a member of the company) for help: 'The reason they [other members] wanted me to contact my teacher was he [Miles' teacher] was an expert in pipe forming, well known in our area' (Example 10).

Theme C Asking for help from outside teams as influenced by Theme 3 Worry

Firstly, although teams are supposed to contact other teams through formal channels, teams use informal ways to reach out to other teams for help when they felt worried about falling behind other teams. For example, one sales team received feedback from a client complaining about the wear limit of a brake pad product (Example 12). Although the normal response time for a complaint was eight to twelve days, Wesley's team urged the R&D team to run some tests as soon as possible by making phone calls and sending texts (Example 12). This was done because the sales team wanted to respond to the client more quickly, and the team members felt that time was slipping away and that they would be behind other sales teams, which would negatively affect performance.

> '… we basically needed to reply to the client within three days to be considered as fast, two days … we almost checked on them [the R&D members] twice a day. If we

> don't keep reminding them [the R&D members], we will be forgotten … time will pass without you noticing … urging them [the R&D members] was the only thing we could do … we don't want to be the last [of all sales teams]' (Example 12).

Secondly, teams also asked for help to bring insights to solve problems when they felt worried about falling behind other teams. In Example 19, a video about a machine making abnormal sounds was recorded and sent to the technology department. The team sent the video to the technology department through WeChat because it took too long to make use of the formal reporting route (Example 19). The team did not want to fall behind the production schedule, which may put the team in a backward place compared with other teams: 'There are only a few of us, we've been watching for half an hour … we'll delay the production schedule, and others will overtake us' (Example 19).

Thirdly, teams improvised to avoid the risk of being punished in the future by directly walking to helpers' (who were outside the teams) offices for help. One participant (Example 10) said outsiders were more willing to help as they did not worry about potential punishment. Thus, their advice would be more objective.

> 'Why do people want to be involved with your project when there is a risk of being punished? … outsiders, who don't have to worry about the risk … they [the outside helpers] are out of the company's control … they [the outsider helpers] give honest advice' (Example 10).

Jack's team (Example 8) offered another example. When Jack's team looked for a new assembly method, the team asked advice from the office equipment office and the HR department because Jack considered the team members may not be willing to speak individually due to possible liability.

> ‘This is the reason why I don’t want to ask team members … usually, you are going to do what you proposed, or at least be responsible for it [your proposal] … but what if the idea turns out wrong, which means they [the top management] will know it … you’re going to be jointly liable … be blamed … I understand this [member not speaking up]. If I was a member, I’d keep my mouth shut so I wouldn’t get into trouble … so I asked people outside the team’ (Example 8).

Theme C Asking for help from outside teams as influenced by Theme 5 Team climate

Firstly, members positive attitude toward successful improvisation made they more willing to help when they were asked for help by others to deviate from a particular procedure, which contributed to the widespread microprocess of different methods for reaching out to helpers because people always received the help: ‘different project teams discussing all the time, helping each other … very normal’ (Example 13). Besides, the positive attitude towards improvisation could be understood as a foundation for the occurrences of improvisation. In Example 18, Mike’s team wanted to shorten the time for obtaining a testing certificate since when the team made over two dozen testing requests, the testing would be delayed due to the testing submission procedure. So, the team improvised to ask other teams to submit testing requests on Mike’s team’s behalf which was a way of bypassing the rule. Such team improvisation occurred because all teams generally accepted it, and many of them were doing the same.

> ‘Submitting [testing requests] on behalf of each other is actually quite common … it does not involve any product quality problems, after all, every team has its peak and valley time of submission testing … [By submitting the requests on each other’s behalf] the peaks and valleys are balanced out’ (Example 18).

It seems Mike's team did not offer any incentive to the other team to bypass the rule of testing submission procedure, however, the incentive could be implicit because the other team assumed Mike's team would do the same (i.e., submit testing request on their behalf) for them in the future.

Theme D Arguing and verifying to construct solutions as influenced by Theme 2 Power

People with positional power (leaders) usually step in when members are trying to come up with an idea (after members have found the cause of a problem). As the leaders' preferences would dominate the team idea generation, the 'arguing' was less intensive, and a team would quickly reach an agreement without much idea verification. For example, Paul, as a leader, took the member's (the machinist) ideas as a suggestion, since Paul knew it was his call to decide what to do. Consequently, there was not a particularly intensive discussion with regard to deciding to make a fastening device to keep a tube-shaped mould component in place (Example 6).

> 'It [the discussion] was just for a few minutes. He [the machinist] said what the problem was, then a few words about how to make the device, and I elaborated on his ideas … it was more like you said one thing, then I add to it … there was nothing to disagree with…' (Example 6; reported by a leader).

The discussion with regard to generating the idea was carried out in a relative turn-taking way between the leader and the team member because the team member would agree and build on the leader's idea. The members tended to be restrained, which calmed the discussion. Reflecting on Paul's team, the machinist on Paul's team may have tended to agree with whatever Paul suggested due to the influence of rank power and deliberately chose to develop Paul's idea (Example 6). This was because the machinist knew that this was the only way to get the job done, i.e., to be on the side of the power. Moreover, Paul's team did not try

to verify the idea of using a fastening device, such as testing whether it could fasten a similar component (Example 6). The team combined rods, wires, and sticks by welding on the mould to make the fastening device (Example 6). However, if it had been a number of members of similar ranks constructing a new idea, the discussion of idea generation would have been more chaotic; members would not be afraid to question each other's ideas to prove their usefulness. For example, within the technology department, team members were divided into two groups to determine whether it was hardness or resistance that was most needed for refining a blade; the result was that they manufactured samples with different-featured materials (Example 18). Reaching a team agreement was more difficult among members as one participant described: 'You have to present it with something solid … make a sample, a prototype, to show that your idea is good' (Example 18). The discussion for using particular materials was described: '…we argued for half an hour…Too many variables … do it, prove your idea, get the metallography detection done … they [the samples] will speak for you' (Example 18). Therefore, teams were more likely to conduct a careful verification of new plans in order to convince each other, while they were less likely to test out the usefulness and feasibility of a new plan when leaders were involved; a team may implement a reckless plan which led to negative outcomes.

Theme D Arguing and verifying to construct solutions as influenced by Theme 3 Worry

Chiefly, the worry about being punished in the future might motivate team members to verify their ideas while coming up with a new plan, because the members would want to ensure that the new plan could work, and be justified as a problem-solving solution. The participants gave examples of simultaneously verifying new ideas while proposing them (Example 11, Example 20). Members of Dean's team were mould designers; they showed new ideas by sketching them in front of each other because it was much more precise than oral expression, and the members could reflect on their design ideas while sketching them

(Example 11). As the participant described the fear of subsequent consequences if the team made a mistake in mould designing (Example 11), it was reasonable to assume that the team would worry about being held accountable in the future, which encouraged the team to pay attention to idea verification.

> 'If we have any ideas about mould design, oral communication is not enough … You have to draw it, construct the mould structure, show your idea … it [the whole project] could be a total re-do over if we made a mistake at the stage of designing. You can't be too careful on this' (Example 11).

In Example 20, three members tested out a different method of packing products and the participant expressed the worry plainly: 'If the results are bad, I mean if the change of the placement leads to more products being scratched, then at least we can say that we have tested it' (Example 20). The testing, i.e., the verification of an idea, became a way to ease people's worries.

Theme D Arguing and verifying to construct solutions as influenced by Theme 4 Time pressure

Chiefly, the time pressure caused by approaching deadlines would make team members more emotional when they were trying to convince each other regarding how a new solution should be like. For example, to meet the delivery deadline, Jack's team were ordered by the top management to speed up the assembly of multi-ring dimensional chains (Example 8). The team realised there was not enough time to hire more temporary workers as they would normally have done, so they decided to change the assembly method (Example 8). When discussing whether to change the assembly method, the participant pinpointed the need for the team to take a break:

> ‘We were a little deadlocked at that time, whether to change the selection or ask people to work overtime, the latter may be the easiest way, but I think we cannot always solve the problem like this, overtime will be endless, right, you can’t ask people to sacrifice every time … it was an intense situation at the meeting... We adjourned for a dozen minutes’ (Example 8).

Without the time pressure from the approaching deadline, the solution discussion was less likely to be highly emotional.

Theme D Arguing and verifying to construct solutions as influenced by Theme 5 Team climate

Firstly, the widely spread tolerant attitude toward unpredictability of team members allowed them to verify an idea when it was newly proposed to find the cause of a problem. For example, when Oscar’s team was arguing for the heat source which had caused the imbalance of temperature on the aluminium pipe, the team members proposed a number of different ideas: ‘[the engineer] thinks the radiation of the mould warmer, the boss [the project manager] said that it was the material overheating (Example 9). Then members verified these ideas immediately: ‘he [the engineer] said as he walked over to have a look [at the mould warmer] …’ (Example 9). As members were not ashamed or embarrassed when it came to making incorrect judgements regarding finding the cause of the problem, they allowed their ideas to be verified by others; if the idea was proved wrong, members were tolerant enough to quickly move on, checking the next possibility.

> ‘… say wrong things are normal, that’s a part of our job, we learn from it [making mistakes], so we can rule out a wrong option … to move on to the next one … not being judgmental on one person’s ability … if you wanted to be on this job for a longer time, you had to be tolerant’ (Example 9).

Secondly, such tolerant attitude toward unpredictability encouraged team members to use all kinds of tests to verify their new ideas when generating them. For example, Jack's team (Example 8) was happy to make some mistakes when organising a small group of assemblers to test a new assembly method.

> 'We kept rearranging the assembler's seat … rearranging the assembly order, we grouped different people to pick specific product parts, and some of the measures turned out to be wrong, but it was all right, it was testing' (Example 8).

Besides, members would be more comprehensive in verifying ideas since a certain degree of cost was acceptable in order to cope with unpredictability. For example, to make a heating protector, Ryan's team (Example 3) tested different types of steel, and the wasted steel was considered a necessary cost.

> 'There was a lot of scrap metal in the end. We just needed to prove the idea [that a protective incident made of steel could reduce oxidation]. If this idea worked, that meant that our judgement of the cause [of the problem] was correct … it was fine making some mistakes, wrong shapes, wrong steel, wrong places … because we're trying to make things work' (Example 3).

Appendix 7: Full description of Study 1 outcomes

Example 1

Jason's team improvised to create a twisted iron frame. This team improvisation immediately reduced the cold seams by slowing the flow of melted plastic from the feeding tubes, enabling the team to complete the day's production tasks with fewer product defects. Therefore, the team improved the product quality as an immediate outcome of improvisation. However, the team hypothesised that creating and installing the twisted iron frame into the exit of the feeding tube might increase the risk of blocking the injection mouths and pipes, and the team might face a higher possibility of the risk of machine breakdown in the future.

Example 2

By improvising a new solution for the surface treatment of a product, Jason's team lost a client's order which caused a profit loss for the company, as a result of which the team's quarter bonus was cancelled. However, the team members still believed they did the right thing by proposing a new plan which aligned better with the positioning of the product. The loss of orders seemed to reinforce a sense of team agreement that the design and manufacture of products should be treated by focusing on high-quality requirements, rather than blindly following the directions of clients. Team cohesion might be improved as a result of such an agreement.

Example 3

To immediately solve the problem of oxidation of a metal product, Ryan's team improvised by creating a heat protector out of metal wastes, rather than improving the heat treatment. In the short-term, the team was able to complete the day's production and achieve an early delivery. Moreover, the team members would have a better chance to apply for more projects in the future regarding similar technical processes as they successfully completed the project. The team members therefore hypothesised that their job security might be increased

in a background of company downsizing. However, the team may lose an opportunity to learn more about the heat treatment process, which might be negative in the long-term.

Example 4

By improvising a diverter pipe, Peter's team immediately relieved the blockage of the feeding bucket and port, enabling the team to complete the day's production task on time. However, the creation of a diverter pipe was a temporary solution; the siltation of the feeding port was increasing but the injection moulding process continued because of the diverter pipe. When the team finished the day's work and removed the diverter pipe, the night-shift team would face a more serious blockage of the feeding port which might result in a serious machine breakdown.

Example 5

Eric's team improvised by welding two gears together to solve the dysfunction of the mould and then delivered it to the client. However, the two-gear structure fell apart a few months later, which meant the team had to visit the client's factory to re-weld the gears. On the one hand, the team improvisation was an unsuccessful technical solution in the long-term which might leave an unprofessional impression on the client; on the other hand, Eric's team was the only one that knew how to repair the mould (because the members kept the improvisation within the team). The team thus hypothesised that the job security might increase.

Example 6

Paul's team improvised by creating a fastening device to repair a mould, which was sent back to production. Although the mould was able to survive production for a few days, it then broke, so the team used the same solution to repair it again. Although the team ensured the production which was essential for the team's performance, such improvisation may cause a risk in the long-term because the mould may enter a stage in the future where it might

not be repaired and may cause damage to the injection moulding machine; consequently, production might be significantly affected.

Example 7

Andrew's team improvised by using only one calpier to measure all aspects of a product, which saved substantial time when it came to carrying out the measurement work and a certain degree of reliability could be achieved because the members were skilful workers. As a result, this improvisation could enhance the team performance in a short-term and job security in a long-term as the team would finish their project faster. However, such improvisation relied on members' experiences, skills, and familiarity with the product they were measuring. Further, the stability of measurement accuracy cannot be guaranteed. It is possible that product returns may increase which could negatively affect the company.

Example 8

To improve the efficiency with which a product was assembled, Jack's team improvised on-site by promoting a skilful assembler to a supervisory role with training responsibility. However, this team improvisation caused a level of interference for the HR department because it had to request an exception for Jack's team's improvised promotion, which was not a part of the standard promotion procedure. The HR department had to determine how to bypass the promotion evaluation process to confirm the team improvisation.

Example 9

When it was approximately time to go off-duty, Oscar's team improvised by not reporting a possible machine breakdown (the team noticed an inclination of the main spindle on a cutting machine) and left the problem to the night-shift team. Although Oscar's team were able to avoid some of their workload and get off duty on time which was good for the

team members' wellbeing, the night-shift team had to deal with the problem which may cause a greater risk of potential machine breakdown.

Example 10

Miles's team improvised by inviting an expert (who worked for a competitor) to help resolve a product defect (the team found a honeycomb of holes inside a pipe product); the team successfully solved the product defect with the help of the outside expert. However, the participant hypothesised that such improvisation might cause the risk of technical information leaking as the outside expert was involved in the team's work.

Example 11

To bypass the internal drawing review process, Dean's team improvised by handing over an engineering drawing to the downstream manufacturing team. Although the team had a member who had reviewed the drawing internally, the manufacturing team needed a formal signature to officially take over the project. The manufacturing team had to request an additional review of the drawing to obtain the signature. As a result, the improvisation of Dean's team saved time for the team to finish their project which might potentially give them some advantages to exceed other teams regarding team performance, however, the other team's work was disturbed.

Example 12

When a product quality-related complaint was received from a client, Wesley's (sales) team improvised by submitting a testing request to the testing centre (which should be submitted by a corresponding R&D team). By asking a favour of the R&D team, Wesley's team was able to get back to the client quickly with a testing certificate. However, as a sales team, the technical judgement they made as to which test should be carried out to respond to the client could be incorrect, hence the client might not be satisfied with the response, leading to a decrease in client satisfaction.

Example 13

To cope with the unpredictability caused by the Zero-COVID policy in China, Tanner's team improvised by mobilising some front-line operators to organise a quick shipment. Although the team successfully shipped a large amount of cargo in a short time to reduce warehouse cargo accumulation, the safety of some front-line workers was put at risk because they were asked by the team to operate forklifts without a licence. Moreover, the team's improvisation occupied about 30 minutes of front-line workers' working time, which had a negative impact on the day's production.

Example 14

Members from the scheduling office improvised by shortening the three days' notice on production rearrangement to one day in order to meet the demand from an important client. The members successfully satisfied the client without causing much chaos in the production arrangement. However, the corresponding production team suffered from the sudden increase in workload and overtime work which may have had an adverse effect on their mental and physical well-being.

Example 15

As a marketing team, Ford's team improvised by introducing a new technology (which was still under development by an R&D team) to a potential client at a trade fair. As a result, the team successfully persuaded the potential client to sign a contract of intention and agree to see some samples. Although this improvisation increased the team's performance and brought possible profit to the organisation, the team may increase their job security because the members would be expected to keep up and close the deal. However, the corresponding R&D team suffered from needing to accelerate the development of the new technology to meet the deadline for sample delivery.

Example 16

Shepherd's team was an apprentice team, undergoing training for welding. The team improvised by welding in a different way (which might not be good for the moulds) because they were extremely bored by the repetitiveness of the work. A senior machinist corrected the team's improvisation. In terms of outcomes, Shepherd's team reduced a degree of boredom by improvising, but the members might not have learned the welding technique properly, which could cause a mould breakdown.

Example 17

Because a team was not assigned to equip the headgear welding mask in a recent allocation of materials, the team improvised by creating a rubber-covered shelf and attaching it to the back of a welding mask. This team improvisation could be positive in enhancing the team's work efficiency and product quality because they could free both their hands to operate, but it may be negative if the members bite the shelf with their teeth for a long time, as this could damage their teeth and jaws.

Example 18

To bypass the test submission procedure, Mike's team improvised by allowing other teams to submit their testing requests. Mike's team was able to submit a large amount of testing requests in a short time and receive the results quickly. Such an improvisation could potentially improve the team performance because the team might finish the project earlier. Moreover, other project teams will be to able submit testing requests and receive testing results quicker than usual if they also ask other teams to submit requests on their behalf. However, using personal connections to bypass test submission procedures might enhance employees' tendency to bypass company procedures, risking disruption to company operations in the long-term.

Example 19

Carl's team improvised by creating a grip handler that could be attached to a mould component so that a member could easily pull out part of the mould to release the excessive air within, preventing the mould from making an abnormal sound. The team ensured the day's production could be completed through this improvisation. However, the air exhaustion of the mould was not properly resolved, which might be risky for future production.

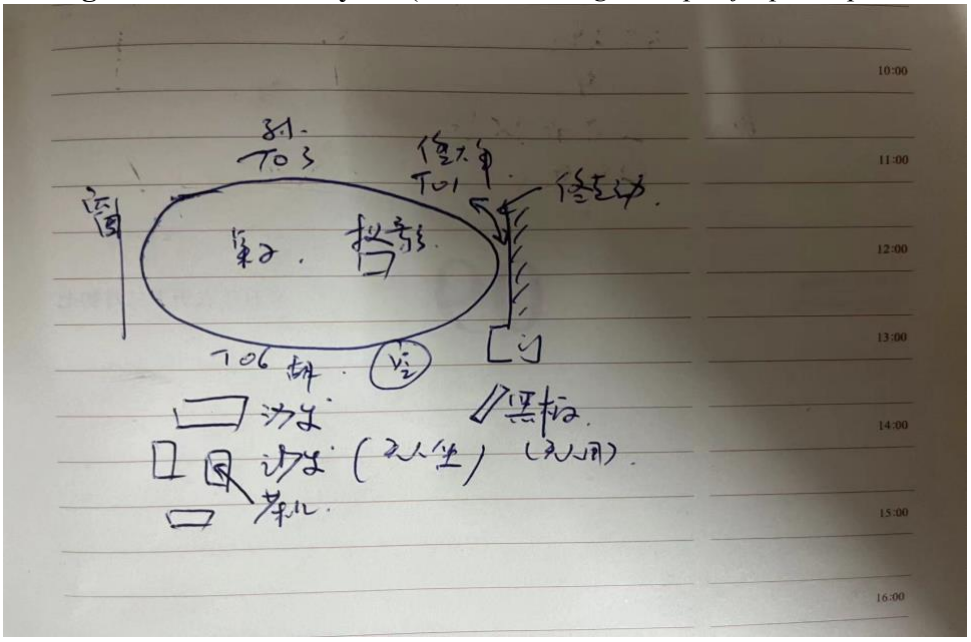
Example 20

To meet the company's goal of reducing shipping costs, Nick's team improvised by changing the way a product was put in packaging boxes, rather than negotiating the shipping costs with a freight company with costs, as the top management suggested. This improvisation worked as a useful alternative to the original plan.

Example 21

As a packaging team, Bob's team improvised by using a large wooden box as the waterproof layer for packaging. Although the team successfully made the delivery which added to the team performance, the improvisation of using wooden boxes was not sustainable in terms of the company's cost management.

Appendix 8: A completed example of one filled-out field note

<table>
<tr><td colspan="3">Serial number of field notes: 1</td></tr>
<tr><td>Date/time 3/8/2022
Start 9.30
End 9.50
Location
Executive building 1</td><td>Team goal
Project debriefing</td><td>Communication channel
Face to face</td></tr>
<tr><td>Project code
DESU NEW XD23
Team code
Management meeting (GLC)
Participant codes
佟大年 T01, deputy general manager
孙怡 T03, purchasing manager
胡悦 T06, Technology department head</td><td>Aim of the meeting
Reiterate the current status of the project and track the progress</td><td>Equipment used
Curtains and projectors</td></tr>
<tr><td colspan="3">Meeting environment
Office</td></tr>
<tr><td colspan="3">Seating situation/room layout (Picture drawing with specific participant codes)
  </td></tr>
</table>

On behalf of the project, things that members have done
Timeframe (after this meeting): from 3rd to 10th August 2022

T06 (Technology Department) emailed the client on 3rd August 2022, asking whether they (the client) would accept the idea of separating handrail accessories and whether the client insisted that the mould needed to be manufactured as a whole. The client replied to the email on 3rd August, saying that as long as there was no problem with the quality of the product, the method of assembling the mould could be accepted. Moreover, before the production of the sample, 3D and engineering drawings of the product were reviewed. The technology department T07 (4th August) called and consulted three outsourcing manufacturers, and the mould price was similar, all of which were about 100,000 RMB. The technology department met with the T02 production department (5th August) to negotiate. Furthermore, during off-work hours, the stamping and gear grinding workshop produced 20 VS60 model blade samples and delivered them to T05 (Quality Control) (8th August) to obtain the relevant data on the blade.

(T01) held an online project meeting with the client (8th August) and determined that all sample deliveries of the project must be completed before the end of October, and bulk commodity delivery should be carried out at the beginning of October.

T03 and T06 talked privately (on the morning of 5th August), firstly, stop doing the new material formula test.

Descriptive notes

Pre-meeting information

The purpose of this meeting is for me to participate in the observation project as a researcher. Tong (T01) always told me in advance that the meeting would be relatively short, and he would briefly talk about the project status, progress, and some problems to be dealt with. Tong is in charge of the company's daily operations; he has been in the company for nine years as the deputy general manager for over five years. he is not a local; technology, quality control and procurement are directly reported to him. The manager, Sun (T03), who will come to the meeting this time, is in charge of the purchasing department, and Director Hu (T06) is the director of the technical department.

During-meeting notes summary

I waited for the meeting in the corner of the office. T01, T03), and T06 came to the office one after another. T01 was responsible for introducing the project; he opened the projector, connected it to his computer, and the PPT showed DESU's new hedge machine project several big words. T01 soon gave a brief about the project: The R&D of this project focused on the blade and a new handrail accessory; the handrail accessory is plastic, and the blade drawing has been sent by the client (here, the drawing was an old model, VS60). The technology department transferred the 3D drawing into a 2D drawing for further engineering. The engineering drawing process of the blade was relatively smooth.

T06 added that the engineering drawing process of the blade may take longer than expected, as the technology department had to consider the feasibility of making

	crafting cards in the future. – It means the technology team needed to consider how the product would be manufactured step by step in the designing phase. T01 interrupted T06's explanation with a hand gesture (T01 raised your hands in the direction of T06. T01 continued to speak: the blade (*the blade here refers to the blade of VS60; the team needs to manufacture the blade of VS60 first and then upgrade it on this basis to develop a new model called VS80*) needed to pass the hardness and metallography test, and the sample should be made as soon as possible. (T01 answered a call during the meeting, lasting around 2 minutes). When T01 finished the call, T06 said that the manufacturing of VS series blades may need to buy some materials because the technology department has no VS series products (materials required by the client). T03 said it would take about a week to buy the materials. T01 instructed T06 that the technology department could borrow some necessary materials from other teams or try other materials. Nevertheless, T01 made clear that the VS60 samples had to be made as soon as possible as a benchmark, and it also represented that our company could develop a new blade. T06 just nodded as he responded. T03 remained silent. Then, the meeting discussed the situation with the handrail accessory. T06 explained the current situation: The sample sent by the client had just taken a 3D shaping, but we were still discussing with the purchasing department whether to do it by ourselves or to find an external contractor and how far we would take the cost control on this. T03 described the costs for finding an external contractor: 70,000 – 80,000 RMB. However, by doing so, the company would lose control of the follow-up maintenance, which would also cause money costs. T01 suggested that if the mould for the handrail accessory or the product itself could be separated, let an external contractor conduct moulds for smaller, less critical parts and assemble them. T06 refuted T01 by saying that he (T06) believed the client would like to have the handrail made via integral moulding – the handrail without assembly (*T06 expressed: if the client wanted an assembled product, the client would not look for us, the tone of saying this is impatient*). T03 supported T06; separating the moulds also required extra materials purchasing. T01 seemed to not respond to T06's questioning. T01 asked the T06 to produce samples of VS60 as soon as possible and figure out the plans for external contractors to develop the handrail accessory. Again, T01 summarised the stage of the project: The R&D of the blade is still at the drawing stage, and the manufacturing of the samples (VS60) should be contributed to the development of VS80; next meeting, the technology department needs to propose some points (about how to improve the VS60). The development of the handrail accessory should focus on the mould (whether in a whole or separated), but check with the client about the mould development.

	T06 and T03 did not raise any questions. **After meeting reflection** *About the roles and relationships* T01 is the deputy (general) manager, similar to the role of project manager/manager in this project, reporting directly to the boss, the general manager. T01 is in charge of making samples/prototypes for more than a dozen new projects. He has been in the company for the longest time, about 15 years. Manager T03, who is in charge of purchasing, has the shortest working time, about three years, and her age is also younger. T06, the head of the technology department, has been working for about ten years. This meeting was more like a progress inquiry; T01 leads the project. T06, as the head in charge of technology matters, is in a powerful position in this meeting. After the speech of T01, he (T06) took the initiative, emphasising the details and importance of his work content to a certain extent. For T06 although T01 is his superior, T06 does not fear T01. *The team's planning and acting* The team plans to send emails to confirm assembly requirements with the client, seek the feasibility of help from external contractors, and purchase new raw materials or borrow some necessary materials from other teams. Cost and productivity must be taken into account in these plans. The overall plan is that the team must quickly produce samples of VS60 for the client to show that the team can adequately develop VS80. Although these plans were not specified for execution, the importance of time was emphasised. The technology department took materials from another team to manufacture VS60 samples in off-duty time.
	Possible team improvisation In the meeting, T01 suggested the tech department could take other projects' materials and steel to make samples of the VS60. The technology department (led by T06) asked people from the manufacturing workshop to produce samples during off-duty time, using the materials that belonged to other teams – the team was supposed to purchase the materials they needed and make the samples during working hours.

Appendix 9: Full description of team improvisation examples (Study 2)

(See Example A and B in the thesis in 5.4.1).

Example number	Involved field note	Summarised team improvisation activity
C	FN15, 11/10/2022	When the team completed the design of the handle product, the team members entered the phase of sample production. Since the company did not assign an injection moulding machine to the team to do the sample production, so the team had to manufacture the samples outside the normal working time. As a result, the samples were produced at night times (often from 8pm to 11pm). The team found the handle's front end was sometimes insufficiently injected, with plastic softening and collapse. Since the team worked outside the working hours, team members needed to solve the problem on the site as the delivery time was approaching (in two days). So, the team members selected a batch of qualified samples, then improvised to make metal locks out of metal strips, in order to wrap around the handle front-end to hide the problem.
D	FN2, 10/8/2022 & FN3, 15/8/2022	The team improvised to not follow the procedure (i.e., the steps of the procedure involved liquid nitrogen refrigeration technology) given by the client but deciding to use a technology the members more familiar with. Since the team did not have access to liquid nitrogen equipment and had little relevant technical knowledge, the team improvised to interpret the drawings of the VS60 model provided by the client as an 'optional procedure' while the client explicitly pinpointed that the liquid nitrogen technology was more advanced in one of the previous meetings. The team improvised to choose the improved quenching step instead of using the liquid nitrogen method; later, in a management meeting, the team defended their team improvisation by claiming that achievement of the purpose of a method was more important than its specific steps.
E	FN2, 10/8/2022 & FN12, 20/9/2022	When a team member designed the handle mould, the shape of the handle became threaded because the mould was designed to be rotatory as the designer believed it would help customers to have a better grab.

		During a management meeting, the team leader did not prepare to talk about the potential selling points because there has been no breakthrough in quality yet. When a manager asked the team leader about the selling points, the team leader improvised to interpret the design of the handle as a new selling point by explaining the threaded handle as a new highlight.
F	FN8, 3/9/2022 & FN11, 15/9/2022	After the team confirmed that the liquid nitrogen cryogenic equipment could not be borrowed from other companies, the team planned to obtain one by leasing it. During the meeting, the team members improvised to spread the cost of the equipment rental evenly to other items that applied for reimbursement, since it would take too much time for the management to approve a large amount of spending. During the meeting, team members interpreted the reimbursement system as unreasonable, which made them have to improvise and break the rule. The team later improvised to explain this improvisation as a reluctant action in a management meeting.
G	FN4, 20/8/2022 & FN7, 2/9/2022	The team carried out rough shaping of the blade samples by testing on different steels and decided to select one by visual comparison because the formal data comparison was usually consistent with the visual comparison results (and they subsequently selected the GCR15 steel). In a follow-up management meeting, the team justified the team improvisation activity decision by claiming they did not want to disturb the operation of the testing centre too much. The result of GCR steel was significantly better than others; formal testing was unnecessary.
H	FN15, 11/10/2022 & FN16, 14/10/2022	When the team discovered that the front end of the handle was inadequately injected, the team created a batch of round metal locks to hide the injection defects. In a follow-up management meeting, the team improvised by stating that the metal lock was a new feature of the handle because the metal could give the plastic handle a quality feel. They said the team considered adding different colours to the metal lock.
I	FN1, 3/8/2022 & FN2, 10/8/2022	Since the development of the new product was required to maintain normal production activities, the team members sought resident engineers' help in manufacturing samples after work (after 6.30 pm).

		However, they were not allowed to operate any machine after work according to factory management regulation.
J	FN2, 10/8/2022	The team asked for help from other companies to borrow a small liquid nitrogen cryogenic device in order to test the procedure that meet the client's requirements. However, the team could not even achieve the same quality outcome (as the VS60, the old version) with the borrowed equipment.
K	FN5, 25/8/2022 & FN6, 31/8/2022	In the meeting, the team decided that the best speed of the spindle should be 0.249m/s, but the machining error of the blade could not be guaranteed when the team members operated the machine, so the team could only seek the help of an experienced grinder.
L	FN10, 13/9/2022	Since the scheduling office could not coordinate the oil cooler with the team, the team asked the team that was using the oil cooler for help and obtained its use for a week.
M	FN2, 10/8/2022 & FN5, 25/8/2022	Since the team wanted to improve the blade's hardness by refining its cooling method, the team discussed how to improve the cooling method, including water, air, oil, and a combination of these three cooling methods by running a computer simulation as supporting proof. The team decided to test the oil cooling first; however, because the scheduling office failed to assign the oil cooler to the team, the team discussed this and decided on site, to use water cooling to test the cooling method. The team chose to do a salt bath cooling.
N	FN9, 9/9/2022	To improve the blade's sharpness, the team discussed the grinding wheel speed and used computer simulation to decide that the grinding wheel speed should be between 35 and 48m/s. During the team meeting, there was conflicts between team members regarding how fast the wheel speed should be, the team improvised to compromise with a speed range.
O	FN13, 22/9/2022	The team discussed the process after the grinding step. Resistance to wear was identified as something that should be improved. During a technical meeting, the team improvised to compromise by adding a new step: the grinding blade was immersed in oil, boiled again, buried in quartz sand and cooled to room temperature as a finished product.

Appendix 10: The rest of analysis of how the microprocesses of team improvisation are affected by the influences regarding the similarities and differences between Study 1 and Study 2

Theme C Asking for help from outside teams as influenced by Theme 1 Location

Similar to Study 1, team members considered the physical distance between them and the resources they needed, such as manpower. Team members chose resident engineers as helpers because they were factory-based and physically closer to the team's worksite (Example I, FN2, 10/8/2022). Besides, the observed team also improvised, because the physical distance between the facilities they were supposed to use and themselves was considered "too far" (FN4, 20/8/2022). In Example A (FN3, 15/8/2022), the technical team complained about the location of the measurement testing office. Members 3D-printed a few blade models to carry with them for instant size comparison where necessary.

Theme C Asking for help from outside teams as influenced by Theme 2 Power

Similar to the findings in Study 1, seniority power influenced the microprocess of different methods for reaching out to helpers. When the rank power was not enough to bring security in dealing with a situation/problem, team members became indecisive regarding an engineering issue due to the lack of techniques or knowledge, members would seek refuge in another source of power, which was seniority in this study. For example, in Example K (FN5, 25/8/2022 & FN6, 31/8/2022), when the team realised none of the members could complete the job task of blade grinding, the team brought in another very experienced grinder on board to operate the machining.

Different from Study 1, being in a "priority" project gave the team members the power to mobilise additional manpower. In Example I (FN1, 3/8/2022 & FN2, 10/8/2022), the technical team knew the HR department would assign resident engineers to help with the project if the team asked because the company asked all department to assist with the

"priority" projects as much as they could. So, the technical leader made a call to the HR manager to ask for help.

In addition, as the microprocess of offering incentive to bypass rule was not found in Study 2, the Theme 2 Power as an influence was therefore not found affecting the microprocess.

Theme C Asking for help from outside teams as NOT influenced by Theme 3 Emotion

Unlike Study 1, Study 2 did not find any relationship between members' anxiety and the theme of asking for help from outside teams. The reasons might be that the NPD team already had the best engineers and mechanics in the gardening equipment division in the Avatar Group, there might be no one outside the team had the expertise to help them ease their anxiety which often was caused by product quality. Besides, the observed team also knew that they were working on a sample delivery project for a new product, and the company was project-based, it would be irrational to ask people outside the team for help since other project teams might contact the client in private to make propose with lower costs for example, which could cause the team to lose the project.

Theme C Asking for help from outside teams as NOT influenced by Theme 5 Team climate

Unlike Study 1, Study 2 did not find the theme 5 organisational protection influenced the theme C asking for help from outside teams. The reasons could be similar with why Study 2 did not find relationship between theme 3 and theme C, a) the observed team was a NPD team in Study 2 had less need to reach out for help as the team already had some of the best people; b) the company was project-based, other teams might try to steal the project; c) one of the microprocesses (i.e., offering incentive to bypass rules) was not found in Study 2.

Theme D Team plan construction as influenced by Theme 1 Location

In addition to Study 1, Study 2 showed that the physical distance between team members could have an impact on the process of team plan construction. During the technical meetings (e.g., FN5, 25/8/2022; FN9, 9/9/2022; FN13, 22/9/2022), members sat in different areas of the room. In Example N, during a technical meeting on improving sharpness, Susan (proposing a faster speed was needed) sat on the side of the sofa facing the door. She held the opposite view on developing the blade to Mike and Carl (insisting on a slower speed), who sat on the side of the sofa facing the window. Kevin, who sat between them, advocated a more balanced idea. Interestingly, as Kevin objected to Susan's proposal, he had been about to reach out and put ash into the ashtray in front of Mike and Carl. Instead, he stood up, walked over to them and sat down. The ashtray was now in front of Kevin and he sat across from Susan. He then explained why he believed it was important to pursue the balance of blade features. This observation showed that the physical distance of the team members related to their views on the topic of the meeting. Perhaps before entering the meeting, the team members had a general understanding of each other's views on the technical direction regarding the improvement of blade sharpness, and the initial seating reflected such an assumption. In the course of the meeting, the team members tended to be physically closer to members with the same views as themselves and kept their distance from those who had different views. The changing of seats might be a way to convey nonverbal communication signals, e.g., Kevin stood up to show he disagreed with what Susan was saying. Sitting across from her was a way of demonstrating he was taking a stand. The physical distance between members may affect their interactions. For example, in Example N, when Kevin sat down with Mike and Carl, although Kevin showed some signs of agreeing with Susan in subsequent discussion (e.g., "nodding while Susan was speaking", FN9, 9/9/2022), it would feel like a betrayal if Kevin chose to change his opinion to support Susan because he felt a sense of closeness to Mike and Carl who were physically closer. So, Kevin ended up siding

with Mike and Carl against the idea of increasing the grinding speed, which was Susan's position. Therefore, although the actions of choosing seats and changing places might be effective in strengthening one's own voice during a meeting, these actions may also influence the opinions of team members by restricting the development of certain viewpoints.

More was found to differ from Study 1: location types might be another component affecting how team members compose a plan for improvisation via influencing the microprocess of convincing each other. For example, in conference-based meetings, team members tended to sit in their seats and speak in an orderly manner, and members tended to express only the materials prepared in advance. These meetings were dominated by the leader. In office-based meetings, team members moved around more frequently (e.g., changing seats in Example N) and were more direct and chaotic in their communication, such as raising arms and loudly expressing agreement (FN15, 11/10/2022), directly interrupting when one expressed disagreement (FN10, 13/9/2022), or using hands to cover another's face as a gesture (FN13, 22/9/2022). In Study 2, as the scene of the meeting became informal, members became more familiar because they were a part of their original workplaces (e.g., a shared office), so members felt safer saying things they might not be willing to say in a formal setting.

Theme D Team plan construction as influenced by Theme 2 Power

As being similar to Study 1 on higher rank leaders who were dominant during team discussion regarding generating new ideas and convincing each other. In Example D (FN2, 10/9/2022 & FN3, 15/8/2022), when the leader refused to apply the client's suggestion, she proposed the idea of refining the heat treatment process of the blade and then instructed the team members to do the preparation.

Differently, Study 2 showed that the impact on team improvisation when power from two sources (i.e., position rank, and seniority) collided with each other tended to influence the

microprocesses involved compromise. In Example N (FN9, 9/9/2022), the team members discussed how to improve the grinding of the blade from the grinding wheel speed and sandpaper material perspective. Susan, the technical leader with a background in heating treatment, advocated speeding up the grinding wheel and reducing the sandpaper's granularity to enhance the blade's sharpness. However, Mike, who was an experienced grinder with a great deal of familiarity with grinding technology, believed that while pursuing sharpness, the durability/service life of the blade and the finish of the blade should also be taken into account: '... the speed of the grinding wheel should not be too fast, and the abrasive paper with higher granularity should be used' (FN9, 9/9/2022). The team members eventually gave up some of their claims, set the wheel speed to a range none objected to, and used moderately granular sandpaper. In this example, Susan, the technical leader with higher rank, and Mike, a member with more experience in grinding and cutting, had more substantial rank power and seniority power, respectively. The powers from two different sources produced a kind of confrontation, which made the team's final solution a compromise, which resulted in each party abandoning their idea to a degree. Moreover, when Mike's technical seniority was less potent than the technical leader Susan's rank power, arriving at a solution came about differently. In Example O (FN13, 22/9/2022), team members discussed adding a heat treatment process after grinding and cutting to enhance the blade's resistance to wear. In this discussion, Susan advocated dipping the blade in oil after grinding and cooling it to room temperature, but the rest of the team, led by Mike, thought the blade should be cooled in quartz sand. The final solution was a superposition of the two ideas, i.e., the blade would be 'immersed in oil, boiled again, then buried in quartz sand and cooled to room temperature as a finished product' (FN13, 22/9/2022). This compromise was because the discussion was about the heating treatment process (Susan's speciality). However, this heating treatment process was related to grinding since it was added after the

grinding process (Mike's speciality). Consequently, it could be seen that Mike's seniority power was somewhat weakened, Susan had rank and seniority power to a certain extent. The powers of both sides did not form an equal confrontation. As a result, the technical leader - Susan - took the lead; the first step was that she advocated that the blade be immersed in oil. Nevertheless, Susan could not ignore Mike's opinion and needed to take it into account. Therefore, Mike's idea of burying the blade in quartz sand was added to the proposal.

In addition, what was found interesting was that when the dominance of rank was impeded, the powerful members would be more dictatorial in some irrelevant matters regarding how the team plan was going to be executed. In Example N, as the technical leader's proposal of increasing grinding speed was rejected by other members, the team reached a speed range for testing when the meeting was ending. The technical leader said: "I wanted you guys to test the blade grinding at a high speed [the leader's proposal which was rejected during the meeting] … first thing tomorrow morning" (FN9, 9/9/2022), then announced the members could leave the meeting when they were already preparing to leave. This observation showed that, when the leader's rank was challenged, the challenged leader might perform meaningless behaviour to maintain an illusory sense of being in charge; in Example N, it was reflected in the leader making insignificant arrangements and issuing an instruction that was already being executed.

Theme D Team plan construction as influenced by Theme 3 Emotion

Similar to Study 1, Study 2 also found the worry about being punished in the future influenced the microprocess of generating new ideas. In Example G (FN4, 20/8/2022), when the team decided to not send the steel materials for quality testing, the members worried about being punished in the future if they misjudged the quality. So, the team improvised by reviewing the quality of steel independently for subjective rating, and then hold a team meeting to discuss the pros and cons, in order to take risks as a team to ease the anxiety.

Theme D Team plan construction as influenced by Theme 4 Time pressure

Similar to Study 1, it was also found that time pressure caused by approaching deadlines influenced the microprocess of convincing each other. In Example M (FN2, 10/8/2022 & FN5, 25/8/2022), the team members discussed how to improve the hardness of the blade by changing the cooling method. When the technical leader, who advocated the use of oil cooling, wanted to convince other members who advocated water cooling and air cooling, to experiment on oil cooling first, the technical leader mentioned the availability of the oil cooler and stressed that 'the oil cooler was not always available... had to make requests in advance' (FN2, 10/8/2022). In this example, what the technical leader was trying to say was that since the oil cooler needed to be booked in advance, the team needed to decide immediately, in that meeting, that it was reasonable to experiment with oil cooling first. By pushing this point and emphasising the time pressure, the technical leader managed to convince the other members.

Theme D Team plan construction as influenced by Theme 5 Team climate

Similar to Study 1, Study 2 also found that employees' high tolerance of unpredictability influenced the how the team generated new ideas when aiming to find the cause of a problem. With a high tolerance to unpredictability, the team knew that errors were inevitable, so the team had the patience and resilience to repeatedly generate and test the feasibility of the new ideas while surprises keep coming up and members keep making errors. In Example M (FN2, 10/8/2022 & FN5, 25/8/2022), at a technical meeting on how to formulate a blade cooling method, the team members discussed a series of combinations of cooling methods: water cooling, air cooling and oil cooling. At the meeting, the team members used computer software to do the simulations. There were constant surprises such as computer crashed, cooling combinations that failed to meet technical expectations, scheduling office called the team to alert the possibility of the oil cooler might not be

available, and the members made mistakes during the simulations such as typing wrong numbers or mixed-up accurate data with incorrect methods. A high tolerance for unpredictability allowed the team to maintain the resilience and patience to constantly adjust the solution. Similar discussion processes took place during the technical meetings to discuss how to improve the blade's sharpness (Example N) and wear resistance (Example O).

Appendix 11: Full description of Study 2 outcomes.

Example A

The team improvised a carry-on metal model of the blade for anytime size comparison to facilitate the NPD process. However, at the company level, the product data for each stage of the blade development process was lost, which was detrimental to the subsequent summary of development experience, and information on technical knowledge was not well recorded and disseminated.

Example B

The team improvised a temporary system for managing wasted cutting fluid after noticing a waste tank blockage during an experiment to improve the rust resistance of the blade. As a result, the team successfully solved the problem of cutting fluid deposition in the waste tank. Unfortunately, this improvisation had a negative impact on blade manufacturing after the NPD process because the temporary wastewater dredging system might be applied in the blade manufacturing process for a longer time, and the downstream manufacturing team may still face the problem of blocking cutting fluid waste.

Example C

When the delivery deadline was approaching, the team improvised by manufacturing a batch of metal locks to cover up the insufficient injection of the handler products so that the products would have a better chance of passing the management and the client's review. However, the injection defects were not solved, the team simply hoped to pass the client's sample review through this improvisation, but the client was likely to find the injection defects covered by the metal lock in the process of product quality review.

Example D

The team improvised by abandoning the liquid nitrogen technology and focusing on traditional quenching techniques. This improvisation was beneficial for the team because the

members could develop a technology they were familiar with; however, the client might not be satisfied with such a change in technology.

Example E

The team improvised to explain the shape of the handler as a new feature of the product. This improvisation was positive for the team and might potentially be beneficial for the organisation as there would be a better chance of obtaining future orders from the client.

Example F

The team improvised to rename an item with larger costs by breaking it down or dispersing it into other items with smaller costs to obtain a budget. In terms of outcomes, the team successfully obtained the money to rent new equipment, but such improvisation made many expense documents unverifiable. Consequently, the company may not be able to keep proper records of income and expenditure.

Example G

The team improvised to make an empirical judgement in terms of making a decision on choosing steel material. Regarding outcomes, this team improvisation contained a level of instability as the comparison was fully dependent on the skills and experiences of members. The company also lost data on the NPD process, which might harm future knowledge dissemination.

Example H

The team improvised by adding metal locks to the grip of a handler product as a new selling feature to the management team. As a result, they covered up the product defects from the management, which allowed the team to advance the progress of the NPD, but such improvised interpretation also incurred an extra workload (i.e. adding different colours to the metal lock).

Example I

The team improvised by asking for resident engineers' help to work during off-duty time to produce blade samples. Consequently, the team advanced the progress of NPD, but working in an understaffed factory after working hours may be risky as many specialised professionals would not be on the site (e.g., machine maintenance staff, and mould specialists).

Example J

The team improvised by asking outside companies for help to borrow new equipment. However, the team might not achieve the same outcome as the client requested.

Example K

In a technical meeting aimed at improving the blade's sharpness, the team improvised by asking an experienced grinder to carry out the grinding work for the team. As a result, the team obtained the best grinding work possible, but this might negatively influence the helper team's work for a short period.

Example L

The team improvised by borrowing an oil cooler for a week from another team. Although the team acquired the oil cooler, the other team had to make a new arrangement which might have resulted in a delay in their work.

Example M

When implementing a team plan of experimenting with the method of oil cooling, the team improvised by using a phased salt bath cooling approach on site. As a result, the team found the outcome to be surprisingly good, and thus changed the main cooling method to salt bath cooling and used oil cooling as a backup plan.

Example N

In a technical meeting aimed at improving the blade's sharpness, the team improvised by compromising on the speed of the grinding wheel, which resulted in a range for the speed

for the manufacturing. This team improvisation allowed the new blade to exhibit a more balanced quality performance and also created a reasonable engineering operation error for the subsequent manufacturing team which made the manufacturing more feasible. Moreover, the team cohesion may be strengthened by reaching the team consensus on the speed of the grinding wheel because the decision was made by the team.

Example O

In a technical meeting held to improve the resistance to wear of the blade, the team improvised a new method by overlaying each other's ideas, which was beneficial for the NPD because the wear resistance would be more stable. Team cohesion might be improved as the team interacted to combine each other's ideas.