Advancing the science and practice of multiteam systems; an exploratory study

Advancing the Science and Practice of Multiteam Systems; An Exploratory Study

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Abstract

Over the past decade, teams research has shifted from studying individuals and teams to studying networks of teams also known as multiteam systems (MTSs) or “team of teams”. These complex team arrangements are fraught with tensions and trade-offs making them difficult to study and difficult to manage. This presents an interesting paradox: how can we build strong teams that simultaneously work well within systems?

The present thesis brings together findings from two studies to advance the science and practice of multiteam systems. First, a systematic literature review (SLR) of the literature on MTS interventions, following widely accepted good practices for conducting SLRs (i.e., PRISMA). Second, an empirical study that tests a new and native theory in the MTS domain (i.e., Luciano et al., 2018a). Using a cross-cultural, cross-sectional field design, this empirical study tested theoretical propositions pertaining to emergent states (i.e., social identity, psychological safety, collective efficacy) and how the shape and size of a system (i.e., structural features) may divide or disrupt teams in that system, with implications for system outcomes. Adopting a survey design 148 participants were sampled, from 14 systems in nine organisations, based in the Middle East, North Africa, United Kingdom and Australia.

The literature review highlighted (1) a lack of MTS intervention studies and (2) that training teams together yields positive system outcomes with more specific insights concerning coordination skills, frame of reference training and the role of leader-teams in the system. Main findings from the empirical study revealed that the combined effect of structural features of an MTS undermined between-team collaboration, as predicted. However, the same structural features taken individually exerted a positive influence on system collaboration. Thus, implying a tipping point at which the effects shift from positive to negative when combined. Other findings contribute to the debate surrounding the optimal level (team or system) for emergent states in an MTS, specifically the benefit of system

identity and system psychological safety and the disbenefit of team psychological safety and team efficacy on system outcomes. Furthermore, control variables in the study were found to play a significant role in facilitating collaboration between teams (i.e., the presence of a leader-team, system tenure and system size). Taken together these findings answer calls from scholars to sample a broad range of real-world MTSs (Mathieu et al., 2018), report on MTS attributes in a consistent manner (Zaccaro et al., 2020), pay greater attention to emergent states and combine the study of emergent states with MTS attributes to explore interrelationships (Shuffler et al., 2015). This thesis advances the science and practice of MTSs and offers promising avenues for future theory, research and practice.

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Statement of Professional Practice

As a Chartered Occupational Psychologist, I am exempt from the first module (Professional Practice Portfolio) of the Professional Doctorate. This thesis therefore satisfies the requirements for Part 2 of the doctorate (Research Thesis). I provide a summary of my professional practice as context to this thesis.

My work experience spans the breadth of areas within organisational psychology (i.e., psychological assessment at work; learning and development; leadership, engagement and motivation; wellbeing and work; work design, organisational change and development). Over the past 18 years I have had the privilege to work in seven countries across four continents as a consultant or in-house human resources professional in a wide variety of settings, equipping me with rich cross-cultural experiences. In my current capacity I work for a regional telecommunications company in the United Arab Emirates and lead company-wide transformation efforts. In keeping with this designation, I am truly passionate about helping companies to transform and helping people and teams to adapt to the modern work context.

Earlier in my career as I undertook the Qualification in Occupational Psychology, I worked for a London local authority during a period of unprecedented change in the United Kingdom public sector. As a member of the organisational development team, facilitating systemic interventions to drive team and organisation-wide outcomes was central to my role. Later, I became a business change consultant for a multinational professional services firm, this gave me exposure to several large clients and eventually I moved to the United Arab Emirates to lead a transformation program in the aviation sector. I moved on to take up a role in a talent and leadership consultancy, in this capacity I had the opportunity to work with clients in Japan and the United States to identify and develop their executive talent.

After almost five years as a consultant, I was keen to expand my in-house experience, and took up a unique opportunity with a scale-up technology company, to lead the talent, learning and culture agenda. My remit included establishing a talent philosophy and processes to embed performance management, succession planning, learning and development, corporate culture and diversity and inclusion. I joined this company when it was 300 people strong, when I left it had reached 3,000+ and had been acquired representing the largest exit of a Middle Eastern start-up. Being part of a company culture steeped in the “tech start-up” space and the phenomenal growth that ensued during my tenure was a career defining and truly memorable experience. During this period, I worked closely with highly interdependent and geographically dispersed teams hailing from diverse functional backgrounds. I became fascinated by the tensions and trade-offs arising between them and curious to understand more about the inner workings of these complex systems. I turned my attention to the teams’ literature and began learning about the new era of teams and teamwork; multiteam systems.

CHAPTER 1
Background to the Research

This chapter sets the scene for the overall thesis, first with a commentary on the modern context of work and working in teams; then an introduction to a modern team arrangement, multiteam systems (MTSs); third, the unique challenges inherent in these complex systems and how those challenges differ from working in more traditional standalone teams are discussed; finally, the chapter closes with a summary of the theoretical developments informing practice and extant research in the MTS domain.

The Changing Landscape of Work and Working in Teams

Teamwork in the modern workplace is being redefined in response to the changing macroenvironment, such as globalisation, digitisation and other global trends shaping our personal and professional lives (Wageman et al., 2012a). Globalisation has led to increased competition and more dynamic marketplaces for corporations, in turn requiring them to be leaner, faster to-market and more adaptive to change. Many organisations are using work teams to achieve this kind of agility (Sundstrom, 1999; Mathieu et al., 2008) and an increasingly global marketplace requires the bringing together of teams with diverse backgrounds and skills to solve the most complex problems (Tannenbaum et al., 2012). In addition, rapid advances in technology allows teams to interact at a distance, facilitating diverse teams and dispersed teamwork. The cost of travel and more recent travel restrictions in response to the global pandemic of 2020, requires organisations to think differently about how they get work done. While many organisations have adopted remote and flexible working models for decades, since 2020 the pace of adoption has accelerated with obvious implications for teamwork and team structures (McKinsey, 2020).

Our understanding of teamwork has advanced significantly over the past century, and we know a lot about what makes teams effective from the numerous meta-analyses and reviews (e.g., Hughes et al., 2016; Mathieu et al., 2017; Salas et al., 2018). Kozlowski and Ilgen (2006), define a team as:

> Two or more individuals who; (b) socially interact (face-to-face or, increasingly, virtually); (c) possess one or more common goals; (d) are brought together to perform organisationally relevant tasks; (e) exhibit interdependencies with respect to workflow, goals, and out- comes; (f) have different roles and responsibilities; and (g) are together embedded in an encompassing organisational system, with boundaries and linkages to the broader system context and task environment. (p. 79)

While these tenets of a team still apply today, historically, teams have been characterised by shared attributes, stable membership and coupled with members from the same team unit who are usually co-located and interact face-to-face (Hackman, 2012; Tannenbaum et al., 2012; Wageman et al., 2012a). This contrasts starkly with how teams are composed today, which is highly dynamic and can comprise members from multiple organisations or multiple teams within an organisation (multiteam membership) and a more fluid movement of members in and out of teams, that rely on technology to interact across space and time (geographically dispersed) (Hackman, 2012; Tannenbaum et al., 2012). Real world examples that highlight this dynamic composition include “flash teams” for example those put together for disaster response and emergency surgery, project-based organisations such as professional services and journalism teams, to name a few.

In this new era of work dominated by fluid, diverse and heterogenous team-based networks, research and practice from the traditional, hierarchical team contexts of yesterday, do not readily apply (Harrison & Humphrey, 2010; Mathieu et al., 2017). Wageman et al. (2012b) highlighted the gap between the team research agenda and how teams operate in the field and consensus is building that teams research, focused on the archetypal team does not accurately represent the dynamic composition of modern teams nor their distributed nature, thus creating a need for higher level team conceptualisations and a greater elucidation of team dynamics (Murase et al., 2012; Wageman et al., 2012a).

Over the past two decades a new organisational form, a meso-level of analysis that is neither the team-level nor the organisation-level, has emerged in the literature, to keep pace with modern team formations (it has been around in practice for far longer); *multiteam systems* "conceptually, MTSs emerged as a new unit of inquiry and analysis in which a tightly coupled network of teams need to coordinate their efforts to achieve one or more goals in addition to those of the component teams " (Luciano et al., 2018a p. 3).

Multiteam Systems: What are they? Where do they Operate?

The scholarly interest in MTSs has proliferated in recent years. Prior to 2014 there was an average of 2.9 papers examining MTSs per year, since then that number has increased to 14 (Zaccaro et al., 2020). This interest is driven by the modern context of work and the recognition that the science and practice of "teams" in the traditional form is unable to solve the complex problems of today and tomorrow (Mathieu et al., 2017, Tannenbaum et al., 2012; Wageman et al., 2012a).

The MTS unit of enquiry shifts the focus from individuals working together as a team, to teams working together as a system. The widely accepted definition of an MTS from the seminal work of Mathieu et al. (2001), sets the threshold at which a group of teams become a system along with other defining characteristics:

> Two or more teams that interface directly and interdependently in response to environmental contingencies toward the accomplishment of collective goals. MTS boundaries are defined by virtue of the fact that all teams within the system, while pursuing different proximal goals, share at least one common distal goal; and in doing

> so exhibit input, process and outcome interdependence with at least one other team in the system. (p. 290)

Teams that work together in an MTS are referred to as component teams, they are distinct units and as is evident from the definition they must still work effectively as a team to achieve their own (proximal) team goals. To also achieve common shared (distal) goals in collaboration with other teams in the system, a goal hierarchy is used as a "linking mechanism" to combine the effects of team goals to achieve superordinate system goals (Marks et al., 2005).

MTSs overcome the principle from the teams' literature that "large teams are bad teams" (Mathieu et al., 2017, p. 461) and by design, an MTS allows for effective mutual adjustment between-teams in real time, that would not be possible between numerous members of one large unit (Davison et al., 2012). They represent an advancement in the teams' literature, where team and organisation-level research failed to explain emerging system-level phenomena (DeChurch & Zaccaro, 2010), and which should be distinguished from other team-based organisational forms such as matrix organisations, the emphasis on between-team collaboration is typically much higher within MTSs (Mathieu et al., 2001).

Initially, the MTS context was primarily used to describe the coordination of multiple teams in high stakes environments for example emergency teams that respond to environmental incidents requiring the coordination of firefighters, police, emergency medical technicians, and hospital teams (DeChurch & Marks, 2006), collectives that "are neither typically full-fledged organisations nor singly teams operating in isolation" (Mathieu et al., 2001, p. 289). However, perspectives have since coalesced that MTSs live and operate across a vast array of domains, to include complex inter-organisational teams, multi-team project management and global business operations (Dietrich at al., 2013; O'Leary et al., 2011). Due to their salience in organisational settings as they describe a network of teams, MTSs became a budding area of interest in group and organisational research (Shuffler et al., 2015; Mathieu et al., 2001). As such, multiteam systems may be “internal”, in other words comprised of teams within the same organisation, for example new product development teams (Marks & Luvison, 2012) or “external” comprising teams that span across organisational boundaries such as emergency disaster response (DeChurch et al., 2011).

Defining Features of an MTS

Given the breadth of settings where MTSs operate and the broad definition, MTSs vary across a plethora of attributes or characteristics. Zaccaro et al. (2012) furthered the literature by offering a framework or typology to classify MTSs by attributes, grouped into three categories: compositional, linkage and developmental. *Compositional attributes* describe the overall demographic characteristics of the MTS and its component teams. This includes: size, the number of individuals and teams in the system; cultural diversity; functional diversity; other demographic diversity measures (e.g., age, gender, tenure etc.); geographic dispersion; boundary status (i.e., whether teams are “internal” from a single organisation or “external” spread across more than one organisation); the temporal orientation of teams (i.e., whether component teams have varying levels of responsibility toward goal completion) and motive structure (i.e., compatibility of goals at varying levels of the MTS goal hierarchy), (Zaccaro et al., 2012; Shuffler et al., 2015). Zaccaro and colleagues (2020) more recently went on to aggregate some compositional attributes to structure a review of the literature. They grouped compositional attributes of geographical, cultural and functional diversity as “component team distance” (CTD) and sorted the literature according to whether MTSs were high, medium or low on this variable.

Linkage attributes as the name suggests, refers to how the teams within a system connect, or link together. Linkage attributes include: the nature and degree of task interdependence between teams in the system, which is a defining feature of an MTS;

hierarchy and power, the degree to which an MTS is organised into a hierarchy (hierarchical arrangements) and the distribution of power in the system (power distribution) including whether a leader-team is formally established and also informal linkage structures such as social relationships and psychological states. Finally, linkage attributes also cover the communication structure (i.e., centralised or decentralised) and the mediums used to communicate (i.e., mixed methods or single mode of communication; Zaccaro et al., 2012).

Developmental attributes refer to how an MTS is formed and matures over time (including how the compositional and linkage attributes evolve with time). Development attributes include; genesis, how the MTS came into existence (i.e., formally appointed or emergent in nature); tenure or lifespan (i.e., short-term, project-based or more long term, permanent systems); stage (i.e., newly formed or well established); membership consistency (i.e., the degree to which the system experiences member and team churn) and linkage consistency (i.e., the degree to which the linkages between teams are stable over time; Zaccaro et al., 2012; Shuffler et al., 2015).

More than the Sum of its Parts

It is the premium on between-team collaboration along with superordinate goals, that distinguishes MTSs from other team configurations (Zaccaro et al., 2012). As team-based collectives, MTSs require both within and between-team collaboration, however within-team collaboration is not considered sufficient for overall system performance by many MTS scholars (e.g., DeChurch & Marks, 2006; Marks et al., 2005; Cobb, 2000; Cobb & Mathieu, 2003; Firth et al., 2015; Davison et al., 2012). As has often been found with standalone or traditional teams (Steiner, 1972; Baumeister., 2016); MTS performance (i.e., the “whole”) is more than the sum of its constituent parts (i.e., team; DeChurch & Mathieu, 2009), but it is the collaboration between-teams in the system that will play the defining role for overall system success (Connaughton et al., 2012).

Let us consider a real-world example; the Mars Climate Orbiter (MCO) satellite, a robotic space probe launched on 11 December 1998, purposed to better understand the climate and surface characteristics of Mars, it weighed 338Kg and cost $125m to build. This MTS comprised three component teams; the systems development team that created the necessary equipment and software; the project management team that provided leadership and overall project management and the operations team that oversaw the launch and flight of the Orbiter once it was in space. The mission failed. Termed a "mishap" in the investigations report which stated that the Orbiter came too close to the upper atmosphere of the planet, causing its destruction, or it continued on into heliocentric space after leaving Mars' atmosphere (Mars Climate Orbiter, 1999). This mishap resulted in the loss of a $500 million multiyear effort. Considering each component team in isolation, the teams were successful in meeting their proximal goals, the Orbiter was built and launched, costs were managed, it was monitored and tracked throughout the nine-month journey, however the superordinate, distal goal was not achieved. The investigation uncovered the root cause:

> The MCO MIB has determined that the root cause for the loss of the MCO spacecraft was the failure to use metric units in the coding of a ground software file, "Small Forces," used in trajectory models. Specifically, thruster performance data in English units instead of metric units was used in the software application code titled SM_FORCES (Small Forces; Mars Climate Orbiter, 1999, p. 6)

Essentially the systems development team worked with different measurement units to the units adopted by the operations team responsible for flying the Orbiter. These norms and processes are not problematic at the team-level, but between-team differences caused catastrophic repercussions for the system and this failure to synergise between the teams was recognised as the ultimate failure.

This example illustrates why coordination and communication are focal issues in MTS research (Dietrich et al., 2013) and what has been cited as a primary reason for MTS failure (Shuffler & Carter, 2018). It reinforces the proposition that team performance is insufficient for overall system functioning and underscores the unique considerations for teamwork situated in a system of interdependent teams (Marks et al., 2005, Shuffler & Carter, 2018).

Countervailing Forces

Teams are the building blocks of MTSs (DeChurch & Mathieu, 2009), and as such the teams' literature and team-level constructs (such as communication, coordination, leadership), naturally provided a foundation for early MTS research (DeChurch & Marks, 2006; DeChurch & Zaccaro, 2010; Marks et al., 2005). However, the complexity of within-team and between-team dynamics, unique to multiteam environments uncovered counterintuitive effects when applying team theory to MTSs. For example, if we consider Tajfel's Social Identity theory that purports we look more favourably upon those in our ingroup and less favourably on those in the outgroup (Tajfel, 1978), in a multiteam context the component team represents the ingroup and everyone else (i.e., other teams) become the outgroup, which is problematic when teams are interdependent, required to collaborate well together for system success; outgroup members are required for the ingroup and system success.

MTS scholars refer to such phenomena with counterintuitive effects at team and system-levels as "countervailing" forces (Asencio et al., 2016; DeChurch & Zaccaro, 2013). This is not unique to one construct or process, countervailing effects have been found in social/affective processes in the MTS literature such as cohesion and trust (e.g., DeChurch & Zaccaro, 2013); Identity (e.g., Porck et al., 2019); they have been reported with behavioural processes such as decentralised planning; known to benefit standalone teams but found to do more harm than good when applied to MTSs (Lanaj et al., 2013) and coordination processes (e.g., Firth et al., 2015; Rico et al., 2018; DeChurch & Zaccaro, 2013; Davison et al., 2012). "Sometimes what 'pushes' a single team in the right direction toward effective team functioning may also be what 'pulls' apart functioning between teams in MTSs, or vice versa." (Shuffler & Carter, 2018, p. 397).

With MTS science still at a nascent stage (Ervin et al., 2018; Power, 2018; Shuffler & Carter, 2018), researchers have called for a shift in thinking, to reconceptualise and re-examine team phenomena through an MTS lens to better understand how to balance both team and system phenomena for overall success (Shuffler & Carter, 2018; DeChurch & Zaccaro, 2010; Shuffler et al., 2015) and solve the puzzle of how to enable performance at the team and system-level simultaneously (Luciano et al., 2018a).

Theories and Models of MTS Functioning

The trade-off between team and system performance led Rico and colleagues (2018) to describe an MTS as a "tension system". What theories and models are available to help practitioners and academics navigate these tensions and distil what facilitates MTS functioning?

Antecedents of MTS Functioning

Shuffler et al., (2015) set direction for subsequent theoretical and empirical forays into MTSs with a timely review of the literature. Leveraging Zaccaro et al. (2012) classification of MTS attributes (i.e., compositional, linkage and developmental), Shuffler and colleagues reviewed 38 empirical studies conducted across disciplines (e.g., military, business, healthcare) and settings (e.g., laboratory, field, quasi-experimental). They presented an MTS research framework as a "working heuristic" which identified the critical factors for MTSs and offered a holistic view of how the MTS attributes impact within and between-team processes, emergent states and outcomes and the interplay among them (Shuffler et al., 2015). Emergent states may be cognitive, motivational, or affective in nature. Sometimes referred to as affective, motivational, cognitive and psychological states. They are described in the literature as dynamic properties which emerge over time and manifest at the group rather than individual level, affected by team context, inputs, processes and outcomes (Marks et al., 2001).

Shuffler et al. (2015) mapped their framework to the team effectiveness model; the input-mediator-output-mediator (IMOI), adapted by Ilgen et al. (2005) from the classic input-process-output (I-P-O) model of teams, Shuffler and colleagues illustrated that the MTS compositional, linkage and developmental attributes (e.g., size, diversity, interdependence, hierarchy, genesis and stage) served as inputs (antecedents), influencing within and between-team processes and outcomes and commented on the inter-relationships of these attributes as shaping one another over time. The resultant model is shown in Figure 1.

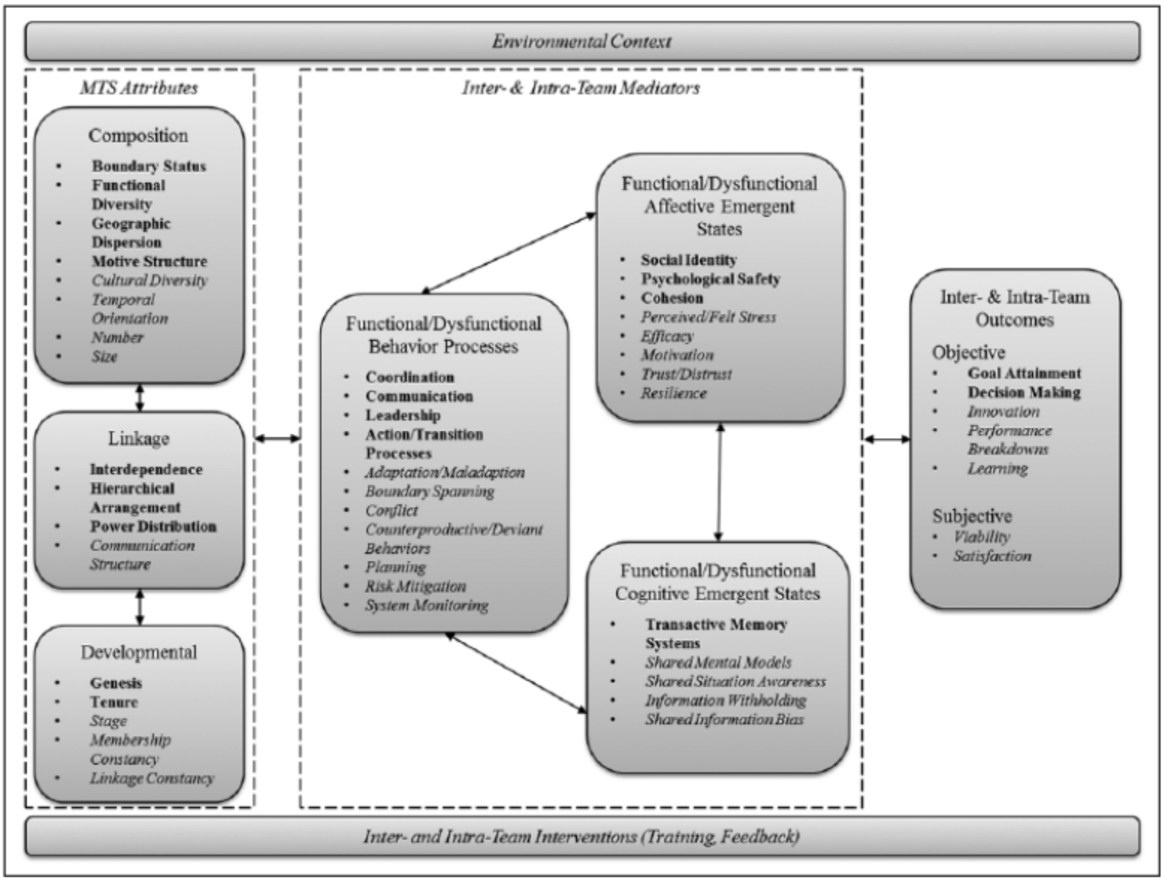
Mediators of MTS Processes

Shuffler and colleagues (2015) identified a comprehensive list of mediating elements, or "functional/dysfunctional processes and emergent states", within the framework. From a review of the literature, they noted that most of these processes and states originated from team-level phenomena but there was a predominance in the MTS extant literature on behavioural processes (>75%) such as coordination, leadership and communication, over the study of potentially equally important emergent states such as identity, psychological safety and cohesion (affective states) and transactive memory system, shared mental models (cognitive states; Shuffler et al., 2015). They highlighted the countervailing effects that many constructs had within-team versus between-team and called for further research into the interplay of these functional and dysfunctional processes and states at the team and system-level of study to further understand what facilitates MTS performance:

> In terms of affective states, social identity, psychological safety and cohesion have been explored empirically to some degree, with effects generally supporting that

Figure 1

MTS Research Framework



Source: Shuffler et al. (2015)
Note. Bold terms refer to constructs that have received significant empirical/theoretical attention, whereas italicised terms are constructs in need of future research/theory.

> while such constructs may be functional at the team and system-levels, they may be uniquely operationalised at each level and may have negative cross-level effects. (Shuffler et al., 2015, p. 28)

Providing further direction for future study, Shuffler and colleagues underscore the importance of studying emergent states in tandem with MTS attributes due to the potential for interactive effects.

MTS Outcomes

In reference to outcomes, the framework identified MTS goal attainment and decision making as those measures receiving most attention in the literature, with opportunities to explore other outcome measures such as innovation and creativity. Shuffler et al. (2015) called for a greater understanding of how system attributes may affect different outcomes via mediators, which could consequently go on to impact future performance episodes of the MTS.

Shuffler et al. (2015) added two broad components to their framework to cover environmental context and interventions as influencing factors ripe for further study. Drawing attention to early research findings which showed the beneficial effects of training MTS members on team and system outcomes (Bienefeld & Grote, 2013; DeChurch & Marks, 2006; Firth et al., 2014), Shuffler and colleagues highlighted the dearth of true intervention studies and the pressing need for this line of research to robustly inform professional practice (Shuffler et al., 2015).

Multilevel Frameworks

With the uptick in MTS extant research since Shuffler et al. (2015) review (noted by Zaccaro et al., 2020) but with a stark gap in theory, this recent review of the literature maintains that the conflicting findings in MTS research remain unexplained by models to-date (Zaccaro et al., 2020); increasingly, researchers are calling for "new and native theory on MTSs" to advance our understanding of these unique organisational forms (Luciano et al., 2018a, p. 1069) and specifying a requirement for more advanced analytical techniques that account for temporal factors in the development of multilevel theories. (Turner et al., 2020).

Multilevel theoretical approaches to advance the MTS domain are emerging to better conceptualise MTSs and provide a testbed for further study, these include a new MTS effectiveness formula (Turner et al., 2020), a framework for coordination and MTS performance (Rico et al., 2018) and a conceptual model for motivation and performance in MTSs grounded on goal hierarchies (Rico et al., 2017).

Despite these promising theoretical developments and a variety of MTS studies, the complexity of MTSs unveiled conflicting research findings, limiting synthesis and application; a unifying theory remained elusive in the MTS domain, plaguing researchers:

> Researchers have wrestled with many issues, including explaining the distinctiveness of the form, conflicting results, variations in team- and system-level dynamics, and the accumulation of knowledge. Practitioners have struggled with a seeming paradox of building strong teams that simultaneously function effectively as a system. Too often, issues of critical importance fall into the rifts between the teams. (Luciano et al. 2018a, p. 1088)

Organisational research to-date has largely studied levels in the hierarchy in a disconnected manner with different assumptions and methodological perspectives for each (Roberts et al., 1978). The conception of organisations as nested entities and the connection between micro, meso and macro levels of analysis is finally being attended to by multilevel theory which offers promising avenues for future researchers (Kozlowski & Chao, 2012).

Multidimensional Framework and Meso-Theory

In 2018, Luciano and colleagues published a multidimensional framework and meso-theory of MTS functioning. MTSs are consistently referred to as “complex” in the literature, but very few have been able to show precisely how they are complex and why it matters. With this unifying theory, Luciano and colleagues answer these two questions. Firstly, their multidimensional framework defines two key structural features of an MTS; differentiation, the degree of difference and separation between MTS component teams, this generates boundary-enhancing forces on the system (reinforcing divides between the teams). The second feature is dynamism, which describes the variability and instability of the system over time (which destabilise and create uncertainty), this creates disruptive forces on the system (Luciano et al., 2018a). In keeping with recommendations by Ranson et al. (1980) for the structuring of organisational structures and how to advance a unified theoretical framework, Luciano and colleagues addressed both the shape of an MTS (i.e., differentiation) and how it changes over time (i.e., dynamism), thereby presenting a structural framework as the linking mechanism to their meso-theory.

In parallel with life space theories by Lewin (1943), a meso-perspective allows for various sources of influence from multiple levels of analysis on a particular criterion, and as such meso-thinking maintains a confluence of these sources of influence (House et al.,1995; Rousseau, 1985). Systems theorists recognise the duality of structure and process with top down and bottom-up effects (e.g., Allport, 1954; Katz & Khan, 1966). The meso-level is influenced by the macro context (i.e., structural features) that shapes the emergence of micro-level phenomena (i.e., individual and team constructs; Hackman, 2003). Luciano et al.'s (2018a) meso-theory connects the structural dimensions of differentiation and dynamism, and the resulting social-psychological forces (boundary-enhancing and disruptive) with their impact on individuals, teams and the system overall (Luciano et al., 2018a). By covering all three levels implicit in an MTS, Luciano and colleagues overcome a pitfall of existing research which predominantly focused on team and system-level of analysis (Luciano et al., 2018a) and ignored the individual level which Kozlowski et al. (2013) referred to as the essential foundation of between-team dynamics in an MTS.

With Fiske's (2004, 2009) social cognition theory as the foundation, Luciano and colleagues propose that the boundary-enhancing and disruptive forces created by the structural features of an MTS (i.e., differentiation and dynamism) direct individual members' belonging needs and their affective and cognitive motives to either the team or system-level dependent on how great the forces are (i.e., low to high differentiation and dynamism), in turn the individual needs and motives manifest as emergent states (i.e., social identity, psychological safety, collective efficacy) at the team or system-level with different implications for between-team collaboration, such that team-level emergent states will hinder it, but system-level emergent states will be conducive to overall functioning (Luciano et al., 2018a).

> Much of the research on MTSs thus far has focused on exogenous factors, such as coordination and leadership (e.g., Davison et al., 2012; DeChurch & Marks, 2006; Lanaj et al., 2013; Marks et al., 2005), which are more akin to surface ripples of the major structural forces creating the deep currents within these systems…this framework provides a theoretical foundation of the domain as well as a common language for MTS work, thereby facilitating the accumulation of knowledge. (Luciano et al., 2018a, p. 1089)

The multilevel framework and meso-theory addresses gaps in the literature for a unifying framework and a reflects a concerted effort to encompass understudied emergent states and their role in MTS functioning.

Thesis Objectives

While the new MTS framework clearly addressed a gap in the literature, it has yet to be tested empirically (to the best of the author's knowledge). There is still much to be known from a practitioner perspective in terms of what works and how best to develop and sustain MTSs. Therefore, this thesis seeks to advance theory and practice, first, with an update on previous systematic literature reviews and a specific focus on the intervention literature in the MTS domain. Chapter 3 presents a systematic review of the literature in a bid to answer the following question: "*What interventions facilitate MTS functioning and by which mechanisms?"*

The second objective of the present thesis, answers calls from scholars to: (1) sample a broad range of real-world MTSs (e.g., Mathieu et al., 2018; Luciano et al., 2018a), (2) report on MTS attributes in a consistent manner (e.g., Zaccaro et al., 2020); (3) pay greater attention to emergent states (e.g., Shuffler et al., 2015); and (4) combine the study of emergent states with MTS attributes to explore interrelationships (e.g., Shuffler et al., 2015). The second study will empirically test the meso-theory presented by Luciano et al. (2018a) and their propositions (Chapter 4) and aims to answer the overarching question *"How do structural features (i.e., differentiation and dynamism) and emergent properties of an MTS (i.e., needs and motives), influence system functioning (i.e., between-team collaboration)?"*. In doing so, detailed information related to MTS structure and attributes across a variety of real-world settings will be gathered and examined in-line with the theoretical propositions. Furthermore, the interaction between emergent properties, system structure and attributes, and system outcomes will be explored across all three levels incumbent of an MTS (i.e., individual, team and system), ultimately seeking to advance the science and practice of the MTS domain.

These thesis objectives will culminate in a final conclusions chapter to synthesise the findings and make recommendations for future theory, research and practice.

CHAPTER 2
Methodology

Having set out the aims and objectives of the research in the preceding chapter, this chapter introduces the overall methodology adopted in the present thesis. Starting with an introduction to research philosophy and an outline of the researcher's pragmatic-critical realist stance, followed by the rationale for the approach employed in two studies, a systematic literature review and a quantitative empirical study. The merits of a systematic literature review are discussed, in addition to potential weaknesses and which tools were selected for the review and why. The cross-sectional field study design employed for the empirical study, is compared, and contrasted with alternative research designs along with the grounds for deploying two distinct survey instruments. Specifically, the utility of single-item survey measures is discussed, along with the design choices made in the study to balance survey length with robust measurement. Finally, the chapter concludes with a justification for the chosen analytical approach and steps taken to address ethical considerations.

Research Philosophy

Some authors will use the terms "methodology" and "method" interchangeably, however, many scholars have suggested that the terms, although they are related, should not be used interchangeably because they are not the same thing (Sikes, 2004; Hussey & Hussey, 1997). Methodology is concerned with an overall strategy or plan of action (Crotty, 1998; Mason, 2002) intricately linked to an author's theoretical perspective or philosophical stance, whereas methods are the techniques used to collect and analyse the data (Hussey & Hussey, 1997) and very much part of the overall strategy (Mason, 2002). Birks and Mills (2011) differentiate between the two, they define methodology as "a set of principles and ideas that inform the design of a research study" while methods are "practical procedures used to generate and analyse data" (p. 4).

Crotty (1995) complained that the terminology used in research literature is confusing, with terms like "epistemology" "ontology" "theoretical perspectives" "methodology" "methods" all "thrown together in a grab-bag style" of non-comparable terms (p. 3). Crotty (1998) went on to describe how they all fit together in a hierarchy to form the research process, known as Crotty's four design elements. Adopting Crotty's design elements, Creswell (2003) developed a research process framework which he suggests, will ultimately guide a researcher to adopt an approach which is either quantitative, qualitative or mixed methods, depending on the underpinning stance. More recently, hailing from the business and management discipline, Saunders et al. (2015) presented their research process model; the research "onion" consisting of six layers which guide researchers through the steps required to create a research design: philosophies (e.g., positivism), approaches (e.g., deductive), strategies (e.g., quantitative), choices (e.g., survey), time horizon (e.g., cross-sectional) and techniques and procedures (e.g., correlational analysis).

In line with these authors, the approach and purpose of the present chapter under the heading of "methodology" is to set out the research strategy and process, from research philosophy through to techniques and procedures employed, and explain the key decisions taken.

Kuhn (1970) introduced the term "paradigm" as a concept to describe a person's set of beliefs forming their world view. A *research paradigm*, therefore, relates to how a researcher's world view exerts an influence over the way in which they conduct research (Krauss, 2005) and has been defined by authors such as Saunders et al. (2012) in relation to examining "social phenomena". A *world view*, is made up of a set of beliefs and assumptions, whether made consciously or not (Burrell & Morgan, 1979), these assumptions may be about the nature of reality, what is real, or as Crotty (1998, p. 10) put it: "the study of being" known as *ontological assumptions*, which fall on a continuum from "there is only one truth/objective reality" to "the world is mostly subjective and open to different interpretations", then there are assumptions about human knowledge, *epistemological assumptions* "how we know what we know" (Crotty, 1998, p. 8) which are concerned with what kinds of knowledge is possible and how we ensure it is legitimate (Maynard, 1994). Epistemological assumptions are closely linked to one's ontological stance. Lastly, there are *axiological assumptions*, the extent to which personal values influence the research process (Saunders et al., 2009).

Scholars have differentiated between a few major types of research philosophies with fundamentally different ways of seeing the world (based upon their underlying ontological, epistemological and axiological assumptions) and which subsequently determines the research design. Different research philosophies typically fall on a paradigm continuum from *objective*, there is only one or limited "truths", which can be measured or quantified, to *subjective*, there are multiple "truths" and accurate measurement is not always possible or desired (Mason, 2014).

Philosophical Stances in the MTS Domain

Two major research philosophies falling at opposite ends of this continuum are positivism (sometimes called scientific) and interpretivism (or anti-positivist) (Galliers, 1991). MTS research reflects a diverse mixture of different theoretical positions that fall along the continuum, for example, conceptual papers that stem from an interpretivist stance at one end and quantitative studies that may be underpinned by a positivist stance at the other with a plethora of different philosophical positions in between.

Implications for this Research

Given the applied nature and the rich information gleaned from both qualitative and quantitative methods that inform this thesis, and the researchers broader thinking, the studies are considered through a pragmatic-critical realist lens. Critical realism is considered to be the middle-ground between a positivist and interpretivist stance (Reed, 2005) and a pragmatic stance, reconciling the two ends of the objectivism and subjectivism continuum that focusses on what works best to answer a given research question (Sale et al., 2002).

Taking this stance strides were made to incorporate the perspectives of both the pragmatic stance and that of the critical realist in several ways. For example, pragmatic in the sense that a quantitative approach was applied to answer a research question that required a quantitative methodology and critical realist in that the researcher was cognisant of the fact that both participants and researchers bring a unique lens to understanding an MTS. This appreciation influenced the choice of questions, the way the questions were posed, the measures used and approach to data analysis and interpretation. Adopting such a stance called for critical reflexive thinking applied at every milestone during the research (see Chapter 6). Consideration was also given to the practical adequacy of the research approach applied to examine the complex and real-world MTS setting.

The two studies in the present thesis answer distinct but complementary research objectives. These objectives were derived from a thorough review of the multiteam systems literature (outlined in Chapter 1) which highlighted gaps in our understanding of what facilitates multiteam functioning. Each study methodology is outlined below along with a rationale for the methods selected and key decisions taken during the design stage.

Study 1: Systematic Literature Review

What is a Systematic Review and how does it Compare to Other Reviews?

Systematic literature reviews originated in the medical field in the early 1970s, owing to the work of Archie Cochrane who was concerned that medical decisions and practices were not based on sound, up-to-date evidence. Toward his vision for evidence-based medicine, Cochrane was pivotal in the formulation of the systematic review methodology (Shah & Chung, 2009). Defined by Cook et al. (1995), a systematic literature review is: “the application of scientific strategies that limit bias by the systematic assembly, critical appraisal and synthesis of all relevant studies on a specific topic." (p. 167).

The practice of systematic reviews has since expanded from medicine to other disciplines such as Management (e.g., Ellwood et al., 2017; Nguyen et al., 2018) Work and Organisational psychology (e.g., Donaldson-Feilder et al., 2019; Robertson et al., 2015) and Health and social care (e.g., Nicaies et al., 2013). A crucial tool for (and foundation of) evidence-based practice, systematic reviews of existing knowledge and evidence, informs policy and supports decisions about research and practice by concluding "what we know and what we do not know" about subject area or question (Briner & Denyer, 2012, p. 112). Unlike other literature reviews, systematic reviews provide a synthesis of the literature that is robust, transparent and replicable (Torraco, 2005). They are robust, because they follow an appropriate design to answer specific questions, akin to well-designed primary research, which is structured but not inflexible and overcomes bias often inherent in other types of literature reviews where authors can pick and choose the literature to support their empirical study. The transparent and replicable nature of SLRs further differentiates them from other reviews which do not openly share their methodology for gaining the literature, further perpetuating bias. In sum, as a research methodology, a systematic review sets out to answer specific questions, follow a consistent process and adhere to a set of core principles to make sound conclusions (Briner & Denyer, 2012).

Despite the advantages of conducting a systematic review, there are some limitations such as inadequate literature searches that discard relevant data and heterogeneity of studies included in the review which can lead reviewers to draw inaccurate conclusions (Jahan, Naveed & Zeeshan, 2016; Burke, 2011). Wright et al. (2007) explain that "Heterogeneity is a double-edged sword; it improves external validity at the cost of internal validity" (p. 23). Hence, adopting narrow inclusion criteria, a core feature of an SLR, creates more homogenous data. Morrell (2008) wrote a polemic about the narrative surrounding evidence-based management, for which systematic reviews are a central tenet. A main argument in his critique is one of defamiliarization; that in using terms like “systematic” “transparency” “evidence” and “narrative”, evidence-based management and systematic reviews draw parallels with a “higher prestige discipline of medical science” where systematic reviews originated and achieve credibility in doing so (p. 618). Other authors have supported this view and challenged the extent to which management studies can be developed as a science given fundamental differences in ontology and epistemology (Pawson, 2001; Learmonth & Harding, 2006). Termed “paradigm wars” by Weick (1999), Khun (1970) differentiates between scientists, who adopt a shared paradigm or consensus about what is a problem and how to solve it, which produces widely accepted knowledge, versus social scientists and organisational research, which he opined, remain mostly conflicted on the fundamentals (Learmonth & Harding, 2006). Morrell goes on to describe further limitations of systematic reviews in relation to the method of accumulation, which can be problematic when aggregating insight from individual, team and organisation levels of analysis. While proponents of systematic reviews (e.g., Petticrew, 2003) acknowledge that there are different types of research synthesised in a systematic review, there is no common framework to compare findings from studies conducted in different research paradigms (Morrell, 2008).

Briner and Denyer (2012), posit that many of the “perceived weaknesses” of a systematic review are in fact the result of commonly held myths, for example “*Systematic reviews require the adoption of a positivistic scientific approach:* Systematic reviews can be conducted from many different science approaches depending, again, on the review question and the assumptions underlying it.” (p. 127). The authors offer a critical appraisal checklist (see Table 1) to overcome some of the weaknesses of a systematic review and ensure that the review is of good quality.

Implications for this Research

Briner and Denyer's (2012) critical appraisal checklist, including items such as *"Was a rational and need for the review stated in relation to previous research and review*" and *"Was the review question clearly defined in terms of population, interventions, comparisons, outcomes and study designs (PICOS) or other relevant framework?"* was adopted to develop the approach taken to conduct the systematic review in present research.

There were several other tools selected for use in the planning and execution of the present study, to ensure good practice. These included the PRISMA checklist, preferred reporting items for systematic reviews and meta-analyses (Moher et al., 2015), the SPIO framework (Study design, Participants, Interventions and Outcomes; Robertson et al., 2015) to help focus the research question and formulate the inclusion and exclusion criteria. SPIO is an adapted version of PICO (Patient groups, Interventions, Comparison, and Outcomes), where PICO is commonly used in systematic reviews in medicine, both frameworks are suited to reviews concerned with intervention studies. Finally, assessing the quality of the evidence is an essential step for any good quality systematic review and there are many tools available to facilitate this process, each suited to different types of studies (Petticrew & Roberts, 2006). The Snape checklist was selected for the present study, because it was designed to appraise quantitative evidence of intervention effectiveness (Snape et al., 2017) and has been widely applied to appraise literature in the wider occupational field (e.g., Donaldson-Feilder et al., 2019).

Study 2: Empirical Research

Research Design

The findings from Study 1 and an in-depth review of the literature described in Chapter 1 and Chapter 4, highlighted the following gaps (1) a lack of MTS field studies reporting on attributes in a consistent manner; (2) a lack of understanding on how emergent states impact MTS functioning; (3) a lack of studies exploring all three levels of analysis in an MTS (i.e., individual, team, system) and (4) a lack of unifying theory in the MTS domain. The second study was designed to address the aforementioned gaps. Chapter 4 presents the second study, a field study that employed a cross sectional design to empirically test a meso-theory of system functioning. The meso-theory (Luciano et al., 2018a) is fully explained in both Chapter 1 (introductory chapter) and Chapter 4 (empirical introduction).

The choice of field study offers greater realism and generalisability of findings than a laboratory or case study would, bolstered by the breadth of MTSs sampled. While a longitudinal temporal design is far more suited to make inferences about causal relationships and processes, getting access to a wide range of MTSs at more than one point in time was unfortunately not feasible. Nevertheless, in the present study, design choices were made to alleviate endogeneity concerns. Data captured from 14 different systems, nine organisations and more than one sources of data (team members and point of contact/leader) sought to address common method variance, frequently associated with cross-sectional designs. Additionally, the inclusion of carefully selected control variables sought to address omitted variable bias.

Research Methods

Surveys. A primary benefit of survey research is the ability to study many variables at a time, often many more than is feasible in a laboratory study. Given the objectives of the present study, two survey instruments were designed to investigate a range of individual, team, and system-level constructs in relation to structural features of the MTS, as defined by the meso-theory (Luciano et al., 2018a) for which the study was testing.

There are several sources of bias inherent in survey research which the study aimed to overcome. First, the self-selecting nature of survey respondents was addressed by carefully crafted communications disseminated by the point of contact for each system, this was a person of influence over the team members in terms of hierarchy (usually a business or human resources leader). To ensure maximum participation, the communication included a description of the purpose of the research and the perceived benefits that would be realised (by individuals, teams, and system). The point of contact continued to follow up with subsequent communications to ensure maximum response rates were achieved. A second source of bias common with survey research relates to the point in time when a survey is conducted. This was mitigated by capturing data on and then controlling for, the genesis of the system i.e., how long since its inception or the stage of system development. Finally, careful consideration was taken to minimise the researchers own bias in the design of survey items by tying these to well-validated scales where possible, and the underpinning theory. The survey design and deployment decisions for each instrument is outlined below.

The first survey instrument was developed to gather data from a single point of contact who was familiar with a given system and who could provide descriptive information about the system, such as the number of teams in the system, the geographic dispersion, how and when the system genesis came about and an evaluation of between-team collaboration and overall system performance. The point of contact was also asked about two structural dimensions of the system, differentiation and dynamism, which are central tenets of the theory being tested. The items for differentiation and dynamism were developed based upon the detailed descriptions presented in the theory. For each dimension there were five sub-dimensions or factors and for each these, Luciano et al. (2018a) provided an overall description, and an anchored rating scale with descriptions for low, medium, and high levels for each factor. Due to the complex nature of these dimensions and the likelihood that respondents would need some clarification, the survey was deployed in the form of a structured interview conducted virtually, whereby the researcher guided the participants through the instrument orally. This allowed for a more consistent measure of differentiation and dynamism across the interviewed subjects.

The second survey was deployed after gathering data from the point of contact. The instrument was developed to gather data from all members of a given system via an online survey (Qualtrics platform), which may or may not have included the point of contact. The items included in the online survey aimed to gather data from team members about the individual, team and system-level constructs being tested, the constructs were taken directly from Luciano et al. (2018a). To ensure a robust instrument, validated scales with strong Cronbach's alpha were sought for each of the variables. However, with nine variables to study in one survey and each item repeating at team and system-level of analysis there was a trade-off between two equally important and competing factors; the length of the survey (inherently linked to participation) versus use of full validated scales. During the recruitment stage of the study and considering insights from discussions with potential participant organisations, survey length was deemed to be a critical success factor. Therefore, a deliberate design choice was made to seek validated scales with the least number of items to minimise the survey length thereby increasing participant experience and completion of the survey. This was further validated by feedback from two organisations participating in a pilot of the survey instruments. As a result, for two variables the use of a single-item measures was adopted. Given the long and ongoing debate of the validity of single-item measures, the advantages and disadvantages of single item measures is discussed below, followed by a description of the single-item measures adopted in the present study.

Discussion on the Utility of Single-Item Survey Measures. Single-item measures are adopted in academic research with mixed levels of acceptance depending on the construct being measured. For example, measuring self-reported facts such as years of education, age, gender and so on is common practice, whereas measuring psychological constructs such as well-being or job satisfaction, are less well accepted; being discouraged by some scholars (Schriesheim et al., 1991). Wanous et al. (1997) in their defence of single item measures even reported that others considered such measures as a “fatal error”. The main argument against using single-item measures comes down to the issue of internal consistency reliability, which single-item measures cannot estimate and hence they are considered unreliable (Nunnally, 1978).

Multi-item measures or scales, on the other hand, allow for a correction of measurement error. In addition, single-item measures do not support structural equation modelling, which requires an estimation of reliable variance. Despite these reported pitfalls of single-item measures, they have been extensively adopted to measure an array of psychological phenomena, such as: expectancy theory (Ilgen et al., 1981); job satisfaction (Scarpello & Campbell, 1983), social power (French & Raven, 1959); self-esteem (Robins et al., 2001); belonging (Nichols & Webster, 2013) and trust (e.g., Snijders & Keren, 2001). Uslaner (2012) contributed to the item-number debate by comparing single item versus scale measures of trust, he highlighted that indicators do not always tap into the same underlying concept which in turn may decrease the validity of multi-item measures (2011, 75–76). A meta-analysis of the research adopting single-item measures of job satisfaction was found to correlate with longer scales measuring the same construct; .63 and the corrected mean correlation of .67 (Wanous et al., 1997), these findings are further bolstered by other empirical data correlating single-item measures with scales and finding them to be just as valid and reliable (Cunny & Perri, 1991; Loo, 2002; Bergkvist & Rossiter, 2007; Dollinger & Malmquist, 2009; Gardner et al., 1998; Nagy, 2002; Wanous et al., 1997).

Wanous and colleagues went on to posit that the single item measures may in fact be more robust than the scale due to differences in the way the scales were measured and their impact on results, the authors went on to state that “it should be interpreted, however, as a case for the acceptability of single-item measures when either the research question implies their use or when situational constraints limit of prevent the use of scales" (p. 250). It is not uncommon for researchers to need to measure multiple constructs on the one hand, while at the same time ensuring a limited number of survey items reduce cognitive load and demand on participant time or resources (Widaman et al., 2011). Practical limitations such as space on a questionnaire (Cunny & Perri, 1991) or issues of face validity, whereby respondents may resent being asked, what could appear to be repetitive questions, may justify the use of single-item measures (Wanous et al., 1997).

Single-Item Measures Adopted in the Present Research. In the present research, an online self-report survey instrument was designed to measure nine variables described in Luciano et al.'s (2018a) Meso theory of MTS functioning. Well validated scales measuring these constructs ranged from one to greater than 20 items per scale which posed a significant challenge for the study. Mindful of the survey-taker experience and the risk that survey fatigue or face validity posed to survey completion, a guiding design principle was survey length, and specifically targeting as few items as possible per construct to increase completion rates and ultimately sample size. Further exacerbating the issue, every survey item was duplicated to reflect the team and the system-level. To that end, two of the nine constructs were included as single item measures: trust and belonging. It was a difficult but intentional trade-off to ensure participation and meaningful engagement with the survey items. What follows is a discussion to elucidate the decision-making process and adoption of these two single-item measures.

Trust. How to define and measure trust is hotly debated in the literature (Cook and Cooper 2003; Lyon et al., 2012). There are three self-report measures of generalised trust that have been well studied; first, the 25-item Interpersonal Trust Scale (Rotter, 1967), found to have limited predictive validity (Carter & Weber 2010; Evans & Revelle, 2008). The second, is a single-item measure of trust, hailed by Bauer (2018) as "the most popular measure of trust" (p. 4) and which he referred to as the "most-people" question (asking whether most people can be trusted or whether it is better to be careful), first appearing in Rosenberg's (1956) five item scale called "faith in people" but which later became a stand-alone item to measure general levels of trust (Miller & Mitamura, 2003).

This single-item, most-people question has been used by the American General Social Survey since 1972, which increased its adoption by other major surveys such as the European Values Survey and the World Values Survey and surveys developed for academic research (Knack & Keefer, 1997; La Porta et al.,1997; Glaeser et al., 2000; Snijders & Keren, 2001; Hayashi et al.,1982; Ho and Kochen 1987; Liou et al.,1990; Yamagishi & Yamagishi 1994).

The most-people question was more widely adopted than Rotter's scale, potentially because of the shorter length of a single-item measure (Bauer, 2018) however, it's validity has challenged by scholars due to the ambiguous nature of the question which is left open to interpretation by respondents (Delhey et al., 2011; Glaeser et al. 2000; Johnson & Mislin 2011). Thirdly, the six item Generalised Trust Scale (GTS; Yamagishi & Yamagishi, 1994) offers an alternative measure of trust which has been proven in cross-cultural research (Carter & Weber 2010; Montoro, Shih, Roman & Martinez-Molina, 2014; Yamagishi 2001).

Even though the most-people question has been widely adopted as a single-item measure of Trust, it was not considered suitable for the present study, largely due to the ambiguous framing of the question. Additionally, given the cross-cultural nature of the sample, the GTS was found to be most relevant. As such, a single-item measure of Trust was adapted from the six-item GTS for inclusion in the present study, the original item *"I am trustful"* was adapted to suit team and system-level *"I trust members of my team"* and *"I trust members of the system"* respectively. Given that the focus of this study is to look at deriving trust needs from a team or system, other items in the GTS scale such as *"most* *people will respond in kind when they are trusted by others"* did not relate well to context. The framing of the single item in the context of team or system addresses recommendations made by Bauer (2018), who suggested that being specific and making explicit references to "trustee groups" is an advantage from a measurement perspective.

Belonging. Leary et al. (2013) developed a 10-item Need to Belong (NTB) scale. Nichols and Webster (2013) constructed a single-item need to belong measure (SIN-B) which was validated across three studies and adapted from the original scale by Leary et al. (2013). The SIN-B showed acceptable concurrent validity with the longer NTB scale. However, a pilot to test the survey instrument with two participating organisations, uncovered that the SIN-B item *"I have a strong need to belong"* was not considered well-suited for the cross-cultural populations in these organisations. Taking into account the advantages and disadvantages of single-item measures discussed above and following the approach by Nichols and Webster for the construct of belonging, a single item from Leary et al. (2013) was used to measure belonging needs. The original item *"I want other people to accept me"* was amended so that the question was framed to target both team and system-level e.g., *"I want members of my team/system to accept me"* and measured on a seven-point scale (1 – strongly disagree, 7 – strongly agree). Earlier studies showed the NTB scale to be reliable, with Cronbach's alpha's ranging between .78 and .87 using samples from Mturk (Leary et al, 2013) and more recently the scale obtained a Cronbach's alpha of .84 among Chinese participants and of .80 among Dutch participants. (Zhang et al., 2020).

Analytical Approach

As stated earlier in the chapter, the empirical study adopts a quantitative analytical approach using multiple linear regressions to test theoretical propositions. Qualitative methodologies play an integral role in the development of systems research, to facilitate a rich, more nuanced understanding of phenomena and lived experiences, that helps us to understand the "why" which complements the "what" and the "when" derived from more objective quantitative methods. Nevertheless, given the objectives of the empirical study, a quantitative approach was considered most suitable. Within the scope of quantitative analysis, design decisions were taken to test the hypotheses using linear regressions despite the nested nature of the data. Hierarchical linear modelling (HLM) or Structural Equation Modelling (SEM) would have been well placed analytical approaches to test the hypotheses, but unfortunately the sample size meant that the study was not powered enough. In addition, the use of single item measures (i.e., belonging and trust) precluded from the use of SEM.

Unlike other measures in the study which did not have to be nested, a measure of between-team collaboration was required for each system (i.e., to test hypotheses 3, 6, 9 and 10). This therefore required the aggregation of individual ratings to achieve an overall rating for each system. Without an appropriate level of agreement among raters of a group (in this case all members of each MTS), aggregating a group (or system) level measure from individual responses "has no construct validity" (Klein et al., 2001, p. 4). Preliminary statistics to assess interrater agreement were conducted to verify whether aggregation to the MTS level was empirically justified. Interrater agreement indices such as the r_{WG} and $r_{WG(J)}$ (used for single items or multiitem measures respectively), are typically computed and compared to threshold values in multilevel research (LeBrenton & Senter, 2008). However, in the absence of clear guidelines to make data aggregation decisions many researchers have fallen foul of appropriate use of these indices which calls into question their theorical contributions (Biemann et al., 2012). R_{WG} and $r_{WG(J)}$ are computed by comparing within-group variances to an expected variance under a null hypothesis of no agreement, however James et al. (1984) offer advice for when and how to compute these statistics by adopting alternative null response patterns (i.e., distribution). This is an important consideration in light of the challenge by some scholars that there is no way to determine when responses correspond to “no agreement” and that by adopting this uniform null hypothesis (i.e., rectangular distribution) it assumes that all answering options have equal probability of being selected (Cohen et al., 2009). A further pitfall of adopting the uniform null distributions is that the results are often over inflated (LeBrenton & Senter, 2008).

Due to the risk of overinflation, the uniform (i.e.., rectangular distribution) should be included as the “upper-bound” of within-group agreement (Biemann et al., 2012, p. 72). Following the recommendations set out by James et al. (1984) which have been endorsed by many scholars (e.g., Biemann et al., 2012; Hater & Bass, 1988; Kozlowski & Hattrup, 1992; Kozlowski & Hults, 1987; Schneider & Bowen, 1985) the study identified a set of null distributions to compute a range of agreement scores within which the true agreement score is most likely to fall (see Table 9). The positively skewed null distribution was selected due to the propensity for participants to consciously, or unconsciously, respond in a socially desirable manner (Guion, 1965; Nunnally, 1978). The central tendency (i.e., triangular) null distribution was selected due to the possibility that participants may select a neutral (i.e., central) response option because they find the items complex or ambiguous (Guilford, 1954; Scott et al., 1979). Central tendency could also be a result of participants being intentionally evasive and cautious as a result of a perceived lack of confidentiality (Guion, 1965). The uniform (i.e., rectangular) null distribution was included heeding advice to use it as the upper-bound and represents the distribution resulting from the instance where there is no systematic response bias in the way participants have responded (James et al., 1984).

It is appropriate to recognise that while R_{WG} and $r_{WG(J)}$ are commonly used by researchers there are several other measures that may be considered. To overcome some of the statistical challenges of $r_{WG(J)}$ the $r^*_{WG(J)}$ and $r_{WGp(J)}$ are two examples (see the summary in LeBreton & Senter, 2008). Another alternative is to calculate interrater agreement using squared deviations from the mean (i.e., a simple standard deviation, SDx) and absolute deviations from the mean (absolute deviation or ADMj) or median (ADMEDj). LeBreton and Senter (2008) point out that while each of these indices have their respective strengths, they all tend to correlate highly with one another. Hence the present study adopted the $r_{WG(J)}$. Similarly, the decision to adopt $r_{WG(J)}$ instead of the interclass correlation coefficient (i.e., ICC1 or ICC2) related to the fact that individual raters did not come from the same team, they came from multiple teams within the MTS. Interrater agreement is a more meaningful statistic in this case as opposed to calculating the reliability of the single rating due to common membership, that is ICC(1), or the reliability of group-level average, that is, ICC(2).

The r_{WG} and $r_{WG(J)}$ has received criticism by scholars over and above the use of inappropriate null distributions, for example the widely accepted cut-off value of .70 has been challenged to be purely arbitrary (e.g., Castro, 2002; Cohen et al., 2001; Lance et al., 2006; LeBreton et al., 2005). LeBreton and Senter (2008) go on to clarify:

> We should mention that any heuristic, ours included, is arbitrary. Heuristics such as $p < .05$, power > .80, or specific values for small, medium, and large effect sizes (J. Cohen, 1988) are just arbitrary 'lines in the sand'. So too is the traditional .70 cut-off value used in the past and the more inclusive set of standards we are offering. (p. 835)

They offer a more inclusive set of cut-off values that are (a) .00 to .03 is lack of agreement, (b) .31 to .50 is weak agreement, (c) .51 to .70 is moderate agreement, (d) .71 to .90 is strong agreement and (e) .91 or greater is very strong agreement. LeBreton and Senter (2008) recommend that these cut-offs should be tailored to the research question and provide an example of a high-stakes context based on interrater agreement data, such as a promotion decision, that would warrant the use of the "very strong agreement" cut-off among raters, whereas other research questions may warrant "little to moderate agreement". For the present study, the traditional cut-off of .70 was adopted.

Ethical Considerations

Important ethical issues for consideration when conducting organisational research includes informed consent (Bryman & Bell, 2007) and confidentiality (Robson, 2002). This thesis adopted several measures to mitigate such issues and ensure that the research was conducted in accordance with professional ethical guidelines set by the British Psychological Society Code of Ethics, the Health and Care Professions Council Standards of Conduct, Performance and Ethics and Birkbeck University Ethics Guidelines. For example, there was a risk that participants may fear repercussions of their comments and answer questions in a socially desirable manner. To address this concern and ensure that responses were authentic, participants were reassured before e.g., email communications from the point of contact in their organisation, and during participation e.g., via online survey instructions, that their responses were anonymous and disclosing demographic data was optional. They were also informed that the data would be aggregated at the group level, and therefore overall trends, rather than individual data will be reported back to their organisation. This was summarised in an information sheet, which was disseminated in advance of participation, the information sheet also contained links to non-profit support organisations in the unlikely event that participants experienced any distress because of their participation. Finally, informed consent was obtained through a preliminary question in the online survey and information about their right to withdraw was provided at the end. The process followed to obtain ethical approval is further detailed in the empirical study (Chapter 4).

CHAPTER 3

Systematic Literature Review

A Systematic Review of Interventions that Facilitate Multiteam System Functioning

Abstract

Modern organisations are reorganising themselves to be better equipped to adapt and respond quickly to changes in the environment. Multi-Team Systems (MTSs) are modern team arrangements that have emerged to solve complex problems. Also known as a "team of teams" they require effective coordination of multiple teams working together interdependently to achieve common goals within and/or across organisational boundaries. This new level of study has gained attention over the past two decades with the development of important conceptual and theoretical frameworks furthering our understanding. Despite burgeoning empirical research, to-date no systematic review has been conducted to examine the efficacy of MTS interventions despite their prevalence in practice. Therefore, the purpose of this study was to systematically review the research on MTS interventions. The search identified 3,176 relevant studies, of which only four met the inclusion criteria. Each study targeted different mechanisms to improve MTS functioning (i.e., performance). The review provides initial support for the efficacy of interventions in MTS environments more broadly and the mediating role of between-team coordination. Consistent findings across the studies offer initial evidence pertaining to the value of expanded team training targeting members and leaders across teams in the system. Evidence was deemed "unclear" for those interventions that related to coordination, strategy and frame of reference training due to the single study nature of the source. Overall, the homogeneity of the studies in terms of design and sample, limit generalisability of findings and make deriving practical implications difficult but offer directions for future research in more applied settings.

Introduction

Since the early work of Hawthorne in 1920s and 1930s, cited by scholars as the origins of teams' research (Salas et al., 2008), the theory and practice of teamwork and team effectiveness has seen tremendous progress. The focus has shifted from individuals in teams (i.e., individual differences) and individual versus team comparisons, to a focus on the team itself and more recently over the past two decades researchers sought to understand the ways that teamwork has evolved to account for increasingly complex "teaming" environments. Such dynamic and changing contexts present challenges that require multiple teams working as a system to coordinate their efforts and achieve superordinate goals. These multiteam systems (or teams of teams) are defined as "two or more teams that interface directly and interdependently in response to environmental contingencies toward the accomplishment of collective goals" (Mathieu et al., 2001, p. 290).

Teams research has advanced the science and practice of group phenomena with multiple meta-analyses that demonstrate a variety of interventions that improve team performance across settings; team building (Klein et al., 2009) team debriefing (Tannenbaum & Cerasoli, 2013) team training (Salas, et al., 2008; Hughes et al., 2016) leadership training (Lacerenza et al., 2017) and planning (Weingart, 1991). However, practices and interventions proven effective at the standalone team-level (in MTS literature defined as component teams) cannot be assumed to facilitate functioning at the system-level "given the faster pace of change in modern organisations and the agility that many teams must demonstrate to perform well, traditional approaches to interventions may also need to be re-thought" (Benishek & Lazzara, 2019 p. 10).

In fact, work on countervailing forces in the MTS literature has shown the opposite can be true, in other words constructs operationalise differently, counterintuitively, at different levels of analysis and what helps the team perform well can hurt the overall system performance and vice versa (DeChurch & Zaccaro, 2010). The study of countervailing forces has been central to empirical MTS research over the past decade (Shuffler & Carter, 2018).

As researchers continue to study MTS functioning drawing on multilevel and multiphasic approaches to contribute to science and practice, some pertinent conceptual frameworks and theoretical models are starting to emerge (Zaccaro et al. 2012; Zaccaro et al., 2020; Luciano et al., 2018a) which have greatly helped to advance the field. One classic model of team effectiveness leveraged by researchers to understand phenomena in multiteam environments, was developed by Hackman and Morris (1975); the input-process-output (I-P-O) model, which asserts that the effect of input variables on outcomes is mediated by process. This was later refined by Ilgen et al. (2005) whereby the term process was replaced by mediator/s to reflect broader variables and capture interactions and emergent states; input-mediator-output-input (IMOI). Adding the input at the end signifies the cyclical nature of team phenomenon and removing the hyphens to signify that causal linkages may not be linear or additive, they could be non-linear or conditional.

Zaccaro et al. (2012), proposed a complementary framework which serves to classify the different kind of input variables specific to an MTS context. This typology of MTS attributes, groups MTS input (e.g., “I” from IMIO) variables into three categories: compositional, linkage and developmental. Compositional attributes relate to how different MTSs may be structured, including the overall demographic composition of the MTS and their teams, such as number of component teams, overall size of MTS, the boundary status i.e., teams come from the same organisation (internal) or span across organisations (external), cultural and functional diversity and geographic dispersion. The diversity compositional attributes were later redefined by Zaccaro et al. (2020) as “component team distance” (CTD), they added another input variable “goal type” with reference to the nature of goals (i.e., physical or intellectual) and used a combination of these compositional attributes to classify

MTSs in their review. Zaccaro et al. (2020) further evolved the original classification framework by using a combination of compositional attributes as a proxy for complexity. While they maintain all MTSs are complex, some may exhibit greater degrees of complexity than others based on a combination of these compositional attributes. For example, an internal MTS with only two or three teams and low CTD reflects lower degrees of complexity compared to external MTSs with more teams and higher CTD (Zaccaro et al., 2020). Linkage attributes are the second group of input variables, described by Zaccaro et al. (2012) and which relate to the different types of mechanisms that link or connect component teams within an MTS. For example, the level of interdependence between teams in the system, the degree to which they are organised in a hierarchy and how power is distributed (e.g., presence of a leader-team or not), the structure of communication among teams (centralised or decentralised) and the modes of communication (e.g., electronic, face to face or mixed). The third group of variables, termed developmental attributes pertains to the characteristics that depict how MTSs shape and evolve over time. For example, how they were initiated (e.g., was it emergent or formally appointed), the lifespan of the MTS in terms of tenure, the stage of formation at the time of study (e.g., newly formed, mature) and the degree to which the MTS is fluid or stable in terms of team members and teams.

A third and noteworthy framework underpinning the MTS literature is the seminal work of Marks et al. (2001) who proposes a temporally based framework and taxonomy of team processes, extensively applied to, and referenced in MTS literature (Shuffler & Carter, 2018; Carter et al., 2015; Zaccaro et al., 2020). Like single teams, MTSs cycle through phases or “episodes” as they complete group tasks. During transition phases, preparatory team processes such as planning and strategizing occur; in action phases, task completion processes such as coordinating behaviour and tracking progress occur and across both phases, Marks et al. (2001) define the processes teams use to manage interpersonal relationships such as conflict management, motivating/confidence building and affect management. They describe the processes that govern interpersonal activities rather than the resulting emergent states.

Taken together the aforementioned frameworks and conceptual models have been instrumental in the study of MTS environments and extrapolation from teams' literature. Leveraging these frameworks, MTS literature reviews (e.g., Shuffler et al., 2015; Shuffler & Carter, 2018; Zaccaro et al, 2020) have greatly advanced our understanding of MTS functioning, however to-date there has not been a literature review based solely on intervention studies in the MTS context. It is crucially important to draw conclusions about the effectiveness of MTS interventions and the mechanisms by which they work as the MTS body of literature continues to proliferate. Shuffler and Carter's systematic review (2018) posed the question "what evidence-based practices exist for facilitating MTS effectiveness?" the papers reviewed to answer this question included thought pieces, case studies and book chapters, only one may be considered a "true" intervention study (Cobb & Mathieu, 2003). Consequently, Shuffler and Carter (2018) summarised three lessons in answer to the aforementioned question (1) Incorporating between-team elements as part of team training can improve both team and MTS performance, (2) Attending to MTS structures and work design is an important part of managing the coordination needed for effective MTS functioning and (3) Leadership influence is a powerful process for MTSs that must be integrated and managed across the system to maximise its benefits.

There are a few additional references to MTS interventions made by other MTS scholars. Based on their review of the literature Zaccaro et al. (2020) endorsed the use of MTS charters and goal hierarchies, to avoid collaboration challenges arising from conflicting priorities. Zaccaro et al. (2020) also advocated for a form of "MTS building" which extends team building principles to the system-level to align goals between-teams and clarify roles and responsibilities. Wijnmaalen et al. (2019) offered prescriptions for effective MTS building and evidence for its utility and MTS training "On the basis of results from the team training literature (Lacerenza et al., 2018), MTS training should be helpful in supporting both system performance and the emergence of important affective, motivational, and cognitive states." (Zaccaro et al., 2020 p. 494). However, statements such as "should be helpful" and "are likely to" used by authors whether referring to MTS interventions, make them speculative and warranted a deeper exploration to ascertain whether these interventions would improve overall system functioning.

This review seeks to update the work by Shuffler and Carter (2018) and dive deeper into the MTS intervention literature more specifically, to explore Zaccaro et al's (2020) propositions and gain a more granular understanding of (1) which interventions *have been empirically tested* to facilitate functioning in the MTS environment and (2) the mechanisms involved.

Method

The present study adopted a systematic approach which followed the five key steps outlined in Briner and Denyer (2012) and as applied by Donaldson-Feilder et al. (2018). The five steps are (1) planning the review (clarifying the scope, search strategy), (2) locating studies (review strategy – selection of papers for inclusion), (3) appraising contributions (data extraction), (4) analysing and synthesising information (data synthesis) and (5) reporting "best evidence" (quality assessment).

Planning the Review

Clarifying the Scope. To commence, a pre-review of the literature was conducted during October 2019 and December 2020 which included the most recent literature reviews that studied MTSs (Shuffler et al., 2015; Shuffler & Carter, 2018; Zaccaro et al., 2020) and which highlighted gaps in current knowledge and understanding. This preliminary phase of the study helped to identify an initial research question which followed an iterative refinement process (Pawson, Greenhalgh, Harvey & Walshe et al, 2005) as new evidence was uncovered the question and sub questions were honed and finally agreed upon by the researchers.

Search Strategy. The keyword search terms identified for the current study were informed by the pre-review of the literature and through discussion with colleagues and researchers. A computerised literature search was conducted of five scholarly databases (PsychINFO, Business Source Premier (EBSCO), Scopus, Ethos and ProQuest) that include publications in fields such as industrial and organisational (I/O) psychology, management, social psychology, communications, human factors, computer science, healthcare, aviation and industrial engineering. The search parameters were: (“multiteam system*” OR “multi-team system*” OR MTS OR “multiteam project*” OR “multi-team project*” OR “MTS project*” OR “intergroup collaboration” OR “distributed system*” OR “joint task force” OR “team of team*” OR “interdependent team*”) AND (Intervention* OR Coordination OR Train* OR Lead* OR “Boundary spanner” OR “Process management” OR “work design” OR Technology OR Feedback OR Charter OR “Autonomous team*”) AND (Work* OR Employ* OR Organi*) Where work* enables broader inclusion of worker, workplace, working; employ* employer, employee, employment; organi* organisation/ organisation, organisations/organisations, organisational/organisational; Intervention* interventions; Train* training, trainer; Lead* leader, leadership, leading; and Team* teams. Only references published in English were sought. For completeness, a “pearl-growing” process was carried out, this involved hand searching the reference lists of all the papers included in the final list to identify any further studies for inclusion. The searches were performed between February and March 2020.

Locating the Studies

Review Strategy – Selection of Papers for Inclusion. Following completion of the initial searches, the bibliographic records were collated in the software reference management tool Mendeley, duplicates were removed, and the reference list was imported to a second reference management tool; Endnote. From here the references were exported to a text file. In order to identify the final papers for inclusion in the review, a series of sifts were performed sequentially that included or excluded papers at each stage, based on predefined criteria (which is explained further on in the text and outlined in Table 1). The first sift conducted a broad screen based on the titles of retrieved records and was carried out independently by the lead author and second researcher, with any discrepancies moderated by a third researcher and disagreements resolved through discussion. Titles that suggested the reference was about interventions in MTSs were retained but a conservative approach was employed whereby if it was unclear from the title alone, they too were retained for further screening.

The abstracts were obtained for the remaining references and subjected to a narrow screening process using specific inclusion and exclusion criteria, based on the Study design, Participants, Interventions and Outcomes framework (SPIO; Robertson et al., 2015). Table 1 details the criteria used. As with the title sift, the author and second researcher independently conducted the abstract sift, with any discrepancies moderated by a third researcher and disagreements resolved through discussion. Initially, the inclusion criteria specified that the study participant population should be restricted to working adults, to give greater practical relevance and generalisability to the findings. However due to the paucity of MTS intervention studies it was agreed at this stage of the screening process, to broaden the inclusion criteria to include student populations. A second title sift was conducted in the same manner as the first and in line with the new inclusion criteria. At abstract stage of the screening process, 45 articles were excluded which did not report on interventions set in an MTS context. Lastly, the full papers were obtained for all remaining records and reviewed independently by the lead author using an excel spreadsheet. The final papers for inclusion were discussed and agreed with the two support researchers. In total, 11 studies were excluded at this stage leaving four final papers in the review.

Table 1

SPIO Narrow Screen Inclusion and Exclusion Criteria

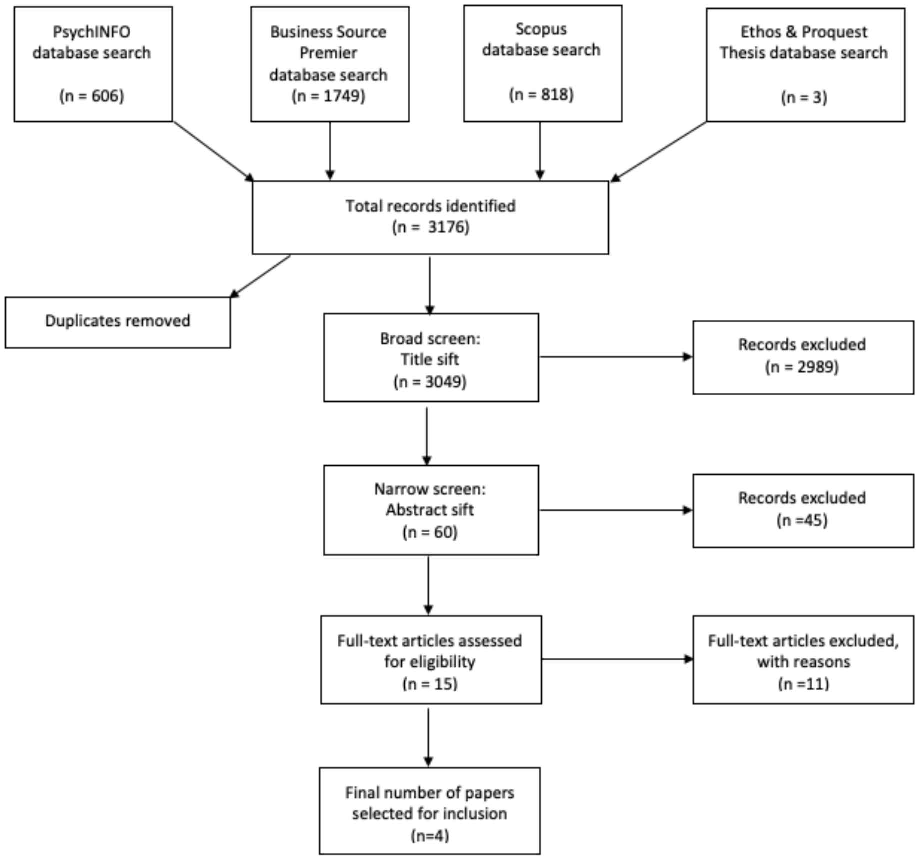
	Inclusion criteria	Exclusion criteria
Study design	- All empirical research both quantitative and qualitative (no thought or opinion pieces) - Explores intervention/s in an MTS - Dissertation (PhD) theses that study MTS interventions	- Non empirical studies (purely theoretical or descriptive) - Non-intervention studies - Books or conference proceedings
Participant population	- Any sector or country - Adult population (age 18+)	- < 18 years of age
Intervention	- Designed for/delivered to team/s which form an MTS - Purpose is to improve/explore MTS functioning - Intervention/s that impact the individual, component team and/or MTS level of functioning	- Intervention studies not in an MTS context
Outcomes	- Includes outcome measures/target variables in which the intervention aims to achieve change	

Note: No date boundary was set for the search due to the nascent stage of the Multiteam System (MTS) body of research.

The flow diagram in Figure 2 sets out the literature retrieval and selection process.

Figure 2

Systematic Literature Review Search Results and Flow Diagram



Appraising Contributions

Data Extraction. To appraise the contributions of each paper, it is helpful to use a data extraction tool to examine and dissect the studies and see how they relate to each other (Briner & Denyer, 2012). The Matrix method (Garrard, 2017), commonly used in systematic reviews recommends using nine columns in the data extraction tool. For this review the tool was adapted with additional columns added pertaining to the MTS topic. The data extracted included information about the study (aim, hypotheses, design), the population (sample number, sample demographics, functional role/background, sample selection methods), MTS attributes/characteristics (compositional attributes, linkage attributes, developmental attributes), the intervention (nature of intervention, facilitator), the measures employed (outcome/target variables, how the variables were measured, from where the measure originated, details of manipulated/ independent variables, the mechanisms, if relevant: moderators and mediators, new or unique concepts/variables), the results and evaluation of the study (main contributions, type of analysis, results, change in outcome/findings, comparison to traditional teams literature, limitations, suggestions for future research, theoretical underpinning), contextual information about the study (country study took place in, other contextual information), implications for practice, my reactions (summary, author bias, challenge of assumptions, pending questions, links to other literature). Each paper was reviewed thoroughly, and the data was extracted independently by the author into the tool for later synthesis and analysis.

Analysing and Synthesising Information

Data Synthesis. The results of the literature search and data extraction yielded only a small number of retained papers (n=4), due to the diversity of interventions employed and the outcomes reported, a meta-analysis was not possible. Instead, an explanatory synthesis was conducted, and the findings are presented in a narrative format in this review. The synthesis aimed to put the findings from the individual studies together "into new or different arrangement and developing knowledge that is not apparent from reading the individual studies in isolation" (Denyer & Tranfield, 2009, p. 685). Data synthesis was conducted by the lead author and discussed at each stage with at least one other researcher through an iterative process of review and revision. These reviews continually checked for consistency and credibility of interpretation by cross referencing the narrative text back to the extracted information contained in the data extraction tool and back to original papers where necessary. Any discrepancies or omissions identified were discussed and improvements made. A third researcher conducted a final check of the synthesis to ensure the final narrative was consistent and credible.

Reporting "Best Evidence"

Quality Assessment. A quality assessment of all final papers included in the review was undertaken to reduce the risk of bias and evaluate the quality of the evidence. Checklists provided by Snape et al. (2016) were used for assessing the quality, carried out by the lead author and checked for consistency by the research team. Snape and colleagues (2016) propose different checklists for qualitative, quantitative and mixed methods papers. The quantitative checklist was used to assess all papers in the present review; however, it was adapted to include the ethics questions which Snape et al. (2016) only included in the qualitative checklist. The researchers agreed evidence statements and corresponding gradings which were developed in line with suggestions by Snape et al. (2016), a summary of which is outlined in Table 6.

Results

The search of databases retrieved 3176 records. Following broad and narrow screening (see Figure 2), four papers were considered suitable for inclusion in this review. Of these four papers, three appeared in peer-reviewed journals (DeChurch & Marks, 2006; Firth et al., 2015; Lanaj et al., 2013) and one was a PhD thesis (Cobb, 2000). The study and population characteristics, MTS characteristics, intervention characteristics and outcome measures for all four papers, are represented in Tables 3, 4 and 5 respectively and are considered in turn below.

Study Characteristics

As illustrated by Table 2, there is considerable homogeneity in the studies' country of origin; they were all conducted in the United States of America. Neither is there much variation in terms of the design, all four studies adopted a quantitative, laboratory simulation with military themed content. Two studies are a “situated experiment” and were part of a multiyear program of research sponsored by the United States Air Force and a large research-oriented university (Firth et al., 2015; Lanaj et al., 2013), whereas the remaining two studies were purely academic (Cobb, 2000; DeChurch & Marks, 2006).

Population Characteristics

Size. As shown in Table 2, there is slightly more variation across the studies in terms of the number and type of participant populations. Two studies had less than 400 participants (Cobb, 2000; DeChurch & Marks, 2006) and two had greater than 2,900 participants. Across the four studies there were a total of 6,954 participants; however, 1,260 participants from Firth et al. (2015) overlap with those studied in Lanaj et al. (2013), but the theoretical scope of work was different.

Demographics. For the two studies that provided information about the gender, age and ethnicity split of the participants, there was one with a female majority (DeChurch & Marks, 2006) and one with a female minority (Cobb, 2000), the average participant age across the two studies was 22 and 20 respectively and the ethnicity makeup was a Hispanic majority (DeChurch & Marks, 2006) and a Caucasian majority (Cobb, 2000).

Professional Discipline and Experience. Half of the studies in this review relied on an undergraduate student sample (Cobb, 2000; DeChurch & Marks, 2006) overall across these two studies the majority were psychology and business students, however Cobb (2000) comprised of mostly reserve officer training cadets (64%). The remaining two studies drew on a working population comprising of US Air Force officers taking part in a five-week leadership development course and who came from a diverse range of professional backgrounds, with between five and nine years of experience.

MTS Characteristics

Table 3 presents the MTS characteristics of the four studies according to Zaccaro et al. (2012;2020) MTS typology, compositional, linkage and developmental attributes. Each of these will be summarised in turn below.

Table 2

Summary of Study and Population Characteristics

Author and year	Country of origin	Control group	Methodology	Study design/type	Population					
					Sample size (*N*)	Gender % Female	Ethnicity	Average age	Experience	Professional discipline
Cobb (2000)	U.S.	Y	Quant	Laboratory simulation – military context	144	31% Female	80% Caucasian 20% Minority groups	20	Undergraduate students	Reserve officer training cadets (64%) Psychology undergraduates (33%) Other students (3%)
DeChurch & Marks (2006)	U.S.	Y	Quant	Laboratory simulation – military context	384	Female: 70%	66% Hispanic 34% Other	22	Undergraduate students	Psychology and Business students
Firth et al. (2015)	U.S.	Y	Quant	Laboratory simulation – military context	3,486 [a]	Unspecified	Unspecified	Unspecified	5-9 years' exp	US Air Force Diverse professional backgrounds
Lanaj et al. (2013)	U.S.	N	Quant	Laboratory simulation – military context	2,940	Unspecified	Unspecified	Unspecified	5-9 years' exp	US Air Force Diverse professional backgrounds

Note: U.S. = United States of America; Y = yes, N = No; Quant = Quantitative; [a] *90 MTSs (N =1,260 participants) overlap with those studied in Lanaj et al. (2013)*

Compositional Attributes. There is considerable variation across the reviewed studies in terms of the overall number of MTSs which ranges from 36 to 249 and the number of participants per MTS which ranges from 4 to 14. However, the number of component teams per MTS was relatively consistent with three of the four studies comprising three component teams (DeChurch & Marks, 2006; Firth et al., 2015; Lanaj et al., 2013) and one study (Cobb, 2000), with the minimum number of component teams allowed according to Mathieu et al.'s, (2001) widely accepted definition of an MTS; "two or more teams that interface directly and interdependently……" (p. 290). One study in the review contained component teams representing separate organisations i.e., external boundary status (Cobb, 2000), while the remaining three studies contained component teams from within the same organisation (DeChurch & Marks, 2006; Firth et al., 2015; Lanaj et al., 2013). The remaining compositional attributes described in Table 3 are homogenous for the entire set of studies reviewed, they all had low component team distance (CTD), "physical" goals and were all consequently classified as "low" complexity according to the complexity framework criteria described by Zaccaro et al., (2020).

Linkage Attributes. Due to the nature of the military simulation employed in all four studies, the modality of communication was mixed, involving both face to face and virtual tools and component teams in each MTS were described as highly interdependent. In three of the studies, all team members were free to communicate with all other members in the MTS (Cobb, 2000; DeChurch & Marks, 2006; Lanaj et al., 2013), however one of the studies manipulated the communication flow among MTS members in two experimental conditions; centralised or decentralised (Firth et al., 2015). Lastly, in terms of hierarchical arrangement, the majority of studies structured MTSs with an appointed leader-team (DeChurch & Marks, 2006; Firth et al., 2015; Lanaj et al., 2013), the remaining study comprised of two dyad teams (Cobb, 2000).

Table 3

Summary of Multiteam System (MTS) Characteristics

	Compositional Attributes							Linkage Attributes				Developmental Attributes		
Author and year	No. of MTSs	MTS size	Partic-ipants per MTS	Bound-ary status	CTD	Goal type	Comp-lexity	Modality (Comms)	Structure (Comms)	Hierarchical arrangement	Interdependence	Genesis	Stage	Tenure
Cobb (2000)	36	2	4	External	Low	Physical	Low	Mixed mode Face to face and virtual tools	Free communication across all members	No leader-teams 2x Dyads	High	Formally appointed teams	Newly formed	Short-term: 5-hour simulation
DeChurch & Marks (2006)	64	3	6	Internal	Low	Physical	Low	Mixed mode Face to face and virtual tools	Free communication across all members	Leader-team Air team Ground team	High	Formally appointed teams	Newly formed	Short-term: 5-hour simulation
Firth et al. (2015)	249[a]	3	14	Internal	Low	Physical	Low	Mixed mode Face to face and virtual tools	Centralised and decentralised manipulation	Leader-team Point team Support team	High	Formally appointed teams	Newly formed	Short-term: 3-hour simulation
Lanaj et al. (2013)	210	3	14	Internal	Low	Physical	Low	Mixed mode Face to face and virtual tools	Free communication across all members	Leader-team Point team Support team	High	Formally appointed teams	Newly formed	Short term: 3-hour simulation

Note. MTS size = Number of component teams in the Multiteam System; boundary status, Component Team Distance (CTD), goal type and complexity were determined according to Zaccaro et al. (2020) framework; Comms = communications; [a] = 90 MTSs (*N* =1,260 participants) overlap with those studied in Lanaj et al. (2013).

Developmental Attributes. Due to the experimental nature of all four studies, the genesis or means by which the MTSs were initiated, was formally appointed, newly formed and short-term with regards to tenure.

Intervention Characteristics

Table 4 presents a summary of the intervention characteristics described below. This includes the length and delivery method of the intervention and the content or type of training for each study.

Intervention Length and Delivery. In addition to a simulation briefing and practice missions, most studies employed group training intervention conditions and control group conditions that lasted from between 3-40 minutes (Cobb, 2000; DeChurch & Marks, 2006; Firth et al., 2015). One study employed an experimental manipulation with two distinct conditions and a verbal instruction to each group (Lanaj et al., 2013). The mode of delivery across the three training intervention studies was relatively homogenous with all of them involving a face-to-face presentation, two involved watching additional video content (Cobb, 2000; DeChurch & Marks, 2006), one involved live demonstrations (Cobb, 2000), and one included a practical exercise (DeChurch & Marks, 2006).

Intervention Content. Two of the four studies delivered training content on strategy and coordination (Cobb, 2000; DeChurch & Marks, 2006), one of these was directed at leaders in the MTS (DeChurch & Marks, 2006) while the other was directed at team members, because there were no leaders formally appointed (Cobb, 2000). One study delivered frame of reference training to appointed leaders in each MTS but also involved team members in more general aspects of the training (Firth et al., 2015). One study manipulated the mode of planning for experimental conditions and gave verbal instructions to direct the teams to conduct pre-simulation planning in a centralised or decentralised manner. The content for each of the interventions are described in turn below.

Table 4

Summary of Intervention Characteristics

					Measures											
Author and year	Intervention type	Content/ Focus	Delivery method	Duration	MTS performance	Between-team coordination	Within-team coordination	Transition process behaviours	Interpersonal process behaviours	Action process behaviours	MTS functional leadership	Coordination failures	Planned and actual proactivity	Planned and actual aspirations	Planned and actual risk seeking	Coordination failures
Cobb (2000)	MTS training	Strategy/ Coordination/ Control + Complexity manipulation	Presentation Videos Live demos	20 minutes	✓			✓	✓	✓						
DeChurch & Marks (2006)	Leadership training	Strategy/ Coordination/ Control	Presentation Video Practical	40 minutes	✓	✓	✓				✓					
Firth et al. (2015)	Leader and Team training	Frame of reference / Control	Presentation Handouts	3 minutes[a]	✓	✓	✓									
Lanaj et al. (2013)	Manipulation (pre-simulation planning and goal setting session)	Decentralised/ centralised planning condition	Verbal instruction	N/a	✓							✓	✓		✓	✓

Note: [a] In addition to a 45 minute briefing

Strategy Training. In one study, leader strategy training involved training leaders to develop a plan that specified how teams would synchronise their actions during the mission. Leaders were taught that effective MTS strategizing requires the following three elements a) acquiring information relevant to the between-team interdependence demands of the task environment, (b) organising and evaluating information regarding each team's contribution to the mission, and (c) communicating this information to MTS component teams before the mission (DeChurch & Marks, 2006). In another study, team strategy training was centred on *transition process behaviours* described by Marks et al., (2001) taxonomy of team processes i.e., goal specification, mission analysis and strategy planning and development (Cobb, 2000).

Coordination Training. In one study, leader coordination training involved training leaders to directly facilitate cross-team coordination during action phases. Leaders were taught that effective MTS leaders coordinate by (a) monitoring the needs and requirements of each component team as they relate to other teams and (b) communicating information to their team about another team (DeChurch & Marks, 2006). In another study, team coordination training was centred on *action process behaviours* described by Marks et al., (2001) taxonomy of team processes i.e., checking progress toward objectives, monitoring their environment, backing up teammates and coordinating actions between teammates (Cobb, 2000).

Frame of Reference Training. One study (Firth et al., 2015), delivered frame of reference training to participants in the experimental condition. This training followed the general recommendations provided in the literature (Cardy & Keefe, 1994; Laughlin, Bonner, Milner & Carnevale, 1999) to convert idiosyncratic, functionally specific factors into a generically interpretable format, easily understood by individuals who may not share the same area of expertise via the construct of calibrated confidence levels, fine-grained behavioural criteria were paired with specific ratings of confidence. Normative confidence-rating decisions were linked to every combination of observations of targets on the game grid in order to provide a useful and efficient script schema, summarised in a handout. The training focused specifically on providing clear performance standards to guide accurate and confident decisions in the context of the MTS simulation exercise. This study employed a unique approach to frame-of-reference training, because it addressed how to express confidence in a decision based on the criteria used to make that decision. Prior research on frame-of-reference training has focused on improving decision accuracy but has not directly aligned confidence with accuracy (Firth et al., 2015).

Centralised and Decentralised Planning. In one study, participants were engaged in either a centralised or decentralised approach to planning and goal setting for the simulation. Decentralised planning was manipulated through a pre-simulation planning and goal-setting session that gave initial planning authority to component teams whereby directors and assistant directors worked with lower-level staff to come up with an initial plan by setting goals for proactivity, aspiration levels and risk seeking. This was then presented to the leadership team. Conversely for the centralised planning condition, the directors and assistant directors first worked with the leadership team to come up with an initial plan, which was then cascaded down to component teams.

Outcomes, Measures and Mechanisms

Table 5 shows all four studies measured MTS performance relevant to their respective simulations. Two studies measured within and between-team coordination (DeChurch & Marks, 2006; Firth et al., 2015). DeChurch and Marks (2006) also measured MTS functional leadership (strategy and coordination) and component team performance. One study measured team process behaviours (transition, action and interpersonal) according to Marks et al. (2001) taxonomy of team processes (Cobb, 2000) and one study measured coordination

Table 5

Summary of Results

Author and year	Measures and Interventions	Main Outcome: MTS performance	Measures: Between-team coordination	Within-team coordination	Transition process behaviours	Interpersonal process behaviours	Action process behaviours	MTS functional leadership	Coordination failures	Planned and actual proactivity	Planned and actual aspirations	Planned and actual risk seeking	Coordination failures
Cobb (2000)	Transition process behaviours (M)	+*				+**	+**						
	Action process behaviours (M)	+**											
	Interpersonal process behaviours (M)												
	Strategy training (I)												
	Coordination training (I)	+*				+*	+*						
DeChurch & Marks (2006)	Leader strategy training (I)	+**	+**					+**					
	Leader coordination training (I)	+**						+**					
	MTS Functional leadership (M)	+**											
	Between-team coordination (M)	+**											
Firth et al. (2015)	Frame of reference training (I)	+*	+*	+*									
	Within-team coordination, main team (M)		+*										
	Within-team coordination, support team (M)												
	Within-team coordination, average across teams (M)		+*										
Lanaj et al. (2013)	Decentralised planning (I)	+/-								+*	+*	+*	+*
	Actual proactivity (M)												
	Actual aspirational behaviour (M)	+*										+*	
	Actual risk seeking behaviour (M)	+*											
	Coordination failures (M)	-*											

Note. (M) = Measure*;* (I) = Intervention; + = positive relationship; – = negative relationship; *p < .05 **p < .01

failures and planned and actual: proactivity, aspirations and risk-seeking behaviour (Lanaj et al., 2013). The findings are described in turn below.

MTS Performance Outcomes. MTS performance is a consistent outcome variable measured across all studies in the review. Other variables studied, fall into two broad categories of within-team or between-team behaviours, described in the mechanisms section below.

Training Manipulations. Three studies used training manipulations to test the impact on overall MTS performance.

Strategy and coordination training. Two of the three studies trained participants in a form of process facilitation; strategy development or coordinating and in both cases the effects of coordination training on MTS performance were indirect (mediated by action process behaviours; Cobb, 2000; or MTS functional leadership; DeChurch & Marks, 2006) and significant ($p < .05$ and $p < .01$ respectively). The effect of strategy training was less straightforward, in both studies no direct effect of strategy training on MTS performance was found. In one study the unsupported hypothesis was attributed to methodological limitations (Cobb, 2000). In DeChurch and Marks (2006), there was an indirect effect, whereby strategy training had a positive significant effect on between-team coordination which in turn improved overall MTS performance. This underscores the importance of mechanisms, such as between-team coordination, in the relationship between interventions and outcomes.

Frame of reference training. One study showed that frame-of-reference training, aimed at reducing representational gaps, significantly improved MTS performance by improving between-team coordination (Firth et al., 2015).

Decentralised Planning. One study explored the impact of decentralised planning on MTS performance and described it as a “double-edged sword” in that it has both positive and negative effects on overall MTS performance (Lanaj et al., 2013). The overall negative effects of decentralised planning on MTS performance were stronger than the positive effects. The mechanisms which mediated the relationship between the intervention and MTS performance outcome, are described in the next section.

Mechanisms. The studies in the review measured a plethora of variables that were found to mediate the relationship between the intervention and MTS performance. All four studies measured between-team variables, while two studies explored within-team variables. These findings are described in the sections that follow:

Within-Team Coordination Mechanisms. The two studies that measured within-team coordination present contradictory findings and conclusions. On the one hand, DeChurch and Marks (2006) showed that between-team coordination predicted significant incremental variance in MTS performance after within-team coordination and performance was controlled for, essentially suggesting the independent effects of between-team coordination on MTS performance. However, Firth et al. (2015) found that while within-team coordination in MTSs is not sufficient for between-team coordination, the latter was in fact impacted by the quality of within-team processes.

Between-Team Mechanisms. ***Between-Team Coordination.*** There are two studies that explicitly measured between-team coordination, and which found this to be a mediator mechanism by which training interventions impacted MTS performance (DeChurch & Marks, 2006; Firth et al., 2015).

Functional Leadership Behaviour (Strategizing and Coordinating). More specifically, DeChurch & Marks (2006) found that training formally appointed leader-teams, comprising leaders of all teams in the MTS, in functional leadership behaviour (strategizing and coordinating) improved between-team coordination and overall MTS performance. Hence functional leadership behaviour mediated the relationship between the training and between-team coordination, and in turn between-team coordination mediated the relationship between functional leadership behaviour and MTS performance.

Proactivity, Aspiration and Risk Seeking Behaviour and Coordination Failures. One study measured four variables (never studied in the MTS literature before): proactivity, aspiration and risk seeking behaviour and coordination failures. This study, by Lanaj et al. (2013) described the impact of the planning intervention on MTS performance as a double edged sword whereby, the positive effects on system performance were attributed to higher proactivity and aspiration levels whereas the negative effects were attributed to between-team dynamics; enhanced risk seeking behaviour and between-team coordination failures. These mediator variables had either a positive or negative impact on overall MTS performance.

Process Behaviours. As mentioned in the MTS performance section above, the results of one study; Cobb (2000), found that the effect of coordination training on MTS performance was fully mediated by action process behaviours. Cobb (2000), based on Marks et al., (2001) taxonomy of team processes, defined *action process behaviours* as those directly involved with carrying out performance tasks, such as: monitoring progress toward goals, systems monitoring, team monitoring and back-up behaviour, coordination activities and communication between team members. The same study uniquely found that transition behaviours provide an important link between interpersonal and action process behaviours. Whereby, *transition process behaviours* are directed at transforming work units and responding to changes in the work environment such as mission analysis and goal specification and formulation and *interpersonal process behaviours* focus on affect driven behaviours associated with reducing interpersonal conflict and keeping team members motivated (Cobb, 2000).

Quality Assessment

In summary all four quantitative studies were limited in providing adequate details on how sampling was conducted, the treatment of missing data and ethical considerations. Table 7 provides a summary of the evidence statements and corresponding quality ratings.

Discussion

This study aimed to ascertain that MTS performance can be improved by interventions. Given that there are only four true intervention studies contained within this review, that each of the interventions varied in terms of content and measures and that they were all set in the same context (US, military-themed lab simulations), it can only be suggested that there is initial, rather than firm evidence to support this. What follows is a discussion of the findings in terms of the two main research questions; (1) what interventions facilitate MTS functioning and (2) which mechanisms impact upon the relationship between the intervention and MTS performance, followed by the limitations of these studies and the implications for research and practice.

Table 6

Evidence Statements and Quality Ratings

Evidence statement	Quality rating	Rationale
Multiteam system performance can be enhanced by interventions	Initial evidence	Few true intervention studies (N=4 in this review), lack of diversity across the studies i.e., all military-based laboratory simulation in U.S.
Expanded team training interventions improve MTS functioning	Initial evidence	Three out of four studies demonstrated that training members and/or leaders across teams in an MTS improves overall performance
Leader training interventions improve MTS functioning /performance	Initial evidence	Three out of four studies demonstrated that interventions targeting leaders in an MTS improves overall performance
Between-team coordination mediates the relationship between interventions and MTS performance	Initial evidence	All four studies found measures of between-team behaviour mediated the effect of the intervention
Between-team coordination, enacted by Leader-teams mediate the effect of training on between-team	Initial evidence	Three laboratory studies offer initial evidence

coordination and ultimately MTS performance		
Coordination training interventions improve MTS performance	Initial evidence	Two studies offer initial evidence, however they both employed student samples
Within-team coordination mediates the relationship between interventions and MTS performance	Initial evidence	Two studies offer contradictory findings
Strategy training improves MTS performance	Unclear evidence	One study found to have the opposite effect; one study had an indirect effect
Reducing representational gaps by Frame of Reference training improves between-team coordination and consequently improves MTS performance	Unclear evidence	One study found support for this
Centralised planning (enacted through leader-teams) facilitates performance in MTS environments more than decentralised)	Unclear evidence	One study found support for this

Note. MTS = Multiteam System; U.S. = United States of America

SLR Question 1: What Interventions Facilitate MTS Functioning

Initial evidence suggests that expanded team training and training involving leaders could be useful interventions to facilitate MTS functioning. Three of the four studies demonstrated that training members across teams in an MTS improves functioning between teams in the system as opposed to traditional team training which is relevant to standalone or component team functioning. This concept of MTS training has been referred to as "expanded team training" in a recent review of the MTS literature by Shuffler and Carter (2018; p. 399) where they cite additional non-empirical and grey literature from aviation and healthcare employing expanded team training with similar positive results on overall MTS functioning (Weaver, 2016; Misasi et al., 2014). The same review went on to highlight findings of an empirical study presented during annual conference proceedings by Cobb and Mathieu (2003) which found that team training targeting within-team processes improved team performance but did not improve MTS performance. However, expanded team training (specifically coordination training targeting both team and MTS) proved enhanced outcomes at both levels. These findings stem from the PhD thesis study included in the current review by Cobb (2000). Further bolstered by Lacerenza et al. (2014), they highlight that a weakness of MTSs is their lack of common training, important in the often-ambiguous MTS contexts, and that this lack of common training prevents teams from building a common understanding of what is going on and what is required of them.

The three studies in this review which incorporated expanded team training targeted training across teams at either the leader level or the team member level. In one study, expanded team training pertained to training formally appointed leader-teams, comprising leaders of all teams in the MTS, in functional leadership behaviour (strategizing and coordinating) which improved between-team coordination and overall MTS performance (DeChurch & Marks, 2006). While this study is limited in generalisability due to the student sample and military-themed laboratory simulation employed, it has been credited for utilising a time-based research design whereby measures of different team processes are aligned with when they are anticipated to occur (LePine et al., 2008). A histometric analysis provides further support for DeChurch and Marks (2006) findings, which found that strategy and coordinating leadership behaviours are integral to MTS performance (DeChurch et al., 2011).

Two studies explored expanded team training of team members (non-leaders), across teams in an MTS, targeting different interventions; coordination and strategy training (Cobb, 2000) and frame of reference training which was aimed at MTS leaders but incorporated all team members and expected leaders to cascade and reinforce the training content (Firth et al., 2015).

In summary, this review provides initial support for the role of expanded team training in facilitating MTS functioning, training leaders and leader-teams, and the benefit of coordination training specifically. More recommendations for training interventions targeting frame of reference training, strategy training and the impact of decentralised planning on MTS performance, remain unclear in light of “single study” evidence and other quality issues mentioned (e.g., generalisability).

SLR Question 2: Which Mechanisms Impact the Relationship Between the Intervention and MTS Performance

Between-team coordination was consistently found to mediate the relationship between interventions described by all four studies contained in this review and overall MTS functioning (i.e., performance), hence demonstrating initial evidence for further empirical validation in new settings. Two studies measured between-team coordination as a standalone variable (DeChurch & Marks, 2006; Firth et al., 2015), whereas two others measured more specific between-team coordinating behaviours (Lanaj et al., 2013; Cobb, 2000). Lanaj et al (2013) provided insights into between-team behaviours never studied in an MTS context before i.e., proactivity, aspirations and risk seeking behaviour, while Cobb (2000) was empirically testing MTS theory in press at the time; the framework and taxonomy of team processes later published by Marks et al. (2001). Cobb (2000) found that the effect of coordination training on MTS performance was mediated by action process behaviours and that transition process behaviours provide an important link between interpersonal and action process behaviours. In other words, transition behaviours may be seen as important enabling activities that enhance other important process behaviours in multi-team environments. These results offered initial support for the emerging theory of MTS being developed at the time of study by Marks et al. (2001). The Marks et al. framework has since been extensively studied in the MTS literature and recognised for its potential as a useful tool for understanding the emergence of team processes and their role in team- and higher-level performance (Kozlowski & Ilgen 2006).

There were some contradictions and inconsistencies between the findings of different studies in the review measuring within-team coordination, consequently the evidence for within-team coordination as a mechanism is unclear. Authors generally agree that within-team coordination and performance is not sufficient to ensure coordination between teams (e.g., Davison et al., 2012; Firth et al, 2015; DeVries et al., 2016). However, debate remains on how crucial within-team elements to overall system performance are, with one study demonstrating that component teams can succeed while the overall system fails (DeChurch & Marks, 2006) and another suggesting within-team performance and coordination is essential for overall functioning (Firth et al., 2015). One proposed explanation suggests that MTS research employing collectives of two- or three-person sub teams (e.g., Cobb, 2000; DeChurch & Marks, 2006) do not truly simulate the dynamic nature of real-world MTSs and operate more as a large undifferentiated, standalone team (Davison et al., 2012; Lanaj et al., 2013). Building on this distinction between size and differentiation in MTSs Zaccaro et al. (2020) used MTS complexity as a lens to review the broader MTS literature and explain contrasting findings across studies. Further work is required to explore the role and significance of within-team coordination on MTS performance.

Three of the four studies provide initial evidence for the mediating role of leader-teams on MTS functioning, two of these are specific to training interventions. Pivotal MTS theory by Mathieu and colleagues (2001) focused a great deal on leadership, identifying it as a critical lever for MTS success, other scholars in the MTS domain provided further support such as Lanaj et al., (2013) and Davison et al., (2012). DeChurch and Marks (2006) included in this review, empirically verified that functional leadership mediated the effects of both types of leader training on between-team coordination and between-team coordination fully mediated the effect of MTS leadership on MTS performance. This would indicate that leader-teams can greatly improve functioning of the system by both developing plans that specify interunit cooperation during transition phases and working to facilitate coordination during action phases. (DeChurch & Marks, 2006). The practical value of DeChurch and Marks (2006) extends beyond the MTS context to validate skill-based training. Based on this study, functional leadership improvements were realised by individuals who do not have leadership experience. Their training models contained three important elements of effective skill-based training environments: opportunities for learning concepts and behaviours, practice, and feedback (McDonald-Mann, 1998) offering an interesting and important contribution to the training and development literature.

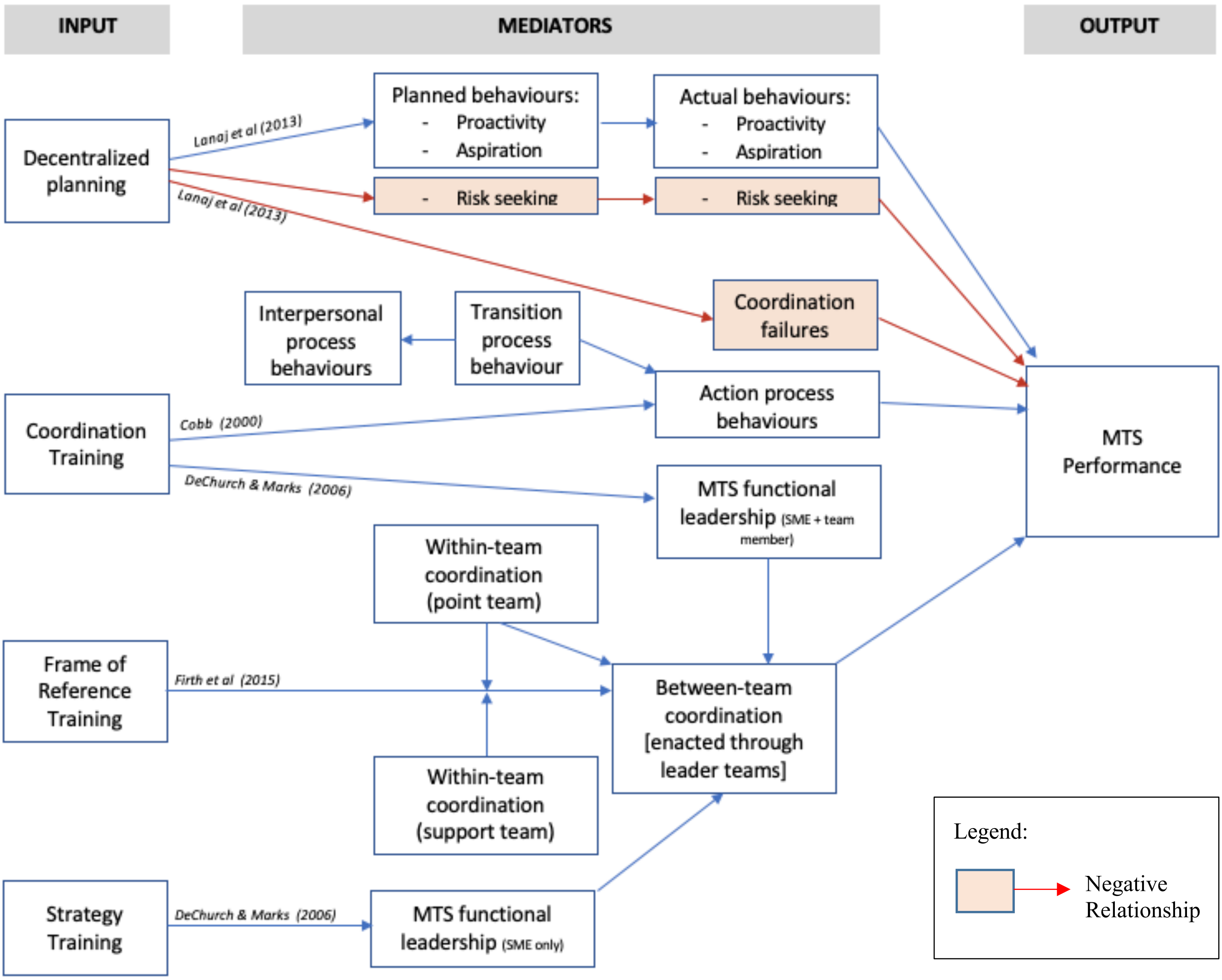
The second study in this review that supported the role of leader-teams was Firth et al. (2015), they demonstrated how between-team coordination enacted by a leader-team, could be improved with frame of reference training, underscoring the important role of leader-teams in reducing cognitive differences among team members (related to how they see problems and tasks) to better coordinated between-teams. This study extends earlier work by the same research team which indicated the important role of leader-teams in an MTS structure (Davison et al., 2012), however Firth et al. (2015) go on to propose that leader-teams alone are not sufficient to drive MTS performance and training these leaders to reduce representational gaps between members will enhance between-team coordination. The third study in the review to support the role of leader-teams in MTSs more broadly than training, comes from Lanaj et al. (2013). Contrary to the teams' literature which promotes decentralisation (Hooker & Csikszentimihali, 2003; Pearce & Sims, 2002) and team interventions based on theories of empowerment (Aryee et al., 2012; Seibert, Wang & Courtright, 2011), this study indicates that centralised planning, enacted by a leader-team, reduces informational complexity and the risk of coordination failures in MTS environments. Illustrating the countervailing effects of phenomena in team versus systems; the functional interdependence and complexity in MTSs "may offset some of the virtues of decentralised structures documented in standalone teams" (Lanaj et al., 2013 p. 749).

Summary of Findings

Taken together, these findings extend understanding beyond the conceptual framework of Shuffler et al. (2015; Figure 1) and outline the pathways to improve MTS performance through a variety of interventions (see Figure 3). While limited in the number of studies reported, common themes (i.e., two or more) around training teams together, training leaders and coordination training offer promising levers for practitioners seeking to improve MTS performance. Implications for practice will be discussed at the end of the chapter.

Figure 3

Synthesis of the Findings from all Studies in the Review



Note. SME = Subject Matter Expert; MTS = Multiteam System

Limitations and Directions for Future Research

There are five main limitations highlighted by this review that may direct future research; (1) limitations associated with the process of conducting the review (2) the dearth of true MTS intervention studies and MTS theories upon which they are based (3) the homogeneity of studies included in the review and consequent lack of generalisability (4) the short-term nature of the research designs and (5) the focus on behavioural processes (e.g., coordination and leadership) and cognitive states does not account for affective motives and emergent states, which are known to impact team-level performance but remain understudied in the MTS context.

First, like any SLR, this review is based on a limited set of keywords and despite best efforts to make this exhaustive of the terms commonly used to refer to multiteam system arrangements, it was not practical to include them all. For example, the somewhat related term "networked system" yielded an unmanageable number of titles, mostly from the information technology domain; given time and resource constraints this term was not feasible to include. Neither was it possible to know all the terms up front, as the study progressed and knowledge of the subject deepened, other related terms arose, such as "multilevel systems" and "multiteam membership". Defining the inclusion and exclusion criteria was not straightforward and required an ongoing, iterative process and series of discussions during the search and sift stage. The inclusion criteria started off quite generic "Intervention/s that impact the individual, component team and/or MTS level of functioning" but was later adapted to define "true intervention studies" that focus on those with a clear manipulation and/or different experimental conditions, as opposed to those laboratory simulations conducted in a field setting which were in and of themselves an intervention for the organisation of study but which did not clearly manipulate something within the simulation that could be considered an intervention. Two examples of papers excluded on these grounds were Davison et al (2012) and DeVries et al. (2016).

Second, there is a shortage of true intervention studies in the MTS literature and hence a limited number reported were reviewed in the present study. In addition, each of the intervention studies in this review explored different interventions and focal variables which limits the generalisability of findings. Third, homogeneity of the study design and sample also precludes from generalising findings; all studies were military-themed laboratory simulations set in the United States and half of them used student samples. While laboratory studies allow strict control over extraneous variables to maximise internal validity, and the studies met recommended laboratory evaluation criteria (e.g., use of behavioural measures, task psychological realism and theoretical contributions, Colquitt, 2008), there is a need for future research to examine the nature of relationships in more applied and varied settings.

In addition to greater breadth of MTS intervention research, the field would more broadly benefit from expanded theory building to inform future intervention studies. Recently, Luciano et al. (2018a) stated that “the development of the MTS domain has been stifled by the absence of theory that clearly delineates the core dimensions influencing the interactions between the individuals and teams operating within them” (p. 1). In response to this challenge, they offer a meso-theory of MTS functioning, a promising advance and basis upon which to elucidate the knowledgebase more fully and the focus of the empirical study described in Chapter 4.

The breadth of MTS types, size and goals are vast (Mathieu et al., 2001) and field settings are likely to place important boundary conditions on the relationships studied. Mathieu et al. (2018) later went on to state that:

> The multitude of idiosyncrasies present in any given MTS field study, too, limit the generalisability of their findings. Unifying frameworks and theories to guide the sampling and study of MTSs as well as integration of results, have been solely needed (Mathieu et al., 2018, p. 349)

Generalisability then, is not without its challenges in the study of MTSs, nevertheless future research should strive for more MTS-level studies replicating these initial findings across different MTS types. As suggested by Zaccaro et al. (2020); future MTS researchers are urged to provide elaborate descriptions of MTS characteristics and apply existing standardised frameworks to describe compositional attributes such as size, boundary-status, goal type and team member characteristics, for example, the typology of MTS attributes by Zaccaro et al., 2012. Building on this point, the findings of the studies contained within this review may be moderated by team member diversity (e.g., cultural, functional) and geographic dispersion (remote or dispersed teams), offering interesting directions for future study.

Fourth, most of the studies contained in the review drew on multiple sources of data to measure the variables and they typically used time-bound research designs, a strong methodological approach to be continued in future studies. However, given the short-term nature of these studies, longitudinal research designs that explore how effects transpire over time would suitably recognise and investigate the temporal nature of MTSs, a call made by other MTS scholars (Standifer, 2012; Klein & Kozlowski, 2000a).

Finally, the research reviewed focused on behavioural processes such as coordination and leadership or cognitive states such as shared mental models, resulting in mostly top-down human resource management practices and tools to drive MTS performance (e.g., leadership training; DeChurch & Marks, 2006, centralised planning; Lanaj et al., 2013, frame of reference training;

Firth et al., 2015 and strategy and coordination training, Cobb, 2000). The findings of this review therefore point to a clear opportunity for future research; we know from the literature on teams that affective and motivational states such as collective efficacy, team cohesion, trust, psychological safety and identity (collective orientation) among others, are all linked to team performance (Salas, Rosen, Burke, & Goodwin, 2009), but these affective motives and emergent states remain understudied and inconclusive in the MTS literature (Luciano et al, 2018a; Shuffler et al, 2015; Zaccaro et al, 2020).

Implications for Practice

Despite the aforementioned limitations, this review offers a number of contributions, relevant to practitioners working to improve MTS performance largely through (a) training to enhance between-team processes in MTSs and based on the premise that a focus on within-team performance or process is not sufficient for between-team success and (b) between-team coordination enacted through “leader-teams”. However, given the dearth of MTS intervention studies, the findings contained in this review (and derived practical applications) are considered “initial” or “unclear” and should be taken as such.

Collective Learning

Overall findings suggest that training team members together, across component teams in a system, makes good sense in the MTS context and supports earlier recommendations by Shuffler & Carter (2018). This training may target leaders in the system, team members across various teams in the system or a combination of the two, what is important is that the focus shifts from training within teams to training across the system to facilitate collective learning.

Coordination Training for Leaders. Initial findings suggest it would be beneficial to train leaders, together with other leaders in the system, to facilitate between-team coordination by (a) monitoring the needs and requirements of each component team as they relate to other teams and (b) communicating information to their team about another team (e.g., DeChurch & Marks, 2006).

Coordination Training for Team Members. Targeted team coordination training to improve action process behaviours, i.e., those directly involved in carrying out tasks, should include content on (a) checking progress toward objectives, (b) monitoring the environment, (c) backing up teammates, and (d) coordinating actions between teammates (e.g., Cobb, 2001).

Frame of Reference Training. Frame of reference training provides shared standards that "gets everyone on the same page" and facilitates between-team coordination by standardising how shared problems are conceptualised. It is a relatively simple and cost-effective training intervention to improve between-team coordination and in turn overall MTS performance (e.g., Firth et al., 2015).

Embed Social Learning Practices. Another way to improve shared cognitions (e.g., mental models) to facilitate system functioning, is to introduce "post-mortem" (Collier et al., 1996) or after-event MTS review and guided reflection practices, these allow teams to share experiences of what worked and what did not and learn collective lessons to apply in practice for future events.

Leverage Next-Generation Learning Technologies

Delivery mechanisms for learning interventions should facilitate interactions across time and space. For geographically dispersed systems and in the post-pandemic era, leveraging progressive technologies to foster collective learning will be an imperative. These technologies allow for "on-demand" and "in the flow of work" learning experiences, that is, at the time the system needs it most, to cultivate the required system learning (e.g., coordination or frame of reference needs). Next generation learning technologies can facilitate both social learning and formal learning, for example they allow for real-time communication through communities of practice forum discussions, they can also integrate with video conferencing for virtual workshops and more formal learning sessions (Bersin, 2019).

Appoint Leader-Teams to Align and Integrate Efforts

Leaders play a crucial role in spanning boundaries between teams in the system. It follows then, that training leaders how to facilitate between-team coordination, as outlined above, is an important avenue for MTS practitioners. Beyond having leaders appointed in an MTS, embedding a formal leader-team to bridge the gaps between the teams (Davison et al., 2012; Zaccaro et al., 2020) and training them together, is likely to improve MTS performance and minimise coordination failures (Lanaj et al., 2013). In the MTS environment team diversity in terms of cultural, language and functional differences between members can hamper real-time communication and cause team members to focus on their team goals over those of the system. Appointing a leader-team may help to overcome this by aligning and integrating efforts in a centralised manner.

Concluding Remarks

MTS literature is at a nascent stage and consequently the application of interventions across a variety of MTS forms is too. Overall, the studies provide initial evidence that MTS performance can be enhanced by interventions and the mediating role of between-team coordination. Findings pertaining to specific interventions are less clear with the most consistent findings pointing to the value of expanded team training. That is, the content and focus of training efforts should not be limited to developing skills relevant to team functioning alone, but instead, training must also address how to manage functioning between teams and training those teams together. Leadership and coordination are important behavioural processes in component teams, initial evidence from this review suggests that these processes can enhance both team and MTS performance, under the right conditions. Similarly, incorporating content in MTS training that targets collective cognition by reducing representational gaps, is worth consideration given the initial findings reported.

The study of countervailing forces in the MTS literature reinforces the system level of study as unique and important. Quantitatively and qualitatively different from the team and organisation level, the MTS level of analysis, the “whole” has proven to be “more than the sum of its parts” whereby team performance and processes are not sufficient for overall system functioning. With more and more teams working in this way, advancing the research agenda to further elucidate the knowledgebase is paramount. Directions for future research illuminated by the present review call for more heterogenous, applied MTS intervention studies, expanded theory building and research into affective and motivational emergent states in MTSs.

CHAPTER 4

Empirical Study

Make or Break? How Structural Features and Emergent States Influence MTS Functioning

Abstract

Despite a proliferation of research into multiteam systems (MTSs) in recent years, there is a paucity of studies that (a) examine MTSs in real-world settings, (b) compare different types of MTSs, and (c) examine emergent states in the MTS context. Initial findings in the MTS domain indicate that emergent states (such as social identity) may have contradictory (or countervailing) effects between team and system-levels (DeChurch & Zaccaro, 2013). This empirical study drew on a meso-theory of MTS functioning (Luciano et al., 2018a) to examine how structural features of an MTS (i.e., differentiation and dynamism) and emergent states (i.e., social identity, psychological safety and collective efficacy) influenced system outcomes (i.e., between-team collaboration). The study employed a cross-sectional field design surveying 148 participants from 14 systems in nine organisations based in the Middle East, North Africa, United Kingdom and Australia. A preliminary interview was conducted with a point of contact from each system to provide data pertaining to the nature of work and other system attributes of interest in the study. This was followed by an online survey disseminated to participants working in the systems and measured 11 constructs stemming from Fiske's social motivation theory (2004; 2009). Multiple linear regression analyses were performed to test the hypotheses.

Main findings supported the expected negative relationship between MTS structural features (i.e., differentiation and dynamism) and between-team collaboration. However, the same structural features taken individually exerted a positive influence on system collaboration. This implies that there is a tipping point at which the effects shift from positive to negative when

combined. The expected relationship between MTS structural features and team-level individual needs and motives (i.e., belonging, affective, cognitive) was not supported, but the positive relationship between team-level needs and motives and their corresponding emergent states was.

Two emergent states, system identity and system psychological safety, were positively related to overall MTS functioning (i.e., between-team collaboration) and the expected countervailing effects of team psychological safety and team efficacy on system outcomes was also supported. Control variables in the study were found to play a significant role in facilitating collaboration between teams (i.e., presence of a leader-team, system stage and system size). Taken together, these findings lend support for many aspects of the meso-theory tested with clear implications for future theory, research and practice.

Practitioner points:

1. Embedding system protocols or ways of working could counteract the divisive and disruptive forces inherent in many MTSs. Protocols should define system governance processes in terms of how work gets done, how teams communicate and share information, the cadence and type of meetings between teams in the system and general expectations among members and leaders. Defining these upfront and early-on leveraging collective wisdom of the teams as opposed to coming top-down from leaders is likely to foster greater commitment to the protocols.
2. Leaders play an important integration role in systems, spanning boundaries between teams, they are well positioned to compensate for divisive and disruptive forces and lead their teams and system to success. Findings point to the importance of fostering system psychological safety and aligning teams around a common system identity. Leaders and leader-teams can play a pivotal role in nurturing these emergent states and should be

trained to appreciate the nuances of an MTS to balance the tensions (countervailing effects) between their respective teams and the system.

3. Progressive human resource technologies offer innovative ways to connect teams across space and time. These technologies enable virtual collaboration, knowledge management, agile goal setting for performance management and communities of practice. All of which are likely to foster collaboration between teams in the MTS environment.

Introduction

Multiteam systems (MTSs) emerge, or are formed, to address complex superordinate goals that are beyond the capacity of a single component team. “A multiteam system brings together a complex variety of skills, knowledge and functions in adaptive structures that are especially suited to managing a highly complex environment” Zaccaro et al. (2012, p. 12). These independent collective entities, comprised of two or more teams, are prevalent across a variety of contexts such as military, space exploration, scientific collaboration, healthcare, and business (Shuffler et al., 2018). They are a hybrid organisational form, larger than an individual team but smaller than an established organisation (Rico et al., 2017) which in some cases span organisational boundaries.

Several pertinent literature reviews have been conducted following two decades of research into MTSs (e.g., Shuffler et al., 2015; Shuffler & Carter, 2018; Zaccaro et al., 2020; Turner et al., 2019) and a lesser number of conceptual frameworks and theoretical models have been developed (e.g., Zaccaro et al., 2012, 2020; Luciano et al., 2018a) since the concept of MTS was introduced by Mathieu et al. (2001). While key lessons have been extrapolated from this literature and advanced the field (see Shuffler & Carter., 2018), a number of unanswered questions remain. In Chapter 3, a systematic review of the literature sought to identify what interventions have been shown to facilitate MTS functioning and by which mechanisms. The high-level findings of this review indicated three significant gaps in the literature. First, there is a paucity of MTS interventions studies; only four were included in the review. Second, all studies were limited in their design and generalisability to the dynamic, global context in which MTSs operate; all the studies included in the review were conducted in the United States, within laboratory settings, using a military-themed simulation and half of them used student samples as part of a dissertation thesis. These findings offer limited insights into the real-world operationalisation of MTSs or the structural features that influence functioning.

Finally, all of the reviewed studies focused on behavioural processes such as coordination and leadership or cognitive states such as shared mental models, resulting in mostly top-down human capital practices and tools to drive MTS performance (e.g., leadership training; DeChurch & Marks, 2006, centralised planning; Lanaj et al., 2013, frame of reference training; Firth et al., 2015 and coordination training, Cobb, 2000). We know from the large body of literature on teams that affective and motivational emergent states such as collective efficacy, team cohesion, trust, psychological safety, and identity (collective orientation) among others, are all linked to team performance (Salas et al., 2009), and are likely to also hold influence in MTS contexts. Yet, affective and motivational emergent states remain understudied and inconclusive in the MTS literature (Luciano et al., 2018a; Shuffler et al., 2015; Zaccaro et al., 2020).

Tajfel and Turner (1979) conducted early research on intergroup relations and how social processes shape perceptions between groups. The concept of emergent states stems from this early work and relates to both team and system-levels in the MTS context. Emergent states have been defined as "properties of the team that are typically dynamic in nature and vary as a function of team context, inputs, processes and outcomes. Emergent states describe cognitive, motivational, and affective states of teams, as opposed to the nature of their member interaction." (Marks et al., 2001, p. 357). Two important findings have been uncovered in the MTS literature regarding emergent states (1) the prevalence of *countervailing forces*, whereby phenomena previously found to benefit team functioning can harm system-level functioning and vice versa (Shuffler & Carter, 2015; DeChurch & Zaccaro, 2010) and (2) studies examining emergent states report contradictory findings, for example, a lack of system identification can foster ineffective communication and between-team conflict, reducing MTS performance (Cuijipers, 2016), contrastingly, system identification may harm MTS performance by depleting resources (Porck et al., 2018). Zaccaro et al.'s (2020) recent literature review highlighted these contradictions and the lack of sufficient theory to explain emergent properties in MTSs or the processes affecting them. They called for more research along this line of inquiry and echo earlier MTS scholars who suggested the same (e.g., Shuffler & Carter, 2015; Luciano et al, 2018a).

Introducing a Meso-Theory of MTS Functioning

The nature of an MTS varies greatly from system to system. MTS features become a crucial context within which teams operate (Mathieu et al., 2007) and have social-psychological consequences which affect members' social cognition and motivation (Luciano et al, 2018a). Investigating MTS phenomena in the context of the environment and defining attributes is key to generating findings to inform practice and to avoid issues with over-generalisations. As such, there is a call from scholars to compare different types of MTSs. Shuffler et al. (2015) noted that few, if any, quantitative studies varied attributes of MTSs and relied mostly on qualitative studies to provide thematic-level findings of variation. Mathieu et al. (2018) drew attention to the "multitude of idiosyncrasies" inherent in MTS field studies which preclude generalisability and cited the "lack of unifying framework to guide sampling and study of MTSs" as a challenge to be addressed (p. 349). More recently, Zaccaro et al. (2020) join the calls and reiterate the need for studies that compare MTS types.

Conceptual frameworks have emerged to classify MTS attributes (Zaccaro et al., 2012; 2020, Luciano et al., 2018a), and while a pitfall of MTS empirical research lies in studying MTSs out of context, without referencing a consistent unifying framework, these frameworks have been used to compare and contrast literature review findings in response to the generalisation challenge mentioned above (e.g., Zaccaro et al., 2020; Shuffler et al, 2015).

The work by Luciano et al. (2018a) contributes to MTS theory by creating a multidimensional framework focussing on two key structural features of an MTS (i.e., differentiation and dynamism) that exert powerful boundary-enhancing (or “divisive”) and disruptive forces respectively, these divisive and disruptive forces represent social-psychological consequences of the structural features and are proposed to affect individual and team behaviour in the system. Luciano et al. (2018a) defined *differentiation* by the following key features: goal discordancy, competency separation, norm diversity, work process dissonance and information opacity, and *dynamism* by the following features: change in goal hierarchy, uncertainty of task requirements, fluidity of system structural configuration, fluidity of system composition, diversion of attention.

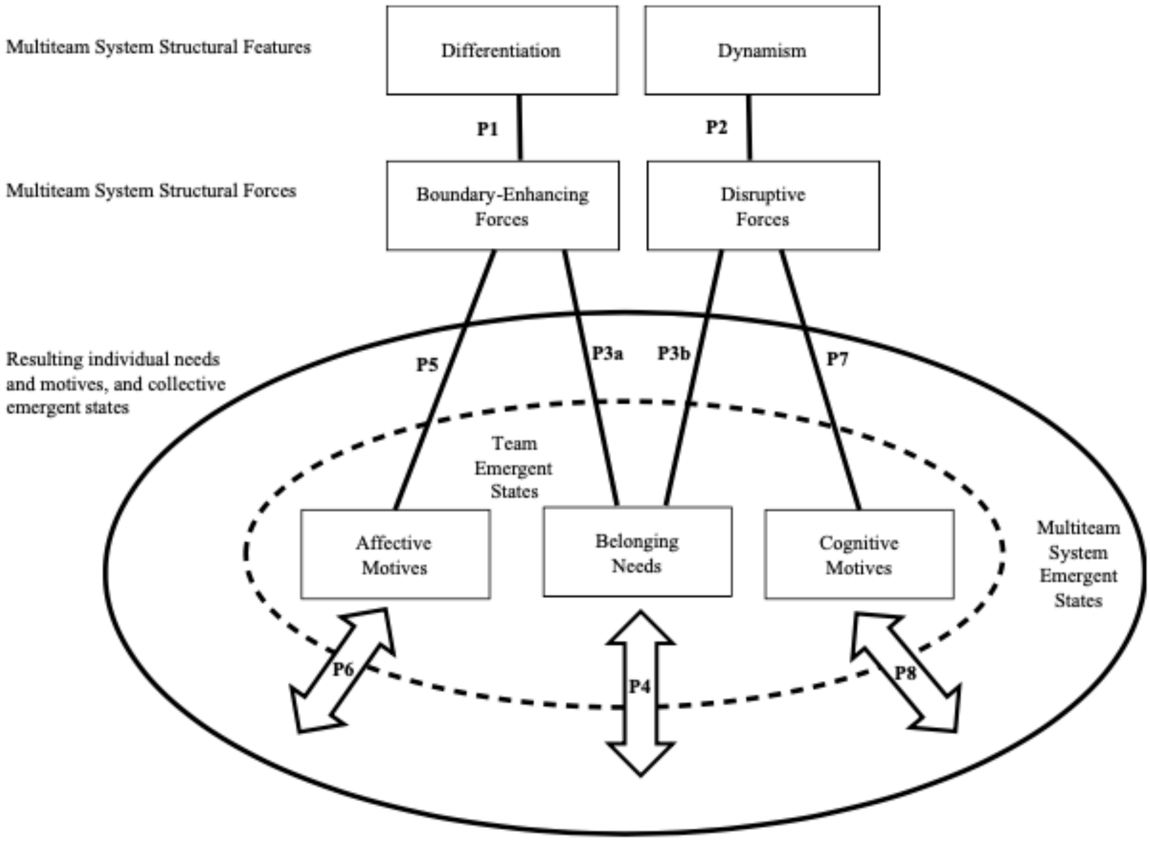
In addition to this structural framework, Luciano et al. (2018a) proposed a meso-theory of MTS functioning that describes the consequences of the structural features and emanating forces on individual needs and motives, and the bottom-up manner that these needs and motives manifest into team and system emergent states, ultimately affecting system functioning. Luciano et al. (2018a) adopts a social cognitive approach (e.g., House et al., 1995) to link these structural features with individuals’ reactions and focus on whether the emergent states are directed toward the component team or system-level. Incorporating Fiske’s (2004) theory of social motives “as the by-products of person-by-situation interactions” and that “individual needs are framed in terms of their orientation toward groups or collectives” (Luciano et al, 2018a, p. 18). Luciano et al. (2018a) took the five needs that shape an individual’s propensity for social interaction and constitute Fiske’s definition of social motivation (i.e., belonging, understanding, controlling, self-enhancing and trust) and made a series of propositions around how these needs and motives manifest into emergent states (i.e., social identity, psychological safety and collective efficacy) at the team or system-level depending on high or low levels of differentiation and dynamism.

The propositions made by Luciano et al. (2018a), (see Figure 4) posit that MTSs with greater levels of differentiation will experience greater *boundary-enhancing forces* and MTSs with greater levels of dynamism will experience greater *disruptive forces*. They go on to propose that greater levels of boundary-enhancing forces (stemming from differentiation) and disruptive forces (from dynamism) will push members to direct their needs and motives toward the component team-level rather than toward the system-level. Individual needs and motives are described by (a) belonging needs; (b) affective motives, met by self-enhancing and trust needs; and (c) cognitive motives, met by understanding and controlling needs. When individual needs and motives (i.e., belonging, affective, cognitive) are met at the team-level, the resulting emergent states will also be directed to the team-level. Emergent states that manifest from belonging needs, affective and cognitive motives are social identity, psychological safety, and collective efficacy, respectively. Importantly, collaboration between teams in the system (i.e., between-team collaboration) will be undermined when emergent states (i.e., social identity, psychological safety, collective efficacy) manifest at the team-level rather than the system-level. Between-team collaboration is a proxy for overall MTS functioning, and it is essential for MTS success and achievement of common goals (Connaughton et al., 2012; Campbell, 1990; Mathieu et al., 2001).

There is currently a paucity of research investigating the emergent states that facilitate between-team collaboration as the extant literature is mostly focussed on leadership functions and centralisation (e.g., DeChurch & Marks, 2006; Lanaj et al., 2013; Davison et al., 2012; Marks et al., 2005; Cobb, 2000), enhanced coordination by reducing representational gaps among members (e.g., Firth et al., 2015) and intrapersonal functional diversity (DeVries et al., 2016). The literature surrounding emergent states in MTS environments and the impact on between-team collaboration is not only understudied but initial findings are conflicting (e.g., Porck et al., 2018 vs Cuijipers et al., 2016). These conflicting findings relate to whether it is the team or system-level that is most optimal for MTS functioning and is explored in greater depth in the discussion.

Figure 4

Meso-Theory Linking MTS Structural Features to Team and System Emergent States



Note. P = Proposition

Source: Luciano et al. (2018a)

The Present Study: Testing a Meso-Theory of MTS Functioning

The present study seeks to empirically test Luciano et al. (2018a) theory and propositions linking structural features of an MTS (i.e., differentiation and dynamism) with individual needs and motives (i.e., belonging, affective and cognitive) to resultant emergent states (i.e., social identity, psychological safety, and collective efficacy) and ultimately to between-team collaboration as the proxy for overall system functioning.

The hypotheses that follow (also depicted in Figure 5) have been developed to test Luciano et al.'s (2018a) meso-theory, therefore the language and terms closely align with the propositions presented in their theory albeit framed as testable hypotheses. The term "prediction" used throughout is appropriate because multiple linear regression analysis is adopted as the analytical approach, whereby independent variables are tested for their potential *predictive role* on outcome variables. In this context, prediction is purely a statistical term that translates to quantifying variability on outcome variables without inferring causality. Causality may only be inferred by study design (e.g., experimental design) and by default with a cross-sectional design, that is not possible in the present study.

Belonging Needs and Social identity. Belonging needs describe the notion that individuals desire strong stable relationships with others (Baumeister & Leary, 1995). Fiske (2004) suggests that a basic need for all people, is to have a sense of belonging in groups. Sherif and Hovland (1961) describe in-group biases and preferences that emerge when team members have more direct contact with one another than with member of other teams. Luciano et al. (2018a) posits that boundary-enhancing and disruptive influences of differentiation and dynamism push individual members to get their belonging needs met at the team-level, which in turn can spark social comparisons between-teams (Hogg et al., 2012; Tajfel & Turner, 1979) which shapes members social identity more in terms of team membership than system membership, thereby undermining between-team collaboration. Tajfel (1978: 63) defined *social identity* as “that part of an individual’s self-concept which derives from his knowledge of his membership of a social group (or groups) together with the value and emotional significance attached to that membership.” Therefore, and in alignment with Luciano et al., (2018a) theoretical propositions, the impact of structural MTS features (i.e., high differentiation and dynamism) will exert powerful forces (i.e., boundary-enhancing and disruptive, respectively) that push individual team members to get their belonging needs met at the team-level more than at the system-level (proposition 3; p. 1084, Luciano et al., 2018a). When belonging needs are met at the team-level more than the system-level, the emergent state social identification will also manifest at the team-level more than the system. When team identity is stronger than system identity, collaboration between teams in the system is impaired (proposition 4; p. 1084 Luciano et al., 2018a). Thus, the following working hypotheses were devised:

Hypothesis 1a: Differentiation and dynamism will predict belonging needs at the team-level, such that as differentiation and dynamism increase team belonging will increase.

Hypothesis 1b: Differentiation and dynamism will predict belonging needs at the system-level, such that as differentiation and dynamism increase system belonging will decrease.

Hypothesis 2a: Team belonging will positively predict team identity, such that as team belonging increases so will team identity.

Hypothesis 2b: System belonging will positively predict system identity, such that as system belonging increases so will system identity.

Hypothesis 3: System identity will exert a stronger positive influence on between-team collaboration than team identity.

Affective Motives and Psychological Safety. Luciano et al. (2018a) describe affective motives, *self-enhancing needs* in the context of Fiske's (2004;2014) social motivation theory: building and maintaining self-esteem by seeking feedback from those whom they are more similar to and have positive relationships with, and *trusting needs*, also in the context of Fiske's social motivation theory "Fiske defines trust as people seeing the world as a benevolent pace and generally speaking, expecting good outcomes, especially from other people." Luciano et al. (2018a p. 18). Luciano et al. (2018a) posit that because of the MTS structural feature, differentiation, individuals will direct their affective motives, in the form of self-enhancement (i.e., feedback seeking) and trust need fulfilment, more toward their component team than toward the system (proposition 5; p. 1085, Luciano et al., 2018a). In doing so, the emergent state, psychological safety will also manifest at the team rather than system-level, undermining between-team collaboration (proposition 6; p.1085, Luciano et al., 2018a). *Psychological safety* is a group-level construct that refers to a common belief that the team is a safe place for interpersonal risk taking (i.e., confidence to speak up) and is associated with positive outcomes (Edmondson, 1999). Based on this, the following hypotheses will be tested:

Hypothesis 4a: Differentiation will predict affective motives at the team-level, such that as differentiation increases team affective motives increase.

Hypothesis 4b: Differentiation will predict affective motives at the system-level, such that as differentiation increases system affective motives decrease.

Hypothesis 5a: Team affective motives will positively predict team psychological safety, such that as team affective motives increase so will team psychological safety.

Hypothesis 5b: System affective motives will positively predict system psychological safety, such that as system affective motives increase so will system psychological safety.

Hypothesis 6: System psychological safety will exert a stronger positive influence on between-team collaboration than team psychological safety.

Cognitive Motives and Collective Efficacy. Luciano et al (2018a) posit that team members will satisfy their needs for cognitive-based motives: understanding needs and control needs, by focusing on what in their environment is more, rather than less, manageable. In an MTS, the component team is more proximal and is likely more strongly influenced by the efforts of a single individual than is the larger system (Dépret & Fiske, 1999). "As such, members will likely react by focusing inward and not seeking or sharing information" Luciano et al. (2018a, p. 21). *Control needs*, related to team members' need to exert influence over their environment is heightened in dynamic or threatening contexts. Kanfer and Kerry (2012) suggest that the often-ambiguous context inherent in an MTS, particularly surrounding the attainment of system goals is likely to push members to focus their attention on their team goals rather than the system goals. The team-level is more in their direct control. Following Luciano's reasoning, members can orient themselves to activities that allow them to reduce uncertainty and focus on more controllable component team activities depending on the MTS environment. Therefore, cognitive-based motives, in the form of information sharing and goal commitment, will be directed toward the proximal team-level, when disruptive forces (i.e., dynamism) are high (proposition 7; p. 1086, Luciano et al., 2018a). As such, the emergent state, collective efficacy, will be directed at the team-level rather than system-level, undermining between-team collaboration (proposition 8; p. 1086, Luciano et al., 2018a). *Collective efficacy* is an emergent motivational state defined as a group's perceived confidence in their ability to achieve desired outcomes (Bandura, 1982). Considering this, the following hypotheses have been developed:

Hypothesis 7a: Dynamism will predict cognitive motives at the team-level, such that as dynamism increases team cognitive motives also increase.

Hypothesis 7b: Dynamism will predict cognitive motives at the system-level, such that as dynamism increases system cognitive motives decrease.

Hypothesis 8a: Team cognitive motives will positively predict team efficacy, such that as team cognitive motives increase so will team efficacy.

Hypothesis 8b: System cognitive motives will positively predict system efficacy, such that as system cognitive motives increase so will system efficacy.

Hypothesis 9: System collective efficacy will exert a stronger influence on between-team collaboration than team collective efficacy.

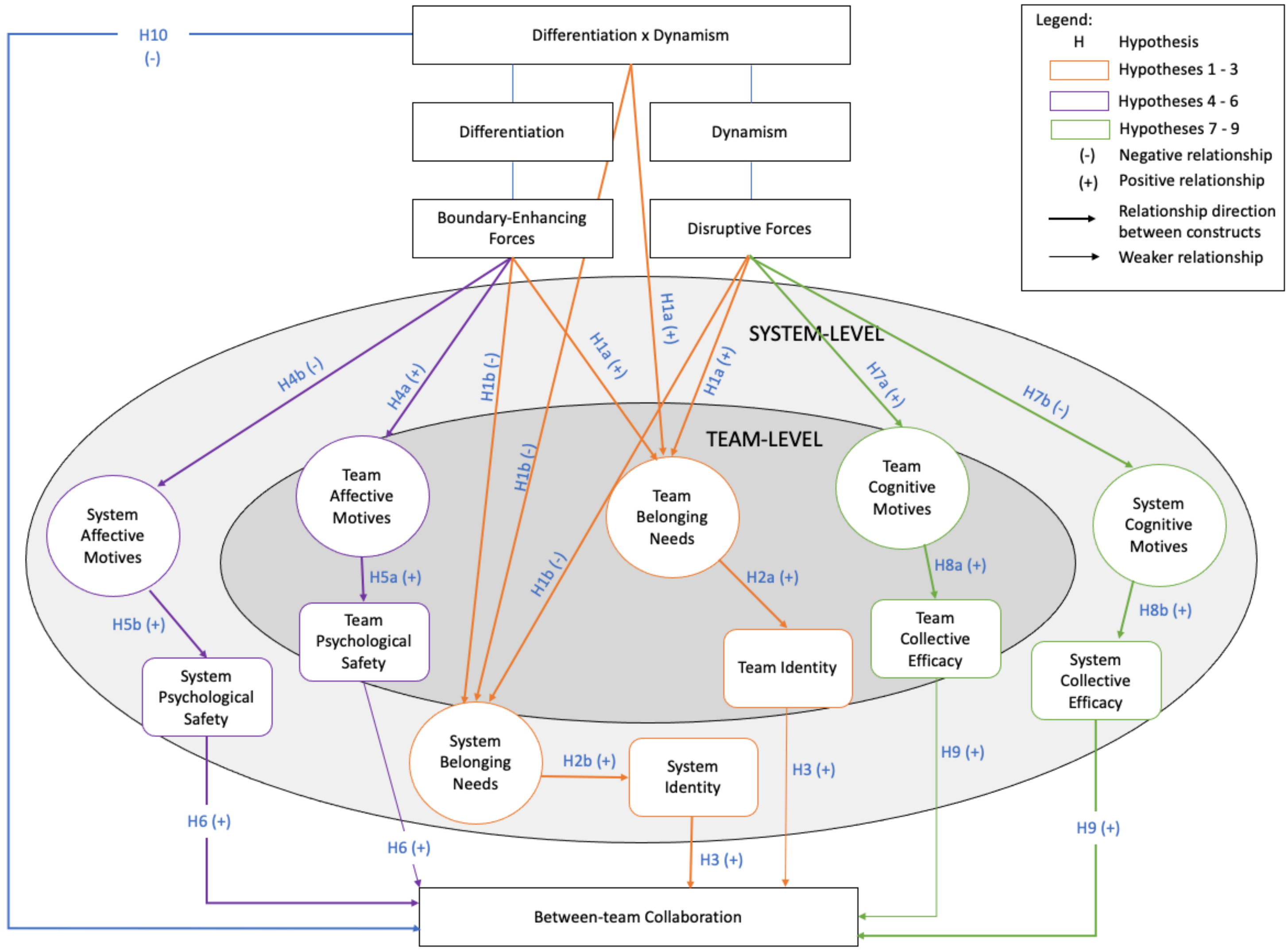
MTS Structural Features. According to Luciano et al. (2018a), two dimensions of an MTS structure (i.e., differentiation and dynamism) will have boundary-enhancing and disruptive effects on the system, respectively. Luciano et al. (2018a) posit that these forces will undermine between-team collaboration with overall negative implications for system functioning. However, the theory suggests that the effect on between-team collaboration is a result of the link between individual needs and motives with corresponding emergent states and finally on between-team collaboration (i.e., hypotheses one through nine). Hence, the final hypothesis seeks to test the direct relationship between differentiation and dynamism on between-team collaboration.

Hypothesis 10: Differentiation and dynamism will predict between-team collaboration, such that as differentiation and dynamism increase between-team collaboration will decrease.

To test these hypotheses, this study draws on a broad sample of MTSs from a variety of contexts and cultures with varying degrees of differentiation and dynamism. To the best of the author's knowledge, this is the first time such study is conducted. The study will address the gaps in extant research outlined in the literature review above (see Chapter 1) and respond to calls made by scholars for greater breadth of MTS field studies and comparison of MTS types (e.g., Mathieu et al, 2018; Zaccaro et al, 2020; Shuffler et al, 2015).

Figure 5

Hypothesised Model



This research makes an important contribution to the MTS literature in four unique ways:

1. **Methodology** – A cross-cultural field study conducted in real-world settings with working adult populations.
2. **Constructs** – The study will respond to calls for deeper exploration into affective and motivational emergent states given the limiting focus on behavioural processes and

cognitive emergent states in existing studies and the inconclusive, contradictory findings that exist about emergent states in the current body of MTS literature.

3. **Context** – MTSs do not operate in a vacuum; they are intricately and inherently linked to their environment. Consistently comparing MTSs that vary along pre-defined attributes and structural features using a conceptual framework, moves knowledge of these complex systems forwards and addresses a significant gap in the literature.
4. **Application** – By empirically testing theory, the findings obtained will build on the existing and growing MTS literature base and inform the design of future interventions and intervention studies seeking to facilitate MTS functioning.

Method

Design

A cross-sectional field study was conducted to test the hypotheses and meet the aims and objectives of the present study.

Sample

Participating Organisations. The present study included a heterogenous sample, recruited from nine organisations that operate in a variety of sectors, ranging in size, from start-ups (< 30 employees) to large multinationals and spanning an equally heterogenous geographic footprint that includes business operations in the United Kingdom, Middle East, Africa, Australia, Europe and worldwide. Organisations from the lead researcher's personal network were approached for participation in the study, complemented by referrals and a social medial campaign. An initial exploratory discussion was convened with the relevant point of contact for each organisation that expressed an interest in the study. The purpose of the initial discussion was to outline the study aims and identify which teams and systems would be appropriate for inclusion based on the widely adopted definition of an MTS set out by Mathieu et al. (2001), two or more teams working interdependently towards one or more common goals while having their own distinct proximal goals.

MTS Attributes. Fourteen MTSs from the nine participating organisations were included in the study, detailed in Table 7. In keeping with the adopted definition of an MTS (see Mathieu et al., 2001), each system had between three and seven teams. Studying MTSs with diverse attributes and characteristics was essential to ensure that the measures of differentiation and dynamism varied across the sample. Attributes such as size, boundary status, structure, inclusion of a leader-team, type of goals, system stage and tenure reflect compositional, linkage and development attributes from the MTS classification framework by Zaccaro et al. (2012;2020), and these system characteristics are presented in Table 7, hereby answering the call from scholars (e.g., Zaccaro et al., 2020) for future MTS literature to report on the characteristics of MTS samples.

Table 7

*Summary of System Characteristics (*N*=14)*

Variable	Range	M	SD
Number of teams per system	2 – 7	5.26	1.68
Number of members per system	4 – 22	10.57	5.32
Stage of development (years)	0.25 – 25	8.25	7.78
Boundary status: *n (%)*			
Internal	n/a	12	(85.71)
External	n/a	2	(14.29)
Hierarchy: *n (%)*			
Leader-team “Yes”	n/a	10	(71.43)

Leader-team "No"	n/a	4	(28.57)
Structure: *n (%)*			
Functional	n/a	10	(71.43)
Cross-functional	n/a	4	(28.57)
Tenure: *n (%)*			
Permanent	n/a	8	(57.14)
Temporary / project-based	n/a	6	(42.86)
Goal type: *n (%)*			
Intellectual	n/a	14	(100)
Physical	n/a	0	(0)

Note. M = Mean, SD = Standard Deviation, n/a = not applicable.

Participants. One hundred and forty-eight working adults completed the online survey. Table 8 provides a detailed summary of the sample demographics. Eighty-two participants reported their age, ranging from 21 to 66 years and an average age of 38 years (SD = 9.7 years). One hundred and forty-one participants disclosed their gender, 46% were male. Of the 137 participants reporting years of work experience, the sample showed a broad spread, ranging from one year to 60 years' experience and an average of 15.5 years (SD = 10 years). Team tenure ranged from less than one year to 27 years, and an average of five years (SD = 4.9 years*; n* = 142), similarly system tenure ranged from less than a year to 28 years, and an average of five years (SD = 5.6 years, *n* = 134). Participants represented a vast array of ethnicities, with the most representative being Caucasian at 22% (*n* = 33) followed closely by Middle Eastern at 19% (*n* = 28). Finally, hierarchy level was reported by one-hundred and forty-five participants and represented an equal split between those in management positions (50%, *n* = 75) and those who were non-managers (47%, *n* = 70).

Table 8

*Summary of Population Characteristics (*N *= 148)*

Variable		
Gender (*N* = 141): *n (%)*		
Male	68	(45.9)
Female	52	(35.1)
Prefer not to say	21	(14.2)
Missing	7	(4.7)
Age, years (N = 82): *mean (SD)*	38.3	(9.7)
Ethnicity (N = 140): *n (%)*		
Caucasian	33	(22.3)
Latino / Hispanic	1	(0.7)
Middle Eastern	28	(18.9)
African	18	(12.2)
North African	5	(3.4)
South Asian	15	(10.1)
Mixed	4	(2.7)
Other	2	(1.4)
Prefer not to say	24	(16.2)
Missing	18	(12.2)
Hierarchy (N = 145): *n (%)*		
Manager	75	(50.7)
Individual contributor	70	(47.3)
Missing	3	(2.0)
Team tenure, years (N = 142): *mean (SD)*	5.2	(4.9)
System tenure, years (N = 134): *mean (SD)*	5.2	(5.6)
Work experience, years (N = 137): *mean (SD)*	15.5	(10.0)

Note: Data contained in this table refer to survey respondents only and exclude the point of contact interviewed for each system. Population characteristics questions were “optional” for respondents to complete. SD = Standard Deviation

Procedure

For each system in the study, a point of contact from the Human Resources department or a business leader, provided informed consent to participate and took part in a 45-minute interview. The interviews took place between November 2020 and June 2021. During the first part of the interview, questions were asked to ascertain key defining attributes of the system, these included asking about compositional, linkage and development attributes from Zaccaro et al. (2012;2020), described above in “MTS Attributes” (see Table 7 and Appendix B). The second and third part of the interview focussed on assessing the system’s level of differentiation and dynamism. Full interview questions are documented in Appendix B.

Subsequently, an email communication was prepared by the researcher and disseminated by the point of contact to members of the system, to invite them to participate in an online survey hosted by Qualtrics. If the point of contact was also a member of the system, they were not invited to complete the survey. The email communication attached a more detailed information sheet describing the purpose of the study, the benefit of taking part and important information about how data is gathered and stored. The researcher was copied on the email so that participants could reply directly with any further queries or clarifications. In some instances, the researcher sent the survey link following an introductory email, in others the point of contact included the survey link in the original email and simply copied the researcher, this was decided on a case-by-case basis depending on the preferences of the organisation.

The survey items were piloted with two points of contact from the first two organisations to sign-up for participation. The purpose of the pilot was to determine approximate response time to complete the survey and check for common and cross-cultural understanding of the items. A key insight from the pilot discussions was the importance of brevity to reduce the cognitive load on participants. With over 60 items in the survey, many of which were duplicated at team and system-level and rather complex in nature, survey completion and completion quality (i.e., common method variance) was at risk. The survey took approximately 12 minutes to be fully completed. Further information about the survey items and any adjustments made based on this pilot, is detailed in the next section.

Ethical Approval

Birkbeck, University of London Board of Ethics granted approval for this study on November 2020 (Appendix C). Participating organisations were provided with background information pertaining to the research, including ethical considerations such as the privacy statement of the system used to host the virtual meeting, data confidentiality, data storage, the right to withdraw and debriefing process. An introductory call was scheduled to explain more about the process and answer any questions. Once informed consent was received from the point of contact for each company (also the interviewee), the process was explained to prospective survey participants via email, including information about the purpose of the study, the benefits to them and how the data would be gathered and stored. The information also contained links to non-profit organisations in the event that participation could in some way cause harm to physical or mental well-being. The online survey included the opportunity to provide informed consent and outlined important information about confidentiality and the participants' right to withdraw. Data were stored confidentially on a password protected file and in an anonymous format.

Measures

A summary of the measures examined in the study can be found below and a full description of items and scales may be found in Appendix A and B. Where scales were adapted to measure team and MTS-level constructs, the term "system" followed by the name of the respective system was used instead of "MTS" for the sake of clarity in participant communications.

Structural Features of an MTS

System Differentiation. Luciano et al. (2018a) proposed the dimension of differentiation pertaining to an MTS which captures the degree of difference and separation between teams in a system at a particular point in time. Luciano and her colleagues defined five subdimensions of differentiation in terms of: goal discordancy, competency separation, norm diversity, work process dissonance and information opacity. They also provided detailed definitions of low, medium, and high for each of these subdimensions. During the structured interview conducted in the present study, these definitions and scale descriptions were read out lout to the specific point of contact and they were asked to rate each of the subdimensions on a 3-point Likert-type scale ranging from 1 (low) to 3 (high). In the present study α was .62.

System Dynamism. Taken from the same theory (Luciano et al., 2018a), the dimension of dynamism which describes the variability and instability of the system over time, was defined by the following subdimensions: change in goal hierarchy, uncertainty of task requirements, fluidity of system structural configuration, fluidity of system composition, diversion of attention. Like the approach taken to assess system differentiation, the point of contact was asked to rate each subdimension of dynamism on a 3-point Likert-type scale ranging from 1 (low) to 3 (high). In the present study α was .61.

Differentiation and Dynamism. The combined measure of the two aforementioned structural features was computed in SPSS by multiplying total differentiation items by total dynamism items.

Individual Needs and Motives – Belonging

Belonging Needs. Team and system belonging needs were measured by a single-item adapted from the validated single-item need to belong measure (SIN-B) by Nichols and Webster

(2013) and the original 10-item Need to Belong (NTB) by Leary et al. (2013). The original NTB item *"I want other people to accept me"* was adapted so it was framed to target both the team- and system-level e.g., *"I want members of my team to accept me"* and *"I want members of my system to accept me"* and scored on a 5-point Likert-type scale from 1 (strongly agree) to 5 (strongly disagree). Please refer to Chapter 2 (Methodology) for a more detailed discussion on the item selection for this measure.

Individual Needs and Motives – Affective

Self-Enhancing Needs, Feedback Seeking. Aligned with Fiske's (2004, 2009) social motivation theory, self-enhancing needs, in terms of team and system feedback seeking was measured using Callister, Kramer and Turban's (1999) established 4-item feedback inquiry scale, adapted from Ashford's frequency of feedback seeking by monitoring or inquiry scale (1986) and used by DeStobbeleir et al. (2019) where α was .81 and by Srikanth & Jomon (2013) α was .87.

Original items such as: *"I ask my co-workers if I am doing a good job"* were adapted to the team and system-level of measurement for the present study, where "co-workers" was replaced by "team members" or "members of other teams in the system". A sample item for team feedback seeking is *"I ask my team members for feedback about my work" and "I ask my members of other teams in the system for feedback about my work"* for system feedback seeking. Items were scored on a 5-point Likert-type scale, ranging from 1 (always) to 5 (never), for participants to indicate the extent to which the four feedback-seeking statements describe their own behaviour. Responses across all four items were totalled, higher scores indicated lower team or system feedback seeking and lower scores indicated higher levels of team or system feedback seeking.

In the present study, the scale showed strong reliability, α was .87 for the team version of the scale and .90 for system-level items.

Trust Needs. Recently validated in cross cultural settings (Jasielska et al., 2019) the Generalised Trust Scale (GTS; Yamagishi & Yamagishi 1994) offers a promising alternative to other instruments that have been challenged in the literature (World Values Survey and Interpersonal trust scale, Rotter, 1967). The GTS has been used to successfully study and predict trusting behaviour, and it has proven useful in cross-cultural research (Carter and Mark Weber 2010; Montoro et al. 2014; Yamagishi 2001). The GTS was designed to measure trust, defined as an expectation of trustworthiness of others or high default expectations of human benevolence (Yamagishi, 2001).

Given that the focus of this study was to look at deriving trust needs from a team or system, items in the original GTS such as *"most people are generally trustful of others"* did not relate well to context. Therefore, and in keeping with the approach taken for team and system belonging, one item from the 6-item GTS was used in the present study, the original item *"I am trustful"* was adapted to suit team and system-level of analysis e.g. *"I trust members of my team"* and *"I trust members of the system"* respectively. Items were scored on a 7-point Likert-type scale from 1 (strongly agree) to 7 (strongly disagree).

As was more fully elucidated in Chapter 2 of this thesis, other researchers such as Cha, et al. (2015) have shown that while the use of single-item measures can be problematic for several reasons (Schriesheim et al., 1991), considerable research indicates that single-item measures are strongly correlated with multiple-item measures of the same concept (Cunny & Perri, 1991; Loo, 2002; Wanous et al., 1997).

Affective Motives. According to Luciano et al. (2018a), affective motives are underpinned by a combination of individual self-enhancing needs and trust needs. Team and system affective motives was therefore comprised of the subscales described above: trust and feedback seeking. Team affective motives was calculated by the sum of team trust and total team feedback, α was .82. System affective motives was calculated by the sum of system trust and total system feedback, α .83.

Individual Needs and Motives – Cognitive

Understanding Needs, Information Sharing. Understanding needs, measured by team and system information sharing was assessed using an established 3-item measure; the information sharing scale by Bunderson and Sutcliffe (2002a). This scale was used in MTS research with a high degree of internal consistency, α was .90 (Jiménez-Rodriguez, 2012).

Original items such as: *"information is freely shared among members of this team"* were adapted for the team and system-level of measurement e.g., *"information is freely shared among members of this team"* and *"information is freely shared between teams in the system"*. Items were scored on a 7-point Likert-type scale from 1 (strongly agree) to 7 (strongly disagree). Responses across all three items were totalled, higher scores indicated lower team or system information sharing and lower scores indicated higher levels of team or system information sharing. In the present study, α was .66 for the team version of the scale and 0.81 for system-level items.

Control Needs, Goal Commitment. Together with understanding needs, control needs reflect cognitive motives. These needs are met by directing attention (i.e., commitment and orientation) to more proximal team goals as opposed to system-level goals and was measured in the present study by goal commitment at the team and system-level.

Team and system goal commitment was measured using an established 4-item scale by Hollenbeck et al. (1989). This scale has been described as "a general, flexible measure in that it can be used to assess goal commitment regardless of goal origin or timing" (Seijts & Latham, 2000a, p. 320) and is one of the commonly used measures of goal commitment (Klein & Kozlowski, 2000; Wright et al., 1994). Also used in MTS research by Davison (2012) and adapted to a 5-item scale by MTS researchers Klein and Kozlowski (2000). Hollenbeck et al. (1989) reported that the scale exhibited a high degree of internal consistency, α was .71.

Original items such as: *"it's unrealistic for me to expect to reach this goal"* were adapted for team and system-level of analysis e.g., *"It's unrealistic to expect the team's goals to be reached"* and "*It's unrealistic to expect the system's goals to be reached.* Based on feedback from the pilot, one item *"It's hard to take the goals of the team/system seriously" was reframed to "I take the goals of the team/system seriously"* and *"quite frankly" was removed from the final item: "quite frankly, I don't care if I achieve the goals of the team".* Items were scored on a 5-point Likert-type scale, ranging from 1 (strongly agree) to 5 (strongly disagree). Items 2, 3 and 4 were reverse scored and responses across all four items were totalled. Higher total scores indicated lower team or system goal commitment and lower scores indicated higher levels of team or system goal commitment. In the present study, α was .33 for the team version of the scale and .43 for system-level items.

Cognitive Motives. Luciano et al. (2018a) meso-theory describes cognitive-based motives in the context of an individual's need for understanding and control. As described above, these needs are measured in the present study by information sharing and goal commitment scales, respectively. The overall construct for team and system cognitive motives comprised these two sub-scales. Team cognitive motives was calculated by the sum of team information sharing and team goal commitment, α was .54. System cognitive motives was calculated by the sum of system information sharing and system goal commitment, α was .68.

Emergent States

Social Identity. Team and system identity was measured using an established 4-Item measure of social identification (FISI, see discussion section of Postmes et al., 2012). The FISI is an adaptation of the scale reported by Doosje et al., (1995) and has adequate reliability (α = .77). MTS scholars Cuijiper et al. (2016) used the 4-item scale (Doosje et al., 1995) in MTS research, with strong reliability; for team identification, trial 1 to 3 α was .93, .96, and .96, correspondingly, for MTS identification, α was .93, .96, and .97.

Original FISI item such as*: "I identify with (in-group)"* was adapted to team and system-level for use in the present study where "in-group" in the original items was replaced with either "team" or "system". Items were scored on a 7-point Likert-type scale from 1 (strongly agree) to 7 (strongly disagree). Responses across all four items were totalled, higher scores indicated lower team or system identity and lower scores indicated higher levels of team or system identity. In the present study, the FISI scale showed strong reliability, α was .85 for the team version of the scale and .91 for system-level items.

Psychological Safety. Team and system psychological safety were measured using an established 4-item measure, developed by Bunderson and Boumgarden (2010), adapted from the original 7-item psychological safety scale by Edmondson (1999). Bunderson and Boumgarden (2010) reported that the scale exhibited a high degree of internal consistency, α was .90.

Original items such as: *"if you make a mistake on this team, it is often held against you,"* remained the same for the team-level measure. However, items to measure system psychological safety were adapted to refer to the relational atmosphere between teams, an approach taken by Fleştea et al. (2017) where the phrase *"thinking of the interaction with other teams in the system"* preceded the original item and replaced the team context e.g., "*Thinking of the interaction with other teams in the system, mistakes are often held against you"*. Items were scored on a 5-point Likert-type scale, ranging from 1 (strongly agree) to 5 (strongly disagree).

Items one and four were reverse scored and responses across all four items were totalled. Higher total scores indicated lower team or system psychological safety and lower scores indicated higher levels of team or system psychological safety. In the present study, α was .46 for the team version of the scale and .56 for system-level items.

Collective Efficacy. Team and system collective efficacy were measured using an established 3-item measure by Homburg and Stolberg's (2006) which they adapted from Schwarzer and Schmitz (1999). Homburg and Stolberg (2006) reported that the scale exhibited a high degree of internal consistency across two studies α was .53 and 0.78 and Jiménez-Rodriguez (2012) adopted the scale in MTS research and reported α was .97

Original items: *"I am sure that we can achieve progress, because we are all pulling in the same direction", "I am confident that together we can solve the problem of climate change"* and *"We can come up with creative ideas to solve environmental problems effectively, even if the external conditions are unfavourable"* were adapted to refer to each member's perception of the team and the system overall where "we" in the original item was replaced by team or system and the environmental context was omitted. Items used in the present study were: *"I am sure that this team/system can achieve progress, because we are all pulling in the same direction", "I am confident that together this team/system can accomplish difficult tasks"* and *"teams in the system come up with creative ideas to achieve important system-level outcomes, even if the external conditions are unfavourable" or "this team can come up with creative ideas to achieve team outcomes, even if the external conditions are unfavourable"* for the team-level variant of item 3. Items were scored on a 7-point Likert-type scale, ranging from 1 (strongly agree) to 7 (strongly disagree). Responses across all three items were totalled, higher scores indicated lower team or system efficacy and lower scores indicated higher levels of team or system efficacy. In the present study α was .84 for the team version of the scale and .92 for system-level items.

Outcome Measures of MTS Functioning

Between-Team Collaboration. Between-team collaboration is essential for MTS success (Connaughton, Williams & Shuffler, 2012), in the present study it is an outcome variable adopted as a proxy for overall MTS functioning (see subsequent "analysis" section for empirical justification) . Between-team collaboration was measured using an established 5-item scale developed by Hoegl et al. (2004) partly adapted from scales used by Mott (1972) who evaluated coordination, cooperation, and communication between different occupational groups in hospitals. Hoegl et al. (2004) reported a high degree of internal consistency, α was .85.

Between-team collaboration is a system-level construct, so original items were adopted in the present study without modification. Sample items include *"Connected processes and activities were well coordinated with other teams" and "conflicts between teams in the system are settled quickly".* Items were scored on a 5-point Likert-type scale, ranging from 1 (strongly agree) to 5 (strongly disagree). Responses across all five items were *averaged*, higher scores indicated lower between-team collaborations and lower scores indicated higher levels of between-team collaboration. An empirical justification for data aggregation of the between-team collaboration measure is offered in the subsequent section (see "analysis"). In the present study α was .81. Unlike other constructs, between-team collaboration is a system-level construct, hence there was only one variation of the scale.

In addition to assessing between-team collaboration by taking an average of system-member scores via the online survey, a structured interview was conducted with a point of contact for each system to measure system constructs (i.e., differentiation and dynamism), described below. The interview included a single item measure of between-team collaboration that asked the point of contact the following question "*to what extent do the teams in the system collaborate well together*", rated on a 5-point Likert-type scale, ranging from 1 (excellent) to 5 (very poor). The average member measure and the point of contact measure were combined for an overall measure of between-team collaboration in each system.

System Performance. Overall system performance was rated by the specific point of contact interviewed for each system with the following question: *"Please rate how well the system is performing overall"* measured on a 3-point Likert-type scale from 1 (overperforming) to 3 (under-performing).

This measure was used in preliminary analyses as a justification for the use of between-team collaboration as an overall proxy for system functioning. See the analysis section below for further information.

Control variables

A review of the literature, including the findings from the SLR in the present thesis (Chapter 3) suggested the need to control for several variables to rule out potential bias from extraneous sources. Given the number of comparisons in the present study and the need for power, only the theoretically most relevant controls were included. Therefore, the following three system-level variables were controlled for in the analyses, system tenure, system size and the presence of a leader-team in the system structure. System tenure, also known as stage of system development, relates to how long the teams in a system have been working together, their degree of familiarity. Experience over time affects the way that teams interact with one another and should be controlled for especially when studying emergent states, as recommended by other MTS researchers (e.g., Cha et al., 2015; DiRosa, 2013). The teams' literature clearly established the link between group size and group processes and outcomes (e.g., Goodman et al., 1986). Similarly, the MTS literature has found the same and linked size to MTS complexity (e.g., Davison et al., 2012; Zaccaro et al., 2020). The final control variable is defined by whether the system included the presence of a leader-team in its structure or not. Chapter 3 of the present thesis elucidates the pivotal role of leader-teams in planning and coordinating processes essential for overall MTS functioning and the initial evidence from extant literature supporting this position (Davison et al, 2012; Lanaj et al., 2014; Firth et al., 2015; DeChurch & Marks, 2006).

Analysis

Prior to testing the hypotheses, a series of preliminary analyses were conducted on the variables of interest (1) descriptive analysis of the participant and system characteristics, included computing the means and standard deviations of variables; (2) internal reliability analyses for scale measures; (3) correlational analysis of the main variables in the study to determine the relationships among the variables and (4) correlation and aggregation statistics to validate the use of between-team collaboration as a proxy for system functioning and the aggregation of the between-team scores for each system. While these analyses do not directly test the hypotheses, they are an important preliminary step for identifying any outliers, measurement errors, problems with the data, or other trends that may warrant further statistical analysis.

To test the main hypotheses in the study, multiple linear regression analyses were conducted. All predictors for each set of hypotheses were entered into the model simultaneously (forced entry), a recommended approach for testing theory (Studenmund & Cassidy, 1987). Alternative approaches such as hierarchical or stepwise regression, which specify a particular order for entering predictors, are influenced by random variation and predictors may not demonstrate predictive power purely because of the order of entry (Field, 2018).

The first group of hypotheses (i.e., hypotheses: 1, 4, 7) were investigated using multiple linear regression to ascertain whether differentiation, dynamism or the interaction of differentiation and dynamism would predict belonging needs, affective and cognitive motives at the team, or system-level. The second group of hypotheses (i.e., hypotheses: 2, 5, 8) investigated whether the team-level needs and motives (i.e., belonging, affective and cognitive) predicted emergent states (i.e., social identity, psychological safety, and collective efficacy) at the corresponding team-level and vice versa for system-level needs and motives and system emergent states. Finally, the third group of hypotheses (i.e., hypotheses: 3, 6, 9, 10) investigated predictors of between-team collaboration.

Between-team collaboration was used as a proxy for overall system functioning. To justify this decision, the system performance measure, as rated by the specific point of contact for each system, was correlated with the same point of contact's rating for between-team collaboration, which revealed the two measures were highly correlated ($r = .29$, $p < .001$). However, to provide a more robust measure of between-team collaboration for the regression analyses and reduce single-source bias (Salas et al., 2018), the specific point of contact single rating, was combined with the average between-team collaboration rating from members of the system, as captured in the online survey distributed to members (see data aggregation statistics). Before combining these scores, further correlation analyses were run as preliminary checks, these uncovered that the specific point of contact rating for between-team collaboration for a given system, was highly and significantly related to the average between-team collaboration score, as rated by individuals in that system, $r = .23$, $p = .005$ and the subsequent combined measure of between-team collaboration, was also correlated with the point of contact's system performance score ($r = .41$, $p < .001$).

The measure of between-team collaboration is an MTS variable and the only measure that required aggregation at the MTS level. Data aggregation statistics were calculated to empirically justify the averaging of between-team collaboration ratings in each system. R_{wg} index of within-group agreement (James et al., 1984) is generally accepted as a justification for aggregating individual data to the group-level (e.g., Kozlowski & Klein, 2000). R_{wg} is the within-group agreement for a single item, whereas $r_{wg(j)}$ combines the r_{wg} estimates for each item of a multi-item measure. Between-team collaboration in the present study comprises five items, hence the use of $r_{wg(j)}$. The $r_{wg(j)}$ compares average observed variances within groups (in this case within each MTS) on each item with that which would be expected based on a uniform distribution. Mathieu et al's., (2001) definition of an MTS underpinned the research and so a minimum of two teams per system and a minimum of four members in each system was applied, like the minimum criteria adopted by other MTS scholars (e.g., DeChurch & Marks, 2006). Due to the criticism levelled at those blindly adopting a uniform (i.e., rectangular) distribution (e.g., Brown & Hauenstein, 2005; Lebreton et al., 2003) and considering James et al. (1984) warning regarding rater response bias, the present study reports the null distributions generated by central tendency (i.e., triangular distribution) and social desirability and positive leniency (i.e., skewed distribution). These sources of bias have been empirically supported in research (e.g., Anastasi, 1982; Nunnally, 1978; Wherry & Bartlett, 1982; James et al., 1984). The $r_{wg(j)}$ calculated based on a uniform (i.e., rectangular) distribution is also reported and represents the upper bound of the likely true agreement (Smith-Crowe et al., 2014). For a more in-depth discussion of aggregation statistics and the decisions taken, including the justification for $r_{wg(j)}$ rather than ICC (1) and ICC (2), please refer to the methodology (Chapter 2).

The resulting $r_{wg(j)}$ coefficients range from 0 to 1, with higher values indicating greater agreement among group members on the target construct. Given that between-team collaboration was used as a proxy for overall system functioning, the target for aggregation was MTS level, therefore $r_{wg(j)}$ estimates were computed for each system to assess the degree to which teams converged in their perceptions of between-team collaboration across the system. Table 9 provides an overview of the $r_{wg(j)}$ values for each system in the study. The median $r_{wg(j)}$ across

MTSs was .92 (uniform distribution) and .86 (triangle and skewed distribution). All $r_{wg(j)}$ values, except one, were above the generally agreed upon cut-off value of .70 (LeBreton & Senter, 2008). As this indicates substantial within-group agreement, individual scores for between-team collaboration were then averaged per MTS, and the resulting MTS-level composite was combined with the specific point of contact rating of between-team collaboration in the system and used in all remaining analyses.

Across the regression models, system-level covariates were controlled. System-level covariates were: (1) the presence of a leader-team or not (2) the stage of system development in terms of years since formation and (3) the size of the system, in terms of the number of teams in the system.

Standard measures of goodness of fit (e.g., R^2) and effect sizes (e.g., Cohen's *d*, Cohen, 1988) were estimated. Power analysis to estimate the minimum sample size required for the analysis was calculated using Gpower v. 3.1.9.6 (Erdfelder et al., 2009). The a priori test was based on a pre-set power ($1-\beta = .95$), a medium effects size ($f^2 = .15$) and $\alpha = .05$ with a maximum of three predictors and three control variables, demonstrated that the required sample was 146, with a power of .95. There are no prior studies which explored the breadth of variables studies in the present research, however selecting a medium effect size was guided by other MTS studies testing some of the same constructs. For example, Cuijipers et al. (2016) reported a positive relationship between MTS identity and MTS performance ($\Omega = .15$, $p < .01$) and Jiménez-Rodriguez (2012) reported positive relationships between MTS effectiveness and team efficacy ($r = .23$, $p < .05$), system efficacy ($r = .26$, $p < .05$), MTS trust ($r = .27$, $p < .05$), system information sharing ($r = .26$, $p < .05$), goal shared mental models ($r = .33$, $p < .05$).

The data cleaning process involved screening for normality, univariate, and multivariate outliers. Multiple linear regression assumptions were checked to determine the suitability of the data. The variables used in the regression model were also checked for multicollinearity by examining the variation inflation factors (VIF) to ensure they do not exceed 10 and tolerance was checked to ensure it did not drop below 0.02 (Menard, 1995). After cleaning the data, a final sample of 148 survey participants from 14 systems was achieved.

Table 9

$R_{wg(j)}$ Statistics for Between-Team Collaboration

System Identification Number	Number of Respondents per System	Distribution		
		Triangular	Slight Positive Skew	Uniform
1	7	.89	.89	.94
2	12	.89	.89	.94
3	5	.00	.00	.56
4	7	.94	.94	.96
5	22	.79	.79	.89
6	11	.70	.71	.86
7	11	.72	.73	.87
8	6	.88	.89	.93
9	12	.69	.70	.86
10	5	.94	.94	.96
11	4	.91	.91	.95
12	14	.87	.87	.93
13	13	.85	.85	.92
14	18	.51	.54	.81

Results

Preliminary Analyses

Table 10 presents the means, standard deviations, and zero-order correlations, for the main variables in the study. Overall, the main outcome variable, between-team collaboration, was significantly associated with system differentiation (r = .21, p < .01), system dynamism (r = -.39, p < .01), emergent states that were significantly, positively associated were system psychological safety (r = .25, p < .01), system collective efficacy (r = .30, p < .01) and collective efficacy at the team-level (r = .30, p < .01), lastly, individual cognitive motives met at the system-level, were also associated with between-team collaboration (r = .20, p < .05). System structural features, differentiation and dynamism did not show associations with any of main variables other than between-team collaboration, with one interesting exception; differentiation and system collective efficacy were positively correlated (r = .19, p < .05).

Multiple Linear Regression Analyses

Models 1 – 6: Group 1. The results from the multiple linear regression analyses were clustered into three groups, according to the similarity of outcomes they were testing. Table 11 presents the summary of six separate regression analyses calculated for Group 1 and examine independent variables predicting whether individual needs and motives (i.e., belonging, cognitive, affective) are directed more at the team or system-level. Model 1 and 2 tested hypothesis 1a: differentiation and dynamism predict belonging needs at the team-level, such that as differentiation and dynamism increase team belonging will increase, and hypothesis 1b: differentiation and dynamism predict belonging needs at the system-level, such that as differentiation and dynamism increase system belonging will decrease. The results showed that none of the predictor variables had a statistically significant effect on team and system belonging. No statistically significant regression equation was found for Model 1 ($F(6, 141) = 1.14$, $p = .344$) or Model 2 ($F(6, 141) = .98$, $p = .443$). Hypothesis 1a and 1b were therefore not supported.

Table 10

*Correlation Matrix between the Main Variables in the Study, Including Mean Scores and Standard Deviations (*N *= 148)*

	Variable	*M*	*SD*	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	Differentiation	8.72	1.85	-																
2	Dynamism	8.18	1.91	-.01	-															
3	Team belonging	1.36	.66	.09	-.01	-														
4	System belonging	1.49	.71	.04	-.01	.86**	-													
5	Team identity	6.78	3.24	-.04	.13	.58**	.50**	-												
6	System identity	7.78	3.78	-.01	.06	.44**	.48**	.82**	-											
7	Team affective motives	15.15	4.63	-.13	.16	.22**	.17*	.15	.03	-										
8	System affective motives	16.92	4.62	-.11	.14	.17*	.19*	.16	.22**	.78**	-									
9	Team psychological safety	8.60	2.80	.11	-.13	.11	.05	.23**	.20*	-.03	-.03	-								
10	System psychological safety	9.29	2.95	.07	-.15	.02	.05	.20*	.34**	-.05	.09	.72**	-							
11	Team cognitive motives	12.51	3.17	.01	.10	.22**	.22**	.27**	.28**	.24**	.20*	.37**	.34**	-						
12	System cognitive motives	13.53	3.96	.04	-.03	.10	.15	.26**	.45**	.10	.23**	.33**	.47**	.78**	-					
13	Team collective efficacy	5.02	2.16	.07	-.08	.33**	.31**	.42**	.31**	.28**	.16	.37**	.30**	.48**	.35**	-				
14	System collective efficacy	5.95	3.21	.19*	-.06	.12	.14	.34**	.52**	-.08	.11	.21*	.39**	.38**	.61**	.44**	-			
15	Between-team collaboration	23.72	9.78	.21**	-.39**	-.08	-.08	.03	.13	.02	.08	.15	.25**	.07	.20*	.23**	.30**	-		
16	System size	5.26	1.68	.47**	-.35**	.06	.04	-.02	.01	-.12	-.10	.22**	.22**	.08	.14	.14	.21*	.63**	-	
17	System stage	8.25	7.78	.30**	.16	.13	.10	.00	.07	.06	.06	.14	.20*	.29**	.24**	.20*	.19*	.33**	.35**	-
18	Leader-team	1.34	.48	.37**	.08	-.14	-.13	-.16	-.09	-.24**	-.12	-.01	.01	-.10	-.07	-.15	.04	-.07	-.18*	-.30**

Note. System size: the number of teams in the MTS; System stage: in years; Leader-team: 1 = yes 2 = no; * $p < .05$ ** $p < .01$

Model 3 tested hypothesis 4a: Differentiation will predict affective motives at the team-level, such that as differentiation increases team affective motives increase. A statistically significant regression equation was found (F (4,143) = 3.45, p = .010, R^2 = .09, ΔR^2 = .06), control variable leader-team (β = -.30, p = .005) and control variable system size (β = -.22, p = .032) were the only significant negative predictors contributing to a total of 6% of the total variance in team affective motives when taking into account all the variables in the model. Model 4 tested hypothesis 4b: Differentiation will predict affective motives at the system-level, such that as differentiation increases system affective motives decrease. The regression equation was not statistically significant (F(4, 143) = 1.30, p = .272), hypothesis 4b was therefore not supported. Model 5 and 6 tested hypothesis 7a: Dynamism will predict cognitive motives at the team-level, such that as dynamism increases team cognitive motives also increase and hypothesis 7b**:** Dynamism will predict cognitive motives at the system-level, such that as dynamism increases system cognitive motives decrease. Significant regression equations were found for both models (F (4,143) = 3.46, p = .010, R^2 = .09, ΔR^2 = .06 and F (4,143) = 2.51, p = .045, R^2 = .06, ΔR^2 = .04, respectively). Control variable system stage (model 5: β = .27, p = .004; model 6: β = .24, p = .012) was the only significant predictor explaining 6% and 4% of the total variance in team and system cognitive motives, when considering all the variables in the model. Consequently, hypothesis 7a and 7b were non-significant.

Table 11

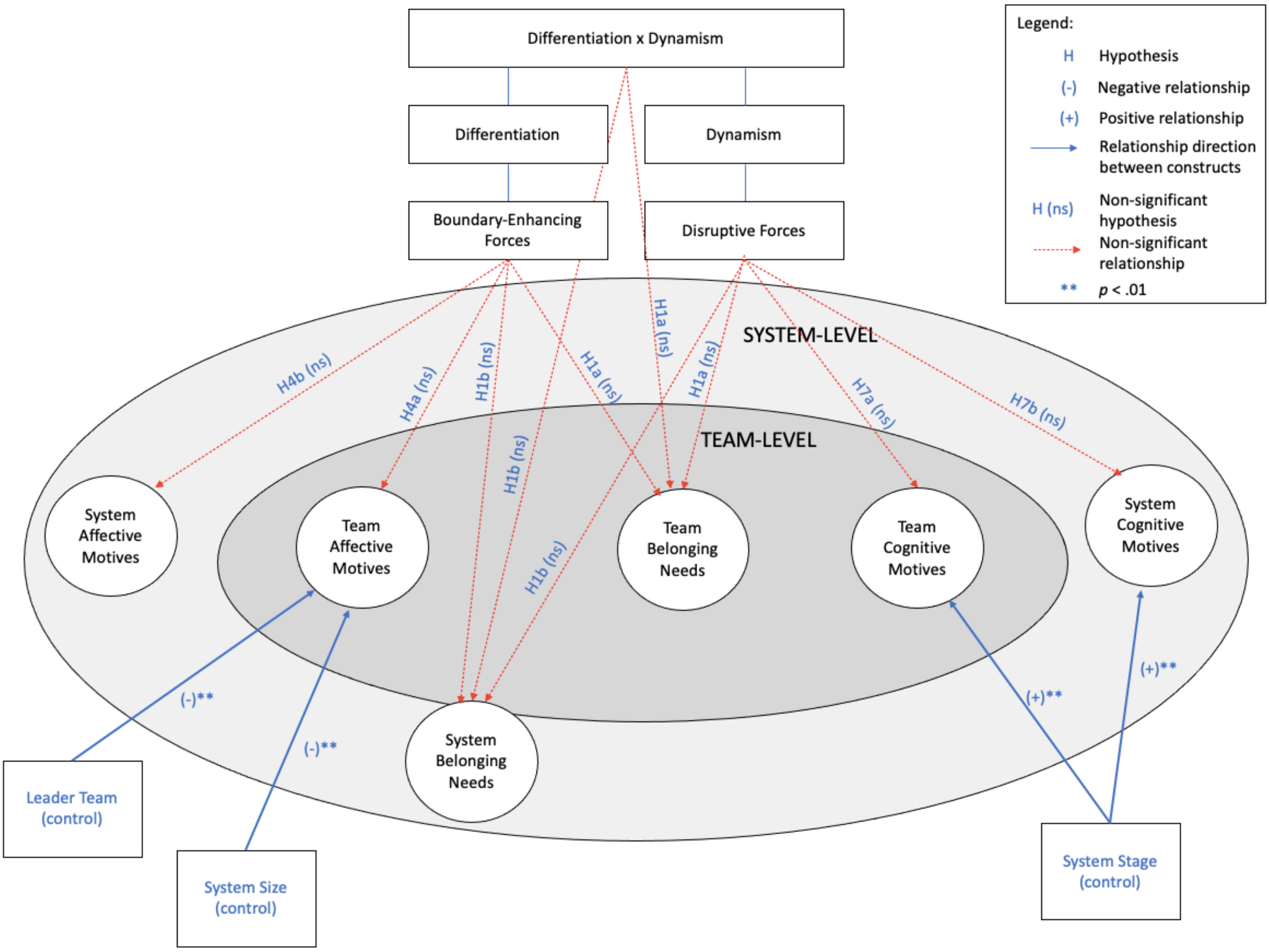
Group 1: Summary of Multiple Regression Analyses Testing Whether Differentiation and Dynamism Predict Team or System Needs and Motives

	Model					
	1	2	3	4	5	6
	H1a (ns)	H1b (ns)	H4a (ns)	H4b (ns)	H7a (ns)	H7b (ns)
	Dependent Variable					
	Team Belonging	System Belonging	Team Affective Motives	System Affective Motives	Team Cognitive Motives	System Cognitive Motives
Controls						
System size	-.09	-.02	-.22**	-.14	.00	.04
System stage	.05	.03	.03	.08	.27**	.24**
Leader-team	-.20	-.16	-.30**	-.12	-.03	.02
Independent variables						
Differentiation	.09	-.56	.08	-.03	-	-
Dynamism	-.11	-.55	-	-	.06	-.05
Differentiation x Dynamism	.13	.86	-	-	-	-
Model Significance	.344	.443	.010**	.272	.010*	.045*
R squared (R^2)	.05	.04	.09	.04	.09	.06
Adjusted R^2 (ΔR^2)	.01	-.00	.06	.01	.06	.04
F statistic	1.14	.98	3.45	1.3	3.46	2.51

Note. Standardised regression coefficients are reported. * $p < .05$ ** $p < .01$ *** $p < .001$
ns = non-significant, H = Hypothesis.

Figure 6

Group 1: What Impact do Structural Features of an MTS have on Needs and Motives



Models 7 – 12: Group 2. Table 12 presents the summary of six separate regression analyses, calculated for group two to examine what level of needs and motives (team or system) predicts team and system emergent states (i.e., social identity, psychological safety, and collective efficacy). Model 7 and 8, tested hypothesis 2a: Team belonging will positively predict team identity, such that as team belonging increases so will team identity and hypothesis 2b: System belonging will positively predict system identity, such that as system belonging increases so will system identity. In both cases statistically significant regression equations were found for Model 7 (*F* (5,142) = 15.19, $p < .001$, $R^2 = .35$, $\Delta R^2 = .0.33$) and Model 8 (F (5,142) = 8.80, $p < .001$, $R^2 = .24$, $\Delta R^2 = .21$), as expected in hypothesis 2a: team belonging predicted team identity ($\beta = .57$, $p < .001$) but system belonging did not, contributing to explaining 33% of the total variance in team identity, when taking into account all the variables in the model. Hypothesis 2a is therefore supported. Similarly, for model 8, system belonging predicted system identity ($\beta = .41$, $p = .004$), but team identity did not, contributing to explaining 21% of the total variance in system identity, when considering all the variables in the model. Hypothesis 2b is also supported.

Model 9, testing hypothesis 5a: Team affective motives will positively predict team psychological safety, such that as team affective motives increase so will team psychological. The regression equation was not statistically significant ($F(5, 142) = 1.60$, $p = .166$), so hypothesis 5a is not supported. Model 10 tested hypothesis 5b: System affective motives will positively predict system psychological safety, such that as system affective motives increase so will system psychological safety. A statistically significant regression equation was found for Model 10 ($F(5,142) = 3.47$, $p = .005$, $R^2 = .11$, $\Delta R^2 = .08$), team affective motives showed negative predictive power ($\beta = -.26$, $p = .046$), whereas system affective motives ($\beta = .31$, $p = .02$) positively predicted system psychological safety, contributing to explaining a total of 8% of the total variance in system psychological safety when taking into account all the variables in the model. Hypothesis 5b was supported.

Models 11 and 12 tested hypothesis 8a: Team cognitive motives will positively predict team efficacy, such that as team cognitive motives increase so will team efficacy and hypothesis 8b: System cognitive motives will positively predict system efficacy, such that as system cognitive motives increase so will system efficacy. In both models, a statistically significant regression equation was found, Model 11 (*F* (5,142) = 9.24, $p < .001$, $R^2 = .25$, $\Delta R^2 = .22$) and Model 12 (*F* (5,142) = 20.50, $p < .001$, $R^2 = .42$, $\Delta R^2 = .40$), as hypothesised, team cognitive motives predicted team efficacy ($ß$ = .53, p = <.001) but system cognitive motives did not, contributing to explaining a total of 22% of the total variance in team efficacy, when taking into account all the variables in the model. Hypothesis 8a was supported. As expected, model 12 demonstrated that system cognitive motives predicted system efficacy ($ß$ = .78, p = .018), and team cognitive motives negatively predicted system efficacy ($ß$ = -.25, p = <.001), contributing to explaining a 40% of the total variance in system efficacy when considering all the variables in the model. Hypothesis 8b was supported.

There were some additional statistically significant findings for Group 2 pertaining to the control variables. In Model 9 and 10, testing hypotheses 5a and 5b; control variable system size, showed significant predictive power ($ß$ = .20, p = .028) on team psychological safety and ($ß$ = .17, p = .047) on system psychological safety.

Table 12

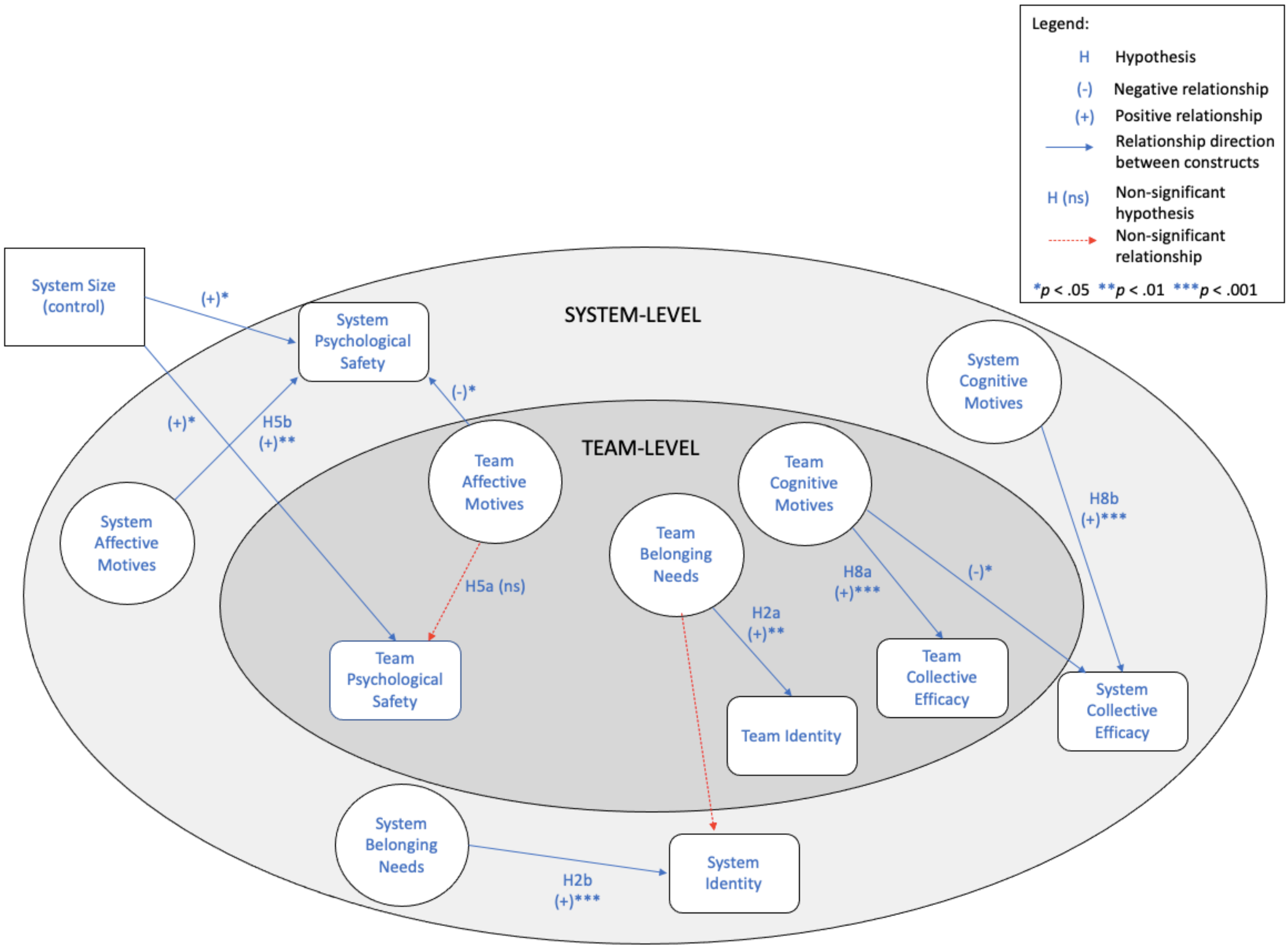
Group 2: Summary of Multiple Regression Analyses Testing What Level of Needs and Motives (Team/System) Predicts Emergent States at Team and System-level

	Model					
	7	8	9	10	11	12
	H2a	H2b	H5a (ns)	H5b	H8a	H8b
	Dependent Variable					
	Team Identity	System Identity	Team Psych Safety	System Psych Safety	Team Efficacy	System Efficacy
Controls						
System size	-.04	-.03	.20*	.17*	.09	.12
System stage	-.09	.03	.08	.16	.02	.07
Leader-team	-.12	-.02	.05	.07	-.08	.11
Independent variables						
Team Belonging	.57**	.08	-	-	-	-
System Belonging	.01	.41***	-	-	-	-
Team Affective Motives	-	-	.03	-.26*	-	-
System Affective Motives	-	-	-.03	.31**	-	-
Team Cognitive Motives	-	-	-	-	.53***	-.25*
System Cognitive Motives	-	-	-	-	-.09	.78***
Model Significance	< .001***	< .001***	.166	.005**	< .001***	< .001***
R squared (R^2)	.35	.24	.05	.11	.25	.42
Adjusted R^2 (ΔR^2)	.33	.21	.02	.08	.22	.40
F Statistic	15.19	8.81	1.59	3.47	9.24	20.50

Note. Standardised regression coefficients are reported. * $p < .05$ ** $p < .01$ *** $p < .001$
H = Hypothesis, ns = non-significant, Psych Safety = Psychological Safety.

Figure 7

Group 2: How do Team and System Needs and Motives Manifest into Emergent States



Models 13 – 16: Group 3. Table 13 presents the summary of four separate multiple linear regression analyses, calculated for group 3 and examine predictors of between-team collaboration, the main outcome variable of the study and proxy for system performance. Model 13 tested hypothesis 3: System identity will exert a stronger positive influence on between-team collaboration than team identity, while controlling for system size, system stage and leader-team. A statistically significant regression equation was found (F (5,142) = 22.73, p = < .001, R^2 = .45, ΔR^2 = .43). As hypothesised, system identity predicted between-team collaboration (*ß* = .29, *p* = .022) but team identity did not, contributing to explaining 43% of the total variance in between-team collaboration, when considering all the variables in the model. These findings lend support for hypothesis 3. Model 14 tested hypothesis 6: System psychological safety will exert a stronger positive influence on between-team collaboration than team psychological safety, controlling for system size, system stage and leader-team. A statistically significant regression equation was found (F (5,142) = 21.99, p = < .001, R^2 = .44, ΔR^2 = .42) with system psychological safety predicting the dependent variable between-team collaboration (*ß* = .181, *p* = .050) while team psychological safety did not, contributing to explaining 42% of the total variance in between-team collaboration, when considering all variables in the model. Hypothesis 6 is supported.

Model 15 tested hypothesis 9: System collective efficacy will exert a stronger influence on between-team collaboration than team collective efficacy, controlling for system size, system stage and leader-team. A statistically significant regression equation was found (F (5,142) = 23.17, p = < .001, R^2 = .45, ΔR^2 = .43), with the control variable, system size (*ß* = .57, *p* = < .001) as the only statistically significant predictor contributing to explaining 43% of the total variance in between-team collaboration, when considering all the variables in the model. Neither independent variables, team efficacy nor system efficacy were significant predictors, hence hypothesis nine was not supported.

Finally, Model 16 tested hypothesis 10: Differentiation and dynamism will predict between-team collaboration, such that as differentiation and dynamism increase between-team collaboration will decrease. A statistically significant regression equation was found, the most significant out of all the models tested in the study (F (6,141) = 35.49, p = < .001, R^2 = .60, ΔR^2 = .59). All independent variables: differentiation (*ß* = 1.76, *p* = < .001), dynamism (*ß* = 1.29, *p* = < .001) and differentiation x dynamism (*ß* = -2.50, *p* = < .001) were significant predictors that contributed to explaining 59% of the total variance in between-team collaboration, when taking into account all the variables in the model. The negative relationship found between combined interaction of differentiation and dynamism on between-team collaboration supports hypothesis 10.

Across all models in group three the control variable: system size, was a highly statistically significant predictor of between-team collaboration; Model 13 (β = .60, p = < .001), Model 14 (β = .60, p = < .001) and Model 15 (β = .57, p = < .001). Model 16, calculated for hypothesis 10, found all three system control variables to be highly predictive of between-team collaboration; system size (β = .47, p = < .001), system stage (β = .31, p = < .001) and leader-team (β = .19, p = .010).

Table 13

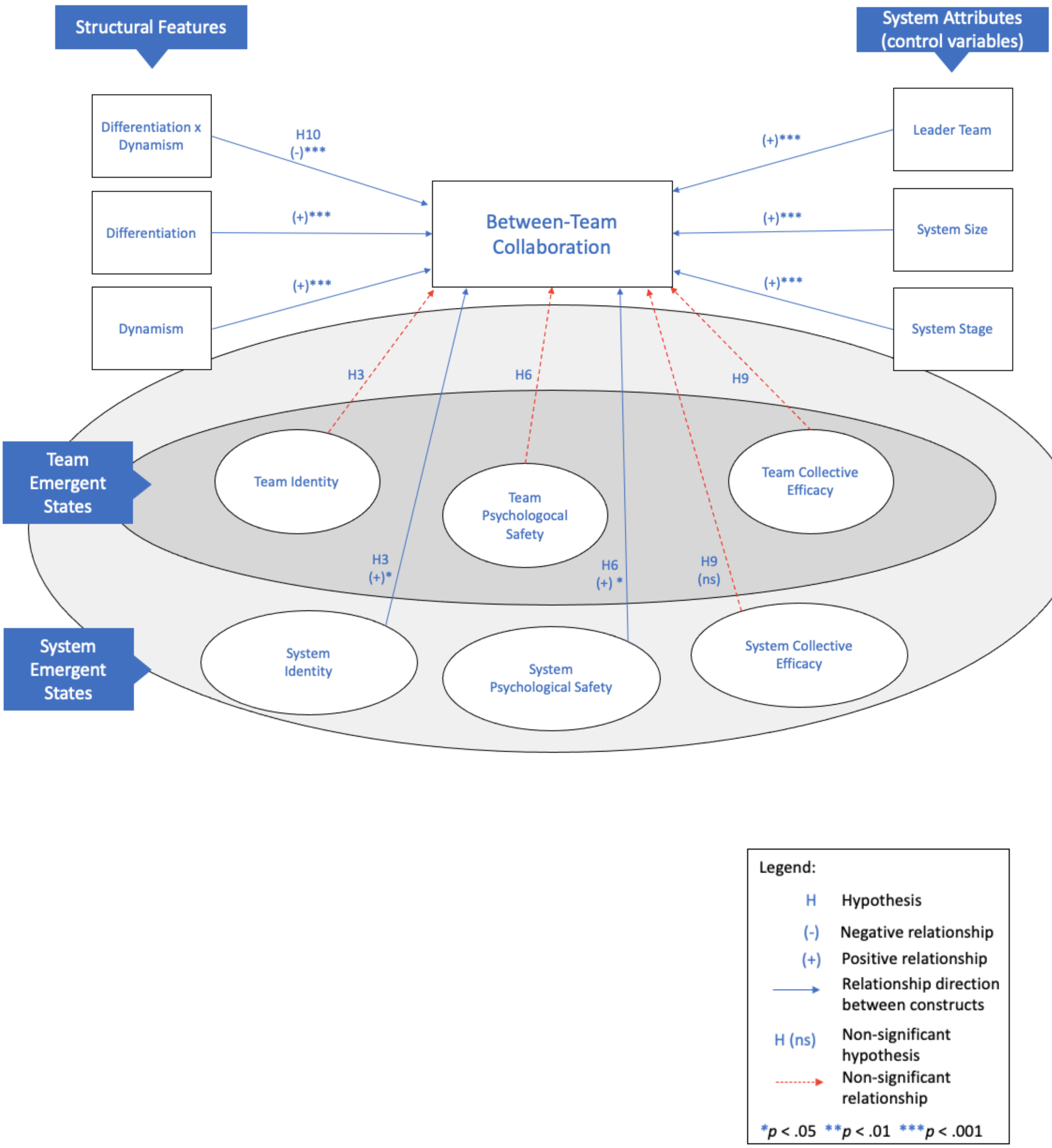
Group 3: Summary of Multiple Regression Analyses Testing Predictors of Between-Team Collaboration

	Model			
	13	14	15	16
	H3	H6	H9 (ns)	H10
	Between-team Collaboration			
Controls				
System size	.60***	.60***	.57***	.47***
System stage	.12	.13	.11	.31***
Leader-team	.07	.07	.07	.19**
Independent variables				
Team Identity	-.16	-	-	-
System Identity	.29*	-	-	-
Team Psychological Safety	-	-.12	-	-
System Psychological Safety	-	.18*	-	-
Team Efficacy	-	-	.09	-
System Efficacy	-	-	.12	-
Differentiation	-	-	-	1.76***
Dynamism	-	-	-	1.29***
Differentiation x Dynamism	-	-	-	-2.50***
Model Significance	<.001***	<.001***	<.001***	<.001***
R squared (R^2)	.45	.44	.45	.60
Adjusted R^2 (ΔR^2)	.43	.42	.43	.59
F Statistic	22.73	21.99	23.17	35.49

Note. Standardised regression coefficients are reported. * $p < .05$ ** $p < .01$ *** $p < .001$
H = Hypothesis, ns = non-significant

Figure 8

Group 3: What Predicts Between-Team Collaboration?



Discussion

The primary purpose of this study was to empirically test a meso-theory of MTS functioning proposed by Luciano and colleagues (2018a). To the best of the authors knowledge, this is the first time the theory has been empirically tested. Sixteen models were developed to test these propositions and were organised into three overarching groups that tested (1) how structural features of the system (i.e., differentiation and dynamism) and the social psychological consequences (i.e., boundary-enhancing and disruptive forces) affected members' needs and motives (i.e., belonging, affective, cognitive); (2) the relationship between individual needs and motives at team and system-level and their association with corresponding emergent states at team and system-level; and (3) which level of emergent states (i.e., team or system) and structural features (i.e., differentiation and/or dynamism) best predicted between-team collaboration.

How Structural Features Influence MTS Outcomes

The model predicting the most amount of variance in the study was Model 16, which examined the predictors of between-team collaboration, the ultimate outcome measure in the study and proxy for overall MTS functioning. As expected, systems with high levels of differentiation and dynamism suffered impaired between-team collaboration lending support for Luciano et al.'s (2018a) propositions that the structural features of an MTS can have detrimental implications for system collaboration. However, the findings do not support group one hypotheses, the expected relationships between these structural dimensions and the level at which individuals get their needs and motives met (i.e., belonging, affective, cognitive). Differentiation and dynamism had no statistically significant impact on members' needs and motives.

One explanation for this finding lies in measurement error. Sub-dimensions of differentiation and dynamism included terms such as: goal discordancy, work process dissonance and information opacity, which are complex constructs to grasp, and respondents may have had different frames of reference and varying degrees of English comprehension. This is particularly pertinent when consideration is given to the cross-cultural nature of the sample. Differentiation and dynamism were assessed by a single point of contact, for each system during an in person virtual session. Every effort was made to simplify the description of the constructs and explain them in simple terms. This was the primary reason for conducting the session in-person and not via an online survey. The scoring process was facilitated by use of an anchored rating scale taken directly from Luciano et al.'s, (2018a) theory (p. 1072 and p. 1076). The scale provided a description and examples for low, medium, and high levels of the constructs. Nevertheless, different frames of reference, related to distinct organisation and national cultures could have precluded a robust and consistent measure across the systems in the study.

In addition, despite the anchored rating scales, what was rated as "high" in these contexts may not be high enough to demonstrate the boundary-enhancing and boundary-disruptive forces expected to push individual needs and motives to the team-level. Alternatively, the measurement error may have been caused by the brevity of needs and motives scales (i.e., belonging, affective, cognitive). The number of items to measure these constructs ranged from single item scales (i.e., belonging and trust) to a maximum of four items (i.e., feedback seeking, information sharing and goal commitment). These themes are explored further in the limitations section.

Building on these insights, the findings for the individual effects of differentiation and dynamism on between-team collaboration are in opposition to the combined effect reported. These two variables taken separately showed positive predictive power on between-team collaboration. Luciano et al. (2018a) posited that these dimensions would undermine between-team collaboration overall, due to the boundary-enhancing and disruptive forces.

However, the authors also discussed the literature pointing to a potential up-side of differentiation and dynamism, for example they noted the following about membership churn, a sub-dimension of dynamism: “In sum, while change in membership may ultimately prove beneficial or detrimental to the system, the change is nevertheless disruptive and destabilizes the system” (Luciano et al., 2018a p. 107). The authors go on to caveat that different combinations of the sub-dimensions which comprise differentiation and dynamism, may be more or less suited to different MTS contexts. It is therefore plausible that the more differentiated *or* dynamic a system, the better teams will collaborate.

Diversity expands cognitive resources and perspectives allowing for greater potential to solve complex problems and innovate (Mathieu et al., 2017). The benefits of diverse teams/systems have been widely reported (e.g., Cannella et al., 2008; Cannon-Bowers & Bowers, 2010). With higher levels of dynamism in a system goals, requirements, team-structures and members are changing frequently, which may create an “opt-in” environment that offsets any negative disruptive forces. A highly dynamic environment is not for everyone and could lead to those who thrive in more agile environments to stay the course and those who do not, leave. Turnover could be voluntary through resignation or involuntary through termination due to performance issues. Those remaining in dynamic systems are likely to have developed the skills and competencies to be effective at between-team collaboration. Similarly, systems operating in this context will likely have developed effective strategies to drive overall system functioning in that context. Dynamism in the form of membership churn has been shown to have a positive influence on outcomes (e.g., Choi & Thompson, 2005; Hausknecht & Holwerda, 2013). Taken together with the combined negative effect of differentiation and dynamism on between-team collaboration, there appears to be a tipping point whereby teams and systems can function well with one or the other but the two together shift the direction of the influence on between-team collaboration.

How Emergent States Influence MTS Outcomes

Other important findings that enrich our understanding of what facilitates between-team collaboration relate to the expected effect of system-level (over team-level) emergent states on between-team collaboration studied in group three analyses. Specifically, higher levels of system identity and psychological safety predicted higher levels of collaboration between teams in a system and in each model, as expected, the team-level was not statistically significant. These findings contradict the only other known study examining psychological safety in an MTS environment (Bienefeld & Grote, 2014) and offers fresh insight into this emergent state which remains understudied in the MTS domain. Findings about the emergent state social identity corroborate earlier MTS theory and research on system identity and its relationship with overall system functioning (e.g. Cuijipers et al., 2016; Hogg et al., 2012) and the detrimental effects of high team identity for system-level outcomes (e.g. Dokko et al., 2014; Carbonelle & Rodriguez-Escoder 2019; DeChurch & Zaccaro, 2010) and confute Porck et al. (2018) who found that overall system identity was counterproductive for system performance. In contrast, neither team nor system collective efficacy predicted between-team collaboration. This would imply that confidence and belief in team and system outcomes is not sufficient for between-team collaboration. Overall, Luciano et al.'s (2018a) theoretical propositions are somewhat bolstered by these findings and offer food for thought for the debate surrounding the optimal level (i.e., team or system). Future research propositions are discussed in the next section.

Countervailing Effects

The findings thus far have elucidated some clear implications for between-team collaboration in terms of structural features and emergent states. Group two analyses examined the relationship between individual needs and motives at team and system-level and their association with corresponding emergent states at team and system-level. Support was found for Fiske's (2004; 2009) social cognition theory that underpinned Luciano et al.'s (2018a) meso-theory and supports other MTS scholars theorising about how individual-level needs and motives manifest at team and system-level as emergent states (Kozlowski et al., 2013). When needs and motives are met at the team-level, corresponding emergent states will crystalise at the team-level too, and vice versa for system-level. In the present study, the first finding meant that team belonging predicted team identity, but system belonging did not and system belonging predicted system identity, but team belonging did not. When it came to individual affective motives (i.e., trust and feedback seeking) and the corresponding emergent state (i.e., psychological safety) neither team nor system affective motives predicted *team* psychological safety, however system affective motives did predict system psychological safety and team affective motives negatively predicted system psychological safety. The latter finding not only supports the hypotheses and theory being tested but also lends support to the countervailing forces literature in MTSs, i.e., what helps a team can hurt the system and vice versa.

The unsupported finding for team psychological safety could be explained by measurement error illustrated by low internal consistency for the team psychological safety scale compared to the Cronbach's alpha of other scales in this group of analyses it was considerably lower. Despite adopting a four-item established scale which showed strong internal consistency in prior research (e.g., Bunderson & Boumgarden, 2010), the cross-cultural context of the sample could have led to different interpretations of the scale items and the original seven-item scale by Edmondson et al. (1999) may have been a more suitable option. However, the same scale items were adapted to measure system psychological safety with marginally better internal consistency and statistically significant findings.

Finally, for this group of findings the model testing the link between cognitive motives and collective efficacy followed the expected pattern, team cognitive motives predict team efficacy, but system cognitive motives did not, and system cognitive motives predicted system efficacy but team cognitive motives negatively predicted system efficacy, also demonstrating a countervailing effect. The relationship between the level of needs and motives and the level of corresponding emergent states becomes even more important when consideration is given to the earlier finding reported that higher system-level emergent states positively predict between-team collaboration. Encouraging belonging needs and affective motives to be met at the system-level is likely to foster system-level emergent states which in turn should enhance collaboration efforts between teams for system success.

Controlling for MTS Attributes

The structural features of an MTS is a central tenet in the theory being tested and the present study has provided empirical support for the overarching impact of structure (i.e., differentiation and dynamism) on between-team collaboration posited by Luciano et al. (2018a). Other features or attributes of an MTS taken from Zaccaro et al.'s (2012) classification framework, were tested in the regression models as covariates and offer further noteworthy findings. The attributes were (1) the presence of a leader-team in the system structure (2) the size of the system in terms of the number of teams and (3) the system stage in terms of its tenure.

First, the presence of a leader-team was predictive of overall between-team collaboration in the present study, lending support to findings from the SLR in the present thesis (Chapter 3) and earlier MTS research suggesting that vertical coordination enacted via a leader-team is essential for these complex networks of teams (e.g., Davison et al., 2012; Firth et al., 2015; DeVries et al., 2016). This warrants further study. The presence of a leader-team was also found to have a strong negative effect on team affective motives but not on system affective motives. In other words, team members' propensity to seek feedback and get trust needs met at the team-level was undermined by the presence of a leader-team but it did not negatively affect their system affective motives. Such system structures are commonly posited by MTS scholars as a predictor of between-team collaboration and system performance (e.g., DeChurch & Marks, 2006) and this finding offers insight into the potential trade-off between team and system-level outcomes. In most cases it is likely that the role of the leader-team intentionally directs team members needs and motives to the system rather than team-level, as posited by Luciano et al. (2018a), to drive overall system outcomes and common goals.

Second, system size predicted team and system-level psychological safety; as the number of teams in the system goes up, so too does the level of team and psychological safety. This seems counterintuitive, especially as MTS scholars maintain that size is linked to complexity (e.g., Davison et al., 2012) and may harm between-team collaboration (e.g., Lanaj et al., 2013). One explanation is the idea that larger systems are compelled to find strategies that aid system functioning, they are more likely to put structures and systems in place to manage the complexity and offset the negative implications of diverse and dynamic systems. These strategies would include effective system leadership and how to foster the right team and system climate. System size was also found to be highly predictive of between-team collaboration across all four models examining this outcome in group three analyses (Models 13 – 16). So, it appears that as the number of teams go up, so too does between-team collaboration. Again, following the same line of reasoning, for larger inherently more complex systems more effort is likely to have to be made to make sure that the right mechanisms are in place to collaborate well and ensure overall system performance.

Finally, the third control variable: system stage, predicted team and system cognitive motives, in other words, the longer the system had been established the more likely that individuals will get their cognitive motives, in terms of information seeking and goal commitment, met at the team and system-level. As individuals get to know other team members and as teams grow in familiarity with other teams' roles, the situation and how their tasks fit together, members are more open to sharing information and increasing attention and effort towards goals. This aligns well with work by Kanfer and Kerry (2012) on motivation in MTSs and teams research into familiarity (Harrison, Mohammed, McGrath, Florey & Vanderstoep, 2003).

Strengths, Limitations and Directions for Future Research

This study contributes to the MTS domain in several ways, principally by empirically testing native MTS theory in cross-cultural, real-world system. The following section discusses the key limitations and strengths of the study structured around eight points, followed by a comprehensive agenda for future research.

First, the study drew on self-reported data. Self-reported data adds value within research because it allows researchers to analyse large samples and gather unique perspectives and on team dynamics (Delice, 2019). However, like other research designs, adopting self-report data risks several biases and low response rates (Thompson, 1967). Common method variance was mitigated by implementing a few recommended strategies to tackle satisficing (e.g., Posakoff et al., 2012) such as varying the response scale according to the scale adopted in the original measure. This meant that the response scale changed back and forth throughout the survey from a 5-point to a 7-point scale. Similarly, the section for the main dependent variable (i.e., between-team collaboration) was positioned at the end of the survey in a different format to other measures in that it did not duplicate items at team and system-level because it was a system-level variable only. Understanding more about this outcome variable was framed as a primary objective of the study (i.e., a cover story) thus creating psychological separation. In addition, between-team collaboration had more items than any other scale (i.e., five). These were the strategies employed to increase separation and reduce potential for satisficing.

Second, the cross-sectional design limits the ability to generalise or make causal inferences regarding the findings reported. Since Marks et al., (2001) raised issues of temporality in MTS research, many other MTS scholars have made the call to adopt multiphasic approach to exploring MTS phenomena (e.g., Davison & Hollenbeck, 2012; de Vries et al., 2016; Faraj & Yan, 2009; Mathieu et al., 2001; Marks et al., 2005, Rico et al., 2018). Endorsing those calls, it is essential for future research to explore these findings using longitudinal or lagged research designs. Third, the combination of the cross-sectional design and self-report survey data fails to conceptualise the variability of dynamic and emergent constructs in the system over time. MTS scholars have recommended the adoption of more patterned approaches to study emergent phenomena (Shuffler & Carter, 2018). For example, social network analysis models the patterns of team composition, states, processes, and performance across multiple levels of analysis and over time (Poole & Contractor, 2011). To truly understand the complexity of MTSs, these approaches are an imperative and will yield a richer, more nuanced appreciation of MTS emergent states. Some authors have challenged Industrial-Organisational Psychology for lagging in the adoption of these approaches to study modern team dynamics (Murase et al., 2012).

Another fascinating avenue for future research examining emergent constructs would be to take a team-centric approach (O'Neill et al., 2015) over the more traditional variable-centric approach. The variable-centric approach treats emergent constructs independently for their effect on outcome variables and an average is calculated at the team-level of analysis (Crawford & LePine, 2013). Shuffler et al. (2018) challenge the simplifying assumptions made in extant MTS literature adopting the variable-centric approach (e.g., Davison et al., 2012; DeChurch & Marks, 2006; Murase et al., 2014) and champion the opportunity for MTS researchers to employ the team-centric approach they developed called "intrateam state profiles”. In doing so, MTS researchers can uncover potentially heterogenous intrateam properties and the implications for system functioning (Shuffler et al., 2018).

Pioneering MTS researchers may consider adopting progressive technology for more novel and unobtrusive approaches to study the complex MTS environment. Kozlowski et al., (2016) advocated for the use of computational modelling, often used in engineering and computer science, to overcome the limitations of data collection in an MTS. Further, DeChurch et al. (2018) highlighted the opportunity to leverage trace data collected from digital sources such as email. Studying MTSs in the wild present numerous challenges and the adoption of cutting-edge technologies such as these, offer promising advances for the domain.

Fourth, the advantages and disadvantages of the analytical strategy used in the present study warrant consideration. Multiple regression analyses allowed for the effective testing of the hypotheses; however, a mediated regression analysis could have been adopted to examine the indirect effects of differentiation and dynamism on between-team collaboration. Furthermore, the data gathered from organisations was nested and it would therefore have been even more insightful to leverage the nested nature of the data with hierarchical linear modelling. Unfortunately, due to the number of observations gathered ($N = 148$) the study was not powered enough to allow for nested modelling. Future replication studies with larger samples should consider testing the hypotheses with HLM or mediated regression analysis.

There were other analytical choices worthy of discussion, for example whether to correct for type 1 error. To account for the multiple comparisons calculated in the regression models, one option could have been to attenuate for multiple comparisons with a correction for type 1 error (e.g., by using a Bonferroni correction). However, following the cautionary advice of other researchers across disciplines (e.g., Gelman et al., 2012; Lachlan & Spence, 2006; Nakagawa, 2004; Perneger, 1998) Bonferroni was not deemed necessary. Some have gone as far as to say that it creates more problems than it solves (e.g., increased type two error; Perneger, 1998) while others explain that it is not common practice in social science research (e.g., Lachlan & Spence, 2005) or challenge its utility (e.g., Gelman et al, 2012). An alternative strategy was adopted to overcome the risks of Bonferroni and multiple comparisons, this involved describing what would be done and why (during the planning stage) followed by transparent reporting of all the data, even the negative and non-significant findings (as recommended by Perneger, 1998).

Alternatively, SEM would have suited the study well and has been recommended by scholars for multilevel modelling, due to its benefits over linear regressions for predictive analytics (e.g., Delice et al., 2019). Despite its practical value, there were two barriers to adopting SEM; First, like HLM, it is likely that the study was not powered enough for this technique, for example Comrey & Lee (2013) specify a requirement of at least $N = 300$, and second, SEM ideally requires a minimum of three items per variable. Due to the single item measures (i.e., belonging and trust) selected for the survey, SEM was not considered the most optimal solution.

Fifth, the constructs measured in the study drew on well-established scales, nevertheless not all these scales were validated in cross-cultural nor MTS contexts and those that were tested in MTS contexts were often reported in grey literature. Wherever possible words and phrases were adapted for greater cross-cultural understanding without losing the essence of the original item and based on feedback from the pilot, as described in the measures section. Participants in the study came from both individualistic and collectivist cultures, which is considered a strength of the design, however different meanings may therefore be ascribed to some items. This could explain the lower internal consistency reported for a few of the scales (i.e., psychological safety and goal commitment). The debate about equivalence is well documented in the literature more broadly (e.g., Davidov 2009;

Freitag and Bauer 2013; Reeskens & Hooghe 2008) and specifically surrounding trust scales (e.g., Miller & Mitamura 2003). Future research would benefit from scales developed specifically for the MTS context and which have been validated cross-culturally, for instance by adopting multigroup confirmatory factor analysis.

Additionally, research designs testing fewer constructs could afford to probe respondents about what they were thinking while answering items, with a think-aloud approach or adding follow-up open-ended questions (Uslaner, 2018). Furthermore, the use of single-item measures (i.e., belonging and trust) was discussed in-depth (Chapter 2) and highlighted the debate surrounding use of single-items in research along with the rationale for adopting them in the present study. Reaching 100% response rate in each system was achieved in one out of 14 systems, this meant that there were many more potential respondents that were captured in the dataset for each system. The survey platform showed that many respondents started a survey but did not complete it, further bolstering the rationale to limit the number of survey items as much as possible. Therefore, reducing the number of constructs tested in a single study (i.e., selecting either belonging needs or affective motives or cognitive motives) to allow for the use of full scales would be a promising avenue for future research to test the present findings.

Sixth, the constructs differentiation and dynamism would benefit from further testing and refinement. These dimensions were well elucidated by Luciano and colleagues (2018a) with comprehensive scale descriptions, although the language used was somewhat problematic for non-native English speakers. The non-significant relationships between differentiation and dynamism and individual needs and motives could indicate that the high, medium, and low thresholds in the scale descriptions would warrant validating through further empirical testing. To the best of the authors knowledge this was the first time these constructs were tested empirically and perhaps what was defined as high or low by Luciano et al., (2018a) was not high or low enough to elicit the system effects predicted. In the present study, total differentiation and dynamism scores were computed by summing the respective sub-dimensions. This allowed for Luciano et al.'s (2018a) the theoretical propositions to be empirically tested. However, the authors called for future research to explore whether some sub-dimensions could be more important than others and whether there maybe "synergistic or poisonous bundles" of sub-dimensions (Luciano et al., 2018a, p. 1090). The findings of which would further elucidate the theory surrounding structural features of an MTS and inform practical applications.

Seventh, the present study contributes to a prominent debate in the MTS domain surrounding the optimal level (i.e., team or system) of emergent states for MTS success. The literature to-date reports contradictory findings (e.g., Porck et al., 2018; Cuijipers et al., 2016). The present study lends support to the proposition that the system-level is most beneficial for between-team collaboration in a cross-context when it comes to social identity and psychological safety but not when it comes to collective efficacy. However, the system is not the only unit of inquiry in an MTS, teams are required to achieve proximal goals and function well as a team unit. There is a need to understand how to balance the needs of the team and system so success can be achieved at both levels. For example, future research my want to include a measure of team performance to compare the interaction of emergent states at different levels on team and system outcomes. Other team variables worthy of examination are member demographics (e.g., gender), team size and geographic dispersion which may have moderated some of the findings. The countervailing effects reported in the present study further underscores the important need to find the "sweet spot" between team and system-levels of analysis, also highlighted by prominent MTS scholars as an important avenue for future research (DeChurch & Zaccaro, 2013). One cannot be neglected in favour of the other.

Finally, the role MTS attributes requires further consideration. The attributes studied in the present study (i.e., leader-team, system size, system stage) were found to have differing effects on team versus system outcomes. Future research should validate the findings by further examining the impact of leader-teams, system size and system stage on functioning, for instance, does system efficacy mediate the relationship between the presence of a leader-team and between-team collaboration? Is system size an important boundary condition or moderator? How can system leaders be developed for collective leadership in a leader-team structure? In addition to answering these important questions, there are many more system attributes (see MTS classification framework by Zaccaro et al., 2012) that warrant further exploration in future empirical studies as has been recommended by Zaccaro et al. (2020). For example, the boundary status of the system, whether it is internal (i.e., all the teams come from the same organisation) or external (i.e., teams span organisational boundaries), the nature of work or type of goals that teams in the system are stiving towards (i.e., physical goals or intellectual goals) and formation or genesis of the system (i.e., formally appointed or emergent). All of which are likely to have implications for system performance and which warrant further attention.

Practical Applications

The findings elicited from this cross-cultural field study highlights how emergent properties and structural features of an MTS can help or hinder collaboration between teams in a system. Such insights point practitioners to several helpful applications for further consideration:

System Protocols

Systems are inherently complex entities, to set members up for success and put in place guidelines around team and system norms, for example how to communicate and coordinate well together, it is advisable to compile some system protocols up-front during the genesis phase of a system. This may be documented in an MTS charter (see template in Asencio et al., 2012). Topics, like how members will share information, what systems and tools to use, leadership processes and meeting norms should be explicitly and intentionally agreed upon. Given the dynamic nature of most systems, system protocols should be dynamic and reviewed and refined periodically and should not be considered a “once and done” approach.

Vision and Purpose

Teams in a system will benefit from coming together to cocreate a vision and purpose that articulates the collective ambition of the system which individuals can identify with. Practitioners/leaders should take time to generate this collectively which will allow members to connect their respective role to the bigger picture and facilitate system identity as opposed to component team identity. Mathieu et al. (2018) describe how leaders can play this integral role by facilitating “intergroup relational identity” which allows members to identity with the system more broadly, as well as their component teams. If the system is too large to manage a cocreation process with all members, efforts should be made to communicate the vision and purpose widely and train managers to help individuals connect their role to the wider system goals through effective one-to-one meetings and development discussions.

Psychological Safety Interventions

Practitioners would do well to focus on interventions that bring teams together to develop mutual trust and respect. Finding ways to nurture the right mindset and behaviours that foster a ‘safe space” for interpersonal risk taking, where members have a voice to speak up without fear. For example, “pre- or post-mortem” meetings (Klein, 2007; Collier et al., 1996) that bring teams together to plan for action phases coming up or debrief on lessons learned when a phase concludes, or milestone is reached. In creating meeting protocols such as a pre- or post-mortem “failures” are reframed as learning opportunities and members across the system build trust and practice vulnerability. Initial findings in the present study suggest that teams that are too insular and derive self-enhancing and trust needs from members of their own team only, can be detrimental to overall system psychological safety which was found to be crucial for collaboration between teams. A key lever in developing psychological safety will be through leaders that span team boundaries in the system (Bienefeld & Grote, 2014), discussed further below.

Frame of Reference Training

Building on the insights from the literature review (Chapter 3) frame of reference training to foster shared mental models between teams (e.g., Firth et al., 2015) could be one strategy for practitioners seeking to mitigate the negative impact of highly diverse and dynamic MTSs. Shared mental models, or a common understanding of knowledge and how teams conceptualise problems was positioned as a mechanism of leadership training which enhances coordination and collaboration in the system (Murase et al., 2012).

Innovative Technology

Next generation human resource systems and developments in the "HR tech" space promises a multitude of ways to connect teams across space and time with virtual collaboration spaces, pulse engagement surveys, tools for knowledge management, information sharing and goal setting to connect individual, team and system goals with dynamic features that allow for mutual adjustments as requirements inevitably change (Bersin, 2021).

Leadership Development and Leader-Teams

Leaders play a pivotal role in helping to drive the aforementioned points, however developing system leadership will require leaders to build a deep understanding of the difference between the team and system context along with the potential trade-offs between team and system phenomena (DeChurch et al., 2011). Given the importance of striking a balance where too much or too little of something at a team or system-level can be detrimental for outcomes, leaders will need to be highly attuned to the micro and macro contexts within which they operate (or three *foci*; within-team, between-team and external environment, DeChurch et al., 2011) and be trained in the nuances of individual needs and emergent states (Fiske, 2004; 2009) along with functional leadership competencies such as coordination and strategy (e.g., DeChurch & Marks, 2006). Practitioners may want to consider organising leaders into a single leadership team to lead the system outcomes together in parallel with their teams' proximal goals (e.g., Davison et al., 2012; Zaccaro et al., 2020). This seems to facilitate better collaboration between teams and avoid coordination failures (Lanaj et al., 2013). The roles and responsibility of leader-teams versus teams and team members can be tied back to the system protocols and defined up-front during system genesis.

Concluding Remarks

This cross-cultural study examined highly differentiated MTSs in real world settings to empirically test theoretical propositions of system functioning and address both top-down contextual features and bottom-up emergent processes. Several important and novel findings elucidated the knowledgebase surrounding system-level emergent constructs, structural features of a system and MTS attributes. Partial support was found for Luciano et al.'s (2018a) meso-theory, specifically, the findings underscored the impact of the shape and size of an MTS (i.e., differentiation and dynamism) on between-team collaboration and how individual needs and motives manifest into emergent states and the subsequent impact on overall system functioning.

The findings contribute to the existing debate in the MTS literature surrounding the optimal level for emergent states to drive system functioning. While the system-level appeared optimal in most instances in the present study, several opportunities for future research were outlined that will advance our understanding of these emergent properties and how to balance team and system outcomes. Principally, to uncover what is the right amount of differentiation and dynamism or social identity, psychological safety and collective efficacy that sets up teams *and* systems for success and mitigates the potential for countervailing effects. Defining how to strike this balance should be a primary aim of future MTS research and theory building in the domain. Future study should also take into account issues of temporality in chosen research designs and analytic techniques, thereby addressing some of the limitations of the cross-sectional nature of the present study. These findings underscored numerous avenues for practitioners in the field and will be expanded upon further in the next Chapter.

CHAPTER 5
Implications for Theory, Research and Practice

The present chapter draws together overarching conclusions of the thesis and the implications for theory and research, followed by implications for practice and concluding remarks.

Implications for Theory and Research

The systematic literature review (Chapter 3) and empirical study (Chapter 4) in the present thesis provided some initial suggestions regarding the direction for future theory and research. What follows is a synthesis of those findings organised into six overarching themes to advance the science of MTSs.

Striking a Balance Between Team and System

Emergent states, commonly referred to in the literature as attitudes and cognitions (Salas et al., 2008) or cognitive, affective, and motivational states (e.g., DeChurch & Mesmer-Magnus, 2010) remain understudied in the MTS domain. Seminal MTS research by Marks et al. (2001) defined emergent states but in the ensuing twenty years, MTS research into behavioural processes has dominated the literature. Answering calls from scholars to pay greater attention to these constructs in MTSs (e.g., Shuffler et al., 2015; Shuffler & Carter, 2018), there has scarcely been an increase in published papers (e.g., Porck et al., 2018; Cuijipers et al., 2016; Bienefeld & Grote, 2014) with slightly more featured in grey literature/unpublished (e.g., McGuire, 2016; Jiménez-Rodriguez, 2012; DiRosa, 2014; Cianciolo & DeConstanza, 2012; Connaughton et a., 2012; Burke et al., 2014). Accurately capturing these emergent constructs is a methodological challenge potentially driving empirical attention to other MTS constructs. New and novel methodologies to better conceptualise emergent phenomena will be covered later in the chapter.

A prominent theme emerging from this initial line of enquiry suggests that emergent states can have countervailing effects in MTSs. They can operationalise differently at different levels such that what may facilitate team functioning (e.g., team identity) can be dysfunctional at the system-level and vice versa (DeChurch & Zaccaro, 2013). Scholars have debated which level of emergent states (i.e., team of system) is most optimal for MTSs, with conflicting initial findings. Some suggest that the system-level is optimal (e.g., Cuijipers et a., 2016) and others suggesting the team-level is more optimal (e.g., Porck et al., 2018). The empirical study in the present thesis adds to this growing area of interest with specific findings that support system identification and system psychological safety for better collaboration across teams.

Countervailing or negative effects between team psychological safety and between-team collaboration was also found. There is only one known paper (e.g., Bienefeld & Grote) that examines psychological safety in MTSs known to the author, the findings of which contrast with the present research (e.g., Chapter 4). Specifically, Bienefeld & Grote (2014) found that team psychological safety encouraged speaking up behaviour between teams in an aviation MTS, whereas the present research found system psychological safety strongly associated with higher between-team collaboration and team psychological safety negatively associated with between-team collaboration.

MTS effectiveness is not purely about achieving the superordinate goals of the system, but in addition component teams have their own proximal goals to achieve too. Mathieu et al., (2018) describe MTS effectiveness as akin to a balanced scorecard approach. However, in the absence of evidence, understanding the ideal balance between team and system-level constructs remains elusive. Referred to as tension systems (Rico et al., 2018) and a paradox (Mathieu et al., 2018), researchers are called to lean into and leverage polarities thinking (Johnson, 1992, 2014; Mathieu et al., 2018) to study and conceptualise MTS phenomena. Future research studies should incorporate team performance measures in addition to system performance measures when studying emergent constructs. Thereby enabling a more nuanced understanding of the countervailing effects and facilitate theory building for optimal MTS functioning.

Further, interventions should be developed and tested to ascertain what works when it comes to building system emergent states. Present findings would indicate that interventions targeting how to nurture system identity and system psychological safety are worthwhile future endeavours. Clearly this is an area ripe for future research however, researchers should be mindful that one size will not fit all. By adopting a similar approach to the present study, researchers can compare and contrast different types of MTSs and explore the link between MTS attributes and emergent properties. The implications of different MTS types are considered next.

Compare MTSs Across Type and Culture

In their recent review of the MTS literature, Zaccaro and colleagues (2020) illustrated the dearth of studies that compare MTS types and echoed the call made by Mathieu et al., (2018) for future research to address this gap. Mathieu et al., (2018) pointed out that:

> The multitude of idiosyncrasies present in any given MTS field study, too, limit the generalisability of their findings. Unifying frameworks and theories to guide the sampling and study of MTSs, as well as the integration of results has been solely needed (p. 139)

To advance the field, these authors specified a minimum set of attributes for future scholars to report on consistently, these were (a) size of the MTS, in terms of the number of members and the number of teams, (b) boundary status (i.e., whether the teams span organisational boundaries or not), (c) goal type (i.e., physical or intellectual) and (d) characteristics of teams related to diversity and differentiation. Adding to these suggestions, earlier in the review the same authors posited that MTS genesis (i.e., was the system formally appointed or did it emerge) is likely to drive MTS processes and states.

The empirical field study in the present thesis firmly answered this call and reported all the recommended MTS attributes across nine vastly different systems. In addition, the study extended these recommendations and included additional MTS attributes, these were, whether the system had a formal leadership team and the system stage (i.e., tenure). Unique relationships were uncovered that warrant further study. For example, the positive relationship between system size (number of teams) and between-team collaboration and the positive relationship between system size and team and system psychological safety. These findings suggest that as the system grows, members' confidence to speak-up and take interpersonal risks may also increase which positively impacts between-team outcomes. This could suggest that there is something that larger MTSs are doing to offset the complexity that inherently increases as more teams work together in a system. This could be system protocols like a certain cadence of meetings and is likely to be combined with effective leadership capabilities that foster the right climate for psychological safety. Future directions specifically related to leadership and leader-teams are addressed later in the chapter.

System stage in the empirical study (Chapter 4) showed a positive association with team and system cognitive motives and with between-team collaboration, these findings warrant further exploration in future research efforts. System stage in this case was determined by the number of years a system had been working together and is therefore intricately linked to the topic of temporality, discussed as a separate theme in this chapter. MTS scholars have called for studies to examine MTS phenomena, especially emergent constructs, in the context of time and called for theory development that accounts for temporality (e.g., Delice, 2019; Mathieu et al., 2018; Shuffler et al., 2015; Standifer, 2012). Like teams, MTSs have a life span that develops over time and constructs are not static (Kozlowski & Bell, 2012). MTS phenomena, emerge, evolve and adapt over time that could be linear, cyclical or episodic (Kozlowski et al., 1996; Marks et al., 2001). To overcome the limitation of the cross-sectional design adopted in the present research, future research should examine MTS variables using time-based longitudinal or lagged designs and consider a temporal framework suited to the MTS context.

A strength of the present research was that is directly tested all Luciano et al.'s (2018a) theoretical propositions with an empirical design. Testing the meso-theory modelled how top-down structural features (i.e., differentiation and dynamism) and bottom-up emergent properties (i.e., social identity, psychological safety and collective efficacy) affected overall system functioning. With multiple comparisons in the hypothesised model, it was beyond the scope of the study to explicitly examine cross-cultural differences between systems in the sample, although these differences certainly contributed to differing levels of differentiation and dynamism. Unpacking this would have been a fascinating line of inquiry given that the systems spanned both individualistic and collectivist cultures. This echoes the call from Edmondson (2018) to examine the mechanisms of psychological safety cross-culturally. While the cross-cultural context of the sample is a strength of the design, it may also have contributed to the lower internal consistency reported for two scales. This underscores the importance of and pressing need for cross-cultural validation of MTS constructs. To the best of the authors knowledge, a discussion of the implications of national culture in the MTS domain is curiously missing. Therefore, future research should explore MTSs set in different national cultures and the interaction with other MTS variables.

Make or Break? How Structure Impacts upon MTS Outcomes

Luciano et al. (2018a) addressed a gap in the MTS literature with their native meso-theory that takes account of top-down contextual features and bottom-up emergent properties. The present research empirically tested this theory which posits that structural features of the system (i.e., differentiation and dynamism) will have boundary-enhancing and boundary disrupting effects, respectively. The pioneering authors defined and distinguished between the two prominent structural features of an MTS "Differentiation characterises the degree of difference and separation between MTS component teams at a particular point in time, whereas dynamism describes the variability and instability of the system over time." (Luciano et al., 2018a, p. 1067). It was predicted that these forces would undermine between-team collaboration with overall negative implications for system functioning. Thereby, different forms of MTSs will function differently.

Luciano et al. (2018a) elaborated on the way in which differentiation and dynamism affect between-team collaboration by shaping individual needs and motives (micro) which manifest in team-level emergent states and ultimately, that system (meso) level emergent states are optimal for between-team collaboration. As discussed in the thesis thus far, the results lend empirical support to the theory in two ways. First, the findings demonstrated that combined differentiation and dynamism was negatively related to between-team collaboration, and second, system-level emergent states were more positively related to between-team collaboration with countervailing effects reported at the team-level.

Future research should seek to bolster these findings with larger sample sizes. Additional findings that warrant further examination and explanation are the standalone effects of differentiation and dynamism. Both of which had a positive relationship with between-team collaboration. This finding seems to suggest that individually structural dimensions can have a positive influence but together they force a tipping point that changes the direction of the relationship and impact on system functioning. This is a unique and powerful insight that upon further investigation should inform system-level theorising.

Contrary to the theoretical propositions and empirical hypotheses, non-significant findings were reported for the relationship between differentiation and dynamism and individual needs and motives (Chapter 4), these relationships warrant further testing. Cross-cultural considerations were reported as potentially confounding factors. In-keeping with the call made earlier in this chapter, national culture should be more intentionally studied in the MTS domain, both in terms of scale validity and reliability and in terms of how national culture may shape emergent phenomena.

Finally, in relation to top-down structural features, the call is made to better investigate the sub-dimensions of differentiation and dynamism, whether they combine compilationally or compositionally, and importantly whether some sub-dimensions are more important than others, are there “synergistic or poisonous bundles” of sub-dimensions with differing effects on MTSs (Luciano et al., 2018a, p. 1090). Compositional and compilational patterns are discussed in the final theme of the chapter.

Define How to Develop MTS Leadership Capability and Capacity

Findings from the systematic literature review (Chapter 3) and empirical study (Chapter 4) clearly suggest that specific mechanisms that can mitigate the negative influence of the structural features of an MTS or the forces stemming from them, these are summarised in the practical applications section of each paper and at the end of present chapter. These recommendations complement and extend the proposals made by Luciano et al., (2018a) to offset one or more elements of differentiation or dynamism by changing the MTS structure and compensate for the boundary-enhancing and disruptive forces through interventions.

Leadership serves as an integrating or bridging mechanism in MTSs (Mathieu et al., 2018) and is one of the primary levers for system success. The systematic literature review (Chapter 3) uncovered specific leadership functions that are required for success in MTSs. For example, leaders need to provide strategy and coordination within, and between-teams and leadership behaviour should be focused on the team and between-team actions rather than individual team member behaviour (DeChurch & Marks, 2006). Given the single-study source of these findings, more work is needed to replicate the findings in real-world settings.

Researchers should seek to answer more definitely, what functional leadership capabilities are required for systems leadership, when, and how can practitioners develop them? The strong relationship found between system-level emergent states and between-team collaboration (Chapter 4) points to an opportunity for MTS leadership to influence team dynamics. More research is needed to better understand the role of a leader in fostering the right climate for emergent states in the MTS and develop leadership interventions to facilitate this. The present thesis findings indicate promise for systems with leaders who can nurture collective system identity and psychological safety.

The empirical study found a negative relationship between the presence of a leader-team and *team* affective motives but an overall positive relationship between the leader-team and system collaboration. These findings therefore add to the growing literature on the beneficial role of leader-teams in MTSs (e.g., Davison et al., 2012; DeVries et al., 2016). One study in the literature review (Chapter 3) suggested that centralised planning is a mechanism of leader-team success in systems (Lanaj et al., 2013) and another demonstrated that frame of reference leadership training helped to reduce representational gaps and improve overall system functioning (Firth et al., 2015). Again, the single-study source of evidence for these findings, makes future research on this topic an imperative to replicate the results in different field environments. Researchers should seek to uncover deeper insights into the mechanisms by which leaders and leader-teams shape MTS outcomes and build theory to support this.

There has been considerable debate between Locke and Pearce regarding how to define shared leadership (Pearce et al., 2007). Cox et al. (2003, p. 48) defines it as “lateral influence among peers rather than simply relying on vertical, downward influence by an appointed leader.” Generally, MTS scholars recognise that the complexity inherent in an MTS is suboptimal for single person to be solely held accountable for MTS leadership (Uhl-Bien & Marion 2009, Zaccaro & DeChurch 2012). Leader-teams are commonly introduced to the MTS structure as a coordination mechanism between teams, often incorporating elements of shared leadership (Zaccaro et al., 2020) and based on the research findings herein, have been recommended for practitioner consideration in both studies (Chapter 3 and 4).

Evidence in the present thesis is initial but complements other MTS studies examining the influence of leader-teams on MTS outcomes (e.g., Davison et al., 2012; DeVries et al., 2016; Lanaj et al., 2013; Firth et al., 2015). In sum, the MTS leadership research agenda would benefit from research studies into leadership functions (e.g., strategy, coordination, emergent states) and leadership forms (e.g., leader-team) that account for different phases of system development (i.e., temporality) and which compare leadership across different types of MTSs (i.e., attributes, national culture).

The distinction between developing individual leaders and leadership capacities was noted by Day & Dragoni (2015) who termed leadership development a “fledgling field” and highlighted the gap in empirical research into developing collective leadership. Cullen-Lester et al., (2017) reported findings from a survey of practitioners, and urgently called for the adoption of network approaches in leadership development, warning that “practice may be ‘jumping ahead’ of science and making use of some approaches which, despite being grounded in theory, have yet to be empirically examined.” (p. 146). They developed a conceptual model highlighting three practical approaches to improve the leadership capacity of individuals and collectives by adopting networking-enhancing leadership development. These approaches focus on how individual leaders can develop social competence, how to develop individuals to shape networks and how collectives may be developed to co-create networks.

Just as Crawford and LePine (2013) advocated for network analyses to study teams, MTS scholars call for similar approaches to study system leadership (e.g., Cullen-Lester et al., 2017; Mathieu et al., 2018). Specifically, work to extend the findings from the present thesis (i.e., the role of leaders and leader-teams) perhaps by adopting more novel networked methods, offers a compelling direction for future research.

Once systems theory has better elucidated the form and function of MTS leadership, leadership development interventions should be designed and empirically tested. Thereby enabling practitioners to target the development of functional leadership (i.e., how to develop individual system leaders) and collective leadership capacity (i.e., how to develop shared leadership and leader-teams) relevant to different types of MTSs.

Adopt Progressive Methods to Account for Temporality

The self-reported data and cross-sectional design adopted in the empirical study (Chapter 4) allowed data to be gathered from a relatively large sample, spread across multiple geographies and examined over 10 different MTS constructs and their interrelationships. This approach to test MTS theory gathered unique perspectives from participants on team dynamics. However, cross-sectional survey designs are limited as an approach to study emergent and dynamic constructs. As mentioned in the previous sections, many scholars have urged future research to account for time in theory and research (e.g., Standifer, 2012; Shuffler et al., 2015; Shuffler & Carter, 2018; Zaccaro et al., 2020). Similarly, current theorising does not adequately account for temporal dynamics in an MTS (Mathieu et al., 2018). Theoretical and empirical research in this area will help from a practical standpoint to determine what systems need at different stages of development, a new system is likely to need very different interventions than more established systems, for example.

Gaining access to real-world systems, remains one of the biggest impediments for MTS researchers seeking to account for time in their research designs. Longitudinal designs are limited in the literature with most field studies employing cross-sectional designs, case studies or laboratory simulations. These designs, like that adopted in the present research, are therefore limited given the dynamic and emergent nature of MTS phenomena. By treating dynamic constructs as static, captured at one point in time, researchers risk reporting inaccurate and incomplete conceptualisations.

One clear direction to better study the emergent and dynamic of constructs in MTSs overtime is through the adoption of innovative methods and technologies. Luciano et al. (2018b) integrates innovative technologies into existing practices to advance MTS research into dynamic constructs. This presents one of the most exciting and pivotal opportunities for the MTS domain. Luciano and colleagues (2018b) explain that big data is generated through three general types of data streams in team settings (i.e., behaviours, words and physiological responses).

Delice et al. (2019) review the team's literature and extrapolate the most novel methodological tools and approaches to study team dynamics (i.e., attitudes, behaviours and cognitions) over time. Delice et al. (2019) report the adoption of sensors known as sociometric badges to examine behavioural team interaction data based on the work of Waber et al. (2008). Sociometric badges draw on easily accessible technologies such as Bluetooth technology. Bluetooth technology is used by these sensors to detect proximity to others, infrared technology detects face-to-face interactions, microphones detect vocalisation and accelerometers assess movement (Kozlowski & Chao, 2018).

Other approaches to study behavioural dynamics in an unobtrusive manner includes the adoption of digital trace data (i.e., from emails) leveraged in field studies or simulations of real-world contexts (Kozlowski et al., 2015, Kozlowski & Chao, 2018). To generate insight from the second data stream, words, Luciano et al. (2018b) recommended two novel approaches, the first is computer aided text analysis (CATA) and allows researchers to quantify word use and patterns. The second is Hidden Markov Model (HMM, Pentland, 2007) this technique analyses how things are said and examines frequency patterns of speech and the amount spoken over time (i.e., turn taking, interruptions, variation of speaking time).

Quantitative electrocochleography (QEEG, Waldman et al 2015) is an approach to capture and analyse physiological data streams such as brain activity. Group dynamics are studied by placing portable hardware and sensors on individuals and electric activity signals human interactions such as collective cognition (Delice et al., 2019). These novel and promising technologies will undoubtedly advance the field, however essential practical and ethical considerations have been outlined by Luciano et al., (2018b).

Also worthy of consideration for future forays into dynamic MTS constructs are agent-based simulations (ABSs) which mimic target behaviours and explicate dynamic relationships and computational modelling, which uses equations to incorporate large numbers of process mechanisms that simultaneously affect behaviour (Kozlowski et al., 2016). Both approaches overcome issues of sample size and are well suited to multilevel research (Kozlowski & Chao, 2018; Delice et al., 2019).

Kozlowski and Chao (2018) challenged the oversimplification of emergent constructs in organisational research and advocated for the adoption of advanced technologies to address these flawed conceptualisations. They drew a distinction between constructs that are compositional, (i.e., isomorphic) and can be represented by aggregating individual level, micro data to the group or team/meso-level, and those that are compilational. Compilational constructs are heterogenous forms of emergence that do not cluster around the mean. The authors maintain that the issue with much MTS research lies in the limiting assumptions surrounding emergent constructs. Instead of manifesting in a compositional manner, emergent constructs are likely to form patterns across members and teams in a system, thereby representing a compilational nature. Variability in individual response indicates that there is no composition emergence and, in this instance, taking a unit mean is not meaningful.

The issue surrounding the nature of emergent constructs in multilevel environments is also reflected by the distinction between a team-centric approach versus a variable-centric approach (O'Neill et al., 2015). Centric approach versus a variable-centric approach (O'Neill et al., 2015). Whereby the variable-centric approach accounts for independent effects on outcome variables and averages are calculated for the construct (i.e., treated as compositional). Shuffler et al., provide guidance on how to examine dynamic constructs using "intrateam state profiles" to explore more heterogenous properties of the system. Utilising intrateam state profiles to study emergent states is likely to be insightful.

Together, these inter-related avenues for future theory and research provide a roadmap for the advancement of our understanding of MTS with notable implications for practice.

Implications for Practice

To realise the unique problem-solving capabilities offered by MTSs, practitioners are required to mitigate the inherent complexity of MTSs and effectively manage the tensions and trade-offs between different levels in the system. Drawing together the collective findings from the SLR and empirical study, implications for practice have been synthesised and five priority considerations are presented.

Develop Leadership Capability and Capacity

Leaders play an important integration role in an MTS, spanning boundaries between teams, they are perfectly positioned to compensate for divisive and disruptive forces and lead their teams and system to success. Practitioners should develop functional leadership capabilities, such as coordination (e.g., DeChurch & Marks, 2006) and planning skills (e.g., Lanaj et al., 2013) as well as leadership capacity (e.g., Day & Dragoni, 2015) and consider whether the MTS may benefit from incorporating leader-teams in the MTS structure (e.g., Davison et al., 2012; Zaccaro et al., 2020). Leader-teams can be trained together to form a cohesive leadership unit and taught how to balance the tension between their respective team outcomes and overall system success. Leaders undergoing frame of reference training will be best placed to reduce representational gaps between-teams helping to standardise how shared problems are conceptualised. Leaders and leader-teams should be taught how to foster system identity (e.g., Uitdewilligen & Waller, 2012) and psychological safety (e.g., Bienefeld & Grote, 2014) and appreciate the potential down-side of building such climates in their own teams only (e.g., Cuijipers et al., 2016). Fiol et al., (2009) recommend leaders connect team goals and values to overarching MTS goals to help strike the right balance between proximal and distal goal striving and achievement.

Co-Create a Shared Vision and Purpose

Creating a common sense of identity among members of a system will mitigate the potential for siloed ways of working that are likely to exacerbate a "them and us" or "in-group out-group" mentality (Tajfel, 1978). Connecting individuals and teams to a common purpose and ambition could help to nurture system identity (over team identity) and connect teams to a common goal, which in turn should enhance collaboration between teams in the MTS. For maximum engagement and equal representation of different perspectives, where possible defining a system vision and purpose should be done through a process of co-creation with all teams in the system. This bottom-up approach is likely to be more powerful and engaging than one that is cascaded down from the top (Pearce & Ensley, 2004). Where system size precludes from shaping the vision collectively, leaders should take time through team meetings to help connect the component teams to the bigger picture and what the system is driving collectively.

Foster System Psychological Safety

Practitioners should turn their attention to interventions that foster psychological safety at the system-level. This could involve bringing teams together in workshops that develop mutual trust and respect. For example, by applying "team building" practices to systems (e.g., Wijnmaalen et al., 2019), that allow members to connect on a personal level, get to know more about their colleagues' styles and preferences and in doing so build relationships and familiarity as a foundation of speaking-up behaviour. Other efforts that would help to build a "safe space" where team members can speak-up, include team meeting protocols that encourage reflexive practice and the ability to learning lessons from collective experiences and innovate. This has been well documented in the teams' literature (e.g., West et al., 2000) and given the findings from this study, similar reflexive practices could be beneficial in the MTS environment. Borrowing from management strategies and the concept of prospective hindsight; imagining that an event has already occurred (Mitchell et al., 1989), conducting project pre- and post-mortem meeting protocols (Klein, 2007; Collier et al., 1996) across teams in an MTSs, may allow teams in a system to anticipate and mitigate risks (pre-mortem; Klein, 2007)) and learn from collective experiences, particularly those experiences that did not go according to plan (post-mortem; Collier et al., 1996). Creating a climate where failures are reframed as learning opportunities would in turn build confidence in team members to voice concerns about important topics or express perspectives that may be different from the majority view.

Embed System Protocols

A set of clearly defined protocols that govern how work gets done, how teams communicate and share information, the cadence and type of meetings between teams in the system and general expectations, should be set out during the genesis stage of a system's development and could be documented in a system "charter". Asencio et al., (2012) offers a template for an MTS Charter in a Healthcare MTS. Defining these system protocols may be considered the role of a leader-team or alternatively it could be a collective exercise that invites teams to collaborate and co-create the protocols for the system. The latter approach is likely to foster greater commitment to the protocols.

Enable Collective Learning

Practitioners seeking to build strong teams that simultaneously drive system outcomes will want to consider training teams in a system together. Core learning topics for an MTS curriculum should cover essential coordination skills for team members and leaders (e.g., (e.g., Cobb, 2001; DeChurch & Marks, 2006). Specific leadership development interventions that target the leader-team collectively should build their awareness of team-system tensions and strengthen their ability to shape shared identity and psychological safety. Preliminary findings from the SLR suggest that training to reduce representational gaps among leaders and members, provides common standards or a single frame of reference which enhances integration efforts between teams in a system (Firth et al., 2015).

Leverage Innovative Technologies

Progressive learning technologies are increasingly available to practitioners that facilitate on-demand learning experiences for individuals and teams (Bersin, 2019). Leveraging these types of systems makes learning content available anytime, anywhere to individuals working in a system. They also offer the functionality to convene live virtual workshops for groups of collectives and online communities of practice to share knowledge, information and experiences. These kinds of solutions are well suited to large geographically dispersed MTSs. In addition to learning technologies, agile performance management systems offer promising approaches to cascade goals and manage frequently changing priorities (Bersin, 2018). Such technology software connects individuals, teams and MTSs through platforms that enable frequent changes and mutual adjustments. Ideal for diverse and dynamic MTS contexts.

Conclusion

There is a pressing need to find out more definitively “what works?” in an MTS, as highlighted by the systematic literature review. The review offered initial evidence that points to the opportunity to train teams together for greater synergy and to build system-relevant capabilities, specifically coordination skills and leadership development. These serve as leavers to bridge gaps between teams in the complex MTS environment and enhance functioning. Other avenues worthy of further exploration include frame of reference training to increase shared mental models, and MTS planning enacted through leader-teams. The benefits of strategy training for leaders warrants further examination to be more conclusive about the implications for practice. A focused research agenda was discussed which holds promise for the MTS domain.

Building on these insights and to address gaps highlighted by the review, the empirical study contributed to a number of "firsts" in the MTS domain. To the best of the authors knowledge, Luciano et al.'s (2018a) new and native meso-theory has been empirically tested for the first time, as such it is the first time that structural features (i.e., differentiation and dynamism), MTS attributes (i.e., leader-team, system size, system stage) and emergent states (i.e., social identity, psychological safety, collective efficacy) are examined together connecting individual, team and system-levels of analysis. To the best of the authors knowledge, it is the first cross-cultural field study to compare and contrast differentiated MTSs, firmly answering calls for comparisons of different MTS types. The research presents one of the first studies examining psychological safety in the MTS context and contributes to the debate surrounding the optimal level of emergent states for system functioning, supporting the view that system-level states and specifically social identity and psychological safety, are intricately linked to MTS success. The research presented evidence of countervailing effects in an MTS related to psychological safety and collective efficacy which is worthy of further examination. Inversely related to system success are divisive and disruptive structural features of an MTS (i.e., differentiation and dynamism), however taken individually these structural elements were found to enhance collaboration between teams in the system. This finding extends the theory and calls for further empirical testing.

Other unique findings specifically related to MTS attributes such as system size, system stage and the presence of a leader-team, all of which elucidate a more nuanced understanding of MTS attributes and how they shape success. Taken together, these insights present a multitude of opportunities for future research and as such, a comprehensive research agenda was discussed that included leveraging the right methodologies to more accurately measure emergent phenomena and account for temporality.

Similarly, the findings offer practitioners a variety of options when working with these complex MTS entities. For example, embedding leader-teams and system protocols to manage member expectations and embed consistent ways of working which will enable better coordination and collaboration between teams. Leaders and leader-teams require development to be able to nurture the most optimal climate between teams in the system. One that fosters psychological safety and a common identity while carefully balancing the inherent team and system tensions. Practitioners, like researchers, are encouraged to leverage the latest tools and technologies to find novel ways of connecting teams across space and time to manage the complex task environment and create shared understanding between teams.

To conclude, the scale and complexity of real-world problems continues to evolve and highly interconnected MTSs leveraging diverse skill sets and the latest technological advances, will be best placed to help both organisations and societies respond to these changes. The proliferation of research into MTSs in recent years is encouraging and essential for advancing the knowledgebase further. Theoretical frameworks that account for the meso-level of enquiry should continue to be tested and refined along with the adoption of progressive technologies and methodologies to study temporal dynamics. These advances will provide clarity on best practices when working with these tension systems and help practitioners to solve the paradox of how to build strong teams that also operate well as a system. Researchers have found MTSs difficult to study and practitioners have found them difficult to manage, the present findings and directions for the future will propel the science and practice of MTSs into a new era.

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Appendix A

Survey Items for MTS Members (1 of 2)

	PARTICIPANT SURVEY ITEMS		
	TEAM LEVEL		**SYSTEM LEVEL**
	BELONGING		
1	I want members of this team to accept me	2	I want members of this system to accept me
	IDENTITY		
3	I identify with the team	4	I identify with this system
5	I feel committed to the team	6	I feel committed to this system
7	I am glad to be part of this team	8	I am glad to be in this system
9	Being in this team is an important part of how I see myself	10	Being in this system is an important part of how I see myself
	FEEDBACK SEEKING		
11	I ask my team members if I am doing a good job	12	I ask members of other teams in my system if I am doing a good job
13	I ask my team members if they think I am meeting expectations	14	I ask members of other teams in my system if they think I am meeting expectations
15	I ask my team members if people like working with me	16	I ask members of other teams in my system if people like working with me
17	I ask my team members what they think I should be working on	18	I ask members of other teams in my system what they think I should be working on
	TRUST		
19	I trust members of my team	20	I trust members of other teams in the system
	PSYCHOLOGICAL SAFETY		
21	If you make a mistake on this team, it is often held against you	22	Thinking of the interaction with other teams in the system, mistakes are often held against you
23	members of this team are able to bring up problems and tough issues	24	Thinking of the interaction with other teams in the system, members are able to bring up problems and
25	It is safe to take risks on this team	26	Thinking of the interaction with other teams in the system, it is safe to take risks
27	it is difficult to ask other members of this team for help	28	It is difficult to ask members of other teams for help

Survey Items for MTS Members (2 of 2)

	GOAL COMMITMENT		
33	I take the goals of this team seriously	34	I take the goals of this system seriously
35	It's unrealistic for me to expect the team's goals to be reached	36	It's unrealistic for me to expect the system's goals to be reached
37	It is quite likely that the goals of the team may need to be revised depending on how things go	38	It is quite likely that the goals of the system may need to be revised depending on how things go
39	I don't care if the team's goals are achieved or not	40	I don't care if the system's goals are achieved or not
	COLLECTIVE EFFICACY		
41	I am sure that this team can achieve progress, because we are all pulling in the same direction.	42	I am sure that this system (or teams in this system) can achieve progress, because we are all pulling in the
43	I am confident that together this team can accomplish difficult tasks	44	I am confident that together this system can accomplish difficult tasks
45	This team can come up with creative ideas to achieve team outcomes, even if the external conditions are	46	Teams in the system come up with creative ideas to achieve important system-level outcomes, even if the
	BETWEEN TEAM COLLABORATION		
		47	Connected processes and activities are well coordinated with other teams in the system
		48	Duplicated and overlapping activities are avoided between teams in our system
		49	My team generally doesn't have problems coordinating with other teams in the system
		50	Conflicts between teams in the system are settled quickly
		51	Discussions with other teams in the system are conducted constructively
	DEMOGRAPHICS		
52	What is your gender?		
53	How old are you?		
54	How many years have you been working in this team?		
55	How many years have you been working in this system?		
56	Career to-date, how many years' experience do you have?		
57	Please indicate your ethnicity (i.e. peoples' ethnicity describes their feeling of belonging and attachment to a distinct group of a larger population that shares their ancestry, colour, language or religion):		

Appendix B

Part 1: Interview with the MTS Point of Contact – Context

1. What is the industry sector of the business?
2. What is the current size of the business (number of employees)?
3. What is the global footprint of business? (regions/markets/countries)
4. Does the system of focus have a name?
5. How many teams comprise the system?
6. How many members are in each team?
7. What are the system's main objectives/purpose?
8. Are all teams equally responsible for the overall achievement of system goals?
9. Are these all within the same organisation?
10. What is the functional breakdown of the teams in the system?
11. And are the component teams organised according to their function or set up cross functionally?
12. Is there a distinct 'leadership team' as part of the system?
13. Is communication free across the system or centralised through specific members?
14. What is the mode of communication for the system?
15. How did the system come into existence? Formally or informally/it emerged?
16. Is this a long term/permanent system in the structure of the organisation or a temporary /project-based structure?
17. How long has this system been working together?
18. How would you rate collaboration between teams in this system on a 1-5 scale? 1 = excellent
19. How would you evaluate the performance of this team? Or if applicable, how has this team been evaluated recently? Performing, overperforming or underperforming?

Part 2: Interview with the MTS Point of Contact – Differentiation

DIFFERENTIATION FACTORS	ORIGINAL DESCRIPTION (Lucino et al., 2018a)	"SAY..."	"ASK....."	LOW	MEDIUM	HIGH
Goal Discordancy	Dissimilarity and incompatibility of goals and goal priority across component teams	*This factor is about how similar and compatible **goals** and **goal priorities** are across teams in the system*	*How would you rate the system overal for goal discorancy where LOW is......MEDIUM is.......and HIGH is.....(read rating descriptions)*	Component teams have similar goal priorities and compatible goals	Component teams have some variance in goal priorities and somewhat incompatible goals	Component teams have dissimilar goal priorities and incompatible goals
Competency Separation	Distribution and disparity of knowledge and functional capabilities across component teams	*This factor is about how diverse teams in the system are in terms of **knowledge** and **functional background***	*How would you rate the system overal for competency separation where LOW is......MEDIUM is.......and HIGH is.....(read rating descriptions)*	Component teams contain similar knowledge and parallel capabilities	Component teams contain partially overlapping knowledge and somewhat disparate capabilities	Component teams contain vastly different knowledge and disparate capabilities
Norm Diversity	Dissimilarity and incompatibility of policies and expectations across component teams	*This factor is about how similar and compatible **policies** and **expectations** are across teams in the system*	*How would you rate the system overal for Norm diversity where LOW is......MEDIUM is.......and HIGH is.....(read rating descriptions)*	Component teams are governed by similar policies and have compatible expectations regarding "the way things work"	Component teams are governed by somewhat dissimilar policies and have some incompatible expectations regarding "the way things work"	Component teams are governed by dissimilar policies and have incompatible expectations regarding "the way things work"
Work Process Dissonance	Separation and incongruence of work processes across component teams	*This factor is about how **compatible** and **interdependent** team processes*	*How would you rate the system overal for Work process dissonance where LOW is......MEDIUM is.......and HIGH is.....(read rating descriptions)*	Component teams have congruent work processes that are conducted in a real-time intensive manner	Component team processes are relatively harmonious and conducted in a reciprocally interdependent manner	Component team processes are incongruent and conducted independently
Information Opacity ('transparency')	Absence and ambiguity of information about component team activities	*This factor is about how **available/accessible** and **'easy-to-interpret'** is the information about team activities*	*How would you rate the system overal for information transparency where LOW is......MEDIUM is.......and HIGH is.....(read rating descriptions)*	Information about component team activities is available and can be evaluated such that corrections could be suggested	Information about component team activities can be obtained and interpreted in terms of general patterns or trends	Information about component team activities is generally unavailable or uninterpretable

Part 3: Interview with the MTS Point of Contact – Dynamism

DYNAMISM FACTORS	ORIGINAL DESCRIPTION (Luciano et al., 2018a)	"SAY..."	"ASK....."	LOW	MEDIUM	HIGH
Change in Goal Hierarchy	Frequency and magnitude of modifications in goal hierarchy	*This factor is about how frequently the **importance of goals change***	*How would you rate the system overal for change in goal hierarchy where LOW is......MEDIUM is.......and HIGH is.....(read rating descriptions)*	The relative importance of system goals are stable	The relative importance of system goals occasionally shift slightly	The relative importance of system goals change drastically and rapidly
Uncertainty of Task Requirements	Duration and degree of uncertainty of component team activities required to fulfill system goals	*This factor is about how **certain and well-established** are the requirements to meet system goals*	*How would you rate the system overal for uncertainty of task requirements where LOW is......MEDIUM is.......and HIGH is.....(read rating descriptions)*	Requirements to meet system goals are well established and known to component teams	A sense of potential requirements to meet system goals is known to component teams	Requirements to meet system goals are unknown
Fluidity of System Structural Configuration ('fluidity of system structure' better)	Frequency and magnitude of changes in the linkages among component teams (including the relative importance or centrality of different component teams in the system)	*This factor is about how **stable and consistet** is the overall **system structure** (how the teams link together and their relative importance at a given time)*	*How would you rate the system overal for fluidity of system stucture where LOW is......MEDIUM is.......and HIGH is.....(read rating descriptions)*	The linkages among component teams are stable	Specific situations dictate changes in linkages among component teams	Frequent shifts occur in the linkages among component teams, substantially altering workflow
Fluidity of System Composition	Frequency and magnitude of churn in the system, within both team membership and system (i.e., component team) membership	*This factor is about the **frequency and magnitude** of **system churn**, both team members and teams in the system*	*How would you rate the system overal for fluidity of system composition where LOW is......MEDIUM is.......and HIGH is.....(read rating descriptions)*	System and team membership is stable throughout	Some component teams are actively engaged throughout, whereas others serve shorter supporting roles; some teams experience limited membership churn	System and team membership is frequently and substantially reconstituted
Diversion of Attention	Duration and degree to which component team members' attention is focused on matters other than multiteam system–related tasks	*This factor is about **how many systems** team members are part of at any one time*	*How would you rate the system overal for change in diversion of attention where LOW is......MEDIUM is.......and HIGH is.....(read rating descriptions)*	Component teams are members of only one system at a time	Component teams are members of more than one system, but there is some overlap in the type of tasks performed	Component teams are members of multiple nonoverlapping systems

Appendix C

Birkbeck Ethics Approval

Reference number: OPEA-20/21-01

Section E: Declarations

Please confirm each of the statements below by placing an 'X' in the appropriate space

X I certify that to the best of my knowledge the information given above, together with accompanying information, is complete and correct.

X I accept the responsibility for the conduct of the procedures set out in the attached application.

X I have attempted to identify all risks related to the research that may arise in conducting the project.

X I understand that **no** research work involving human participants or data can commence until ethical approval has been given.

Suggested Classification of project by the applicant *(please highlight)*:

ROUTINE

Signed by the applicant:		Date 7.9.20	

If you have answered with "Yes" or "Don't know" to any of the questions in Section C, your project should be classified as either "Sensitive" or "Extremely Sensitive". However note that your project may be "Sensitive" or "Extremely Sensitive" even if you have responded with "No" to all section C questions.

Section F: Classification

FOR USE BY SUPERVISORS OR THE DEPARTMENTAL RESEARCH OFFICER

Classification of project *(please highlight)*:

SENSITIVE / EXTREMELY SENSITIVE / **ROUTINE**

Signed by the Supervisor (if applicable)		Date	08/10/20
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Appendix D

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Author: Margaret M. Luciano, Leslie A. DeChurch, John E. Mathieu
Publication: Journal of Management
Publisher: SAGE Publications
Date: 03/01/2018

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The Science of Multiteam Systems

Author: Marissa L. Shuffler, Miliani Jiménez-Rodríguez, William S. Kramer
Publication: Small Group Research (Behavior)
Publisher: SAGE Publications
Date: 12/01/2015

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