

**Foundational elements of a managerial framework to support  
team creativity in engineering organisations:  
Organising and expanding the body of knowledge.**

by  
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the Faculty of Engineering at Stellenbosch University.



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This dissertation includes three original papers published in peer-reviewed journals or books and one unpublished publication. The development and writing of the papers (published and unpublished) were the principal responsibility of myself and, for each of the cases where this is not the case, a declaration is included in the dissertation indicating the nature and extent of the contributions of co-authors.

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This dissertation is dedicated to Olivia, joy incarnate,  
and to Wouter—from that first smile, unfurled a universe  
that I love to inhabit.

## **Abstract**

Creativity plays a role throughout the engineering design process, and therefore in the problem-solving activity that lies at the root of engineering work. Due to the complex interaction between creativity and the range of factors that influence it, engineering organisations cannot simply be assumed to be conducive environments for creative activity.

The research presented in this dissertation seeks to lay the foundation for the development of a managerial framework to support team creativity in engineering organisations, primarily by organising and expanding the body of knowledge on antecedents and outcomes of team creativity. A key perspective that is adopted in the research is that creativity in itself is not a desirable outcome for organisations to pursue. A framework should, therefore, include information on boundary conditions that cause team creativity to lead to positive outcomes that are meaningful to the organisation, rather than to negative outcomes.

The large body of empirical research on antecedents of team creativity is deemed sufficiently mature to support the development of a framework. Hence, a meta-analysis is conducted to determine the construct-level relationship between team creativity and various antecedents that have been proposed in literature.

The body of empirical research on the outcomes of team creativity is limited, with notable gaps including a lack of research on potential negative outcomes. Consequently, this body of research is deemed not to be sufficiently mature to support the development of a framework. A number of contributions to the body of knowledge on the outcomes of team creativity is offered in this research, including: the outcomes that have been studied are summarised into an extension of an organising framework for knowledge on antecedents of team creativity; and empirical research is conducted on a potential negative outcome, namely unethical behaviour by the team.

The findings of the empirical study indicate that, when team members experience increased levels of either challenge or hindrance stressors, team creativity can lead to unethical behaviour by the team. The mechanism of moral disengagement which facilitates this unethical behaviour differs, based on the type of stressor that is experienced. Specifically, increased levels of hindrance stressors lead to unethical behaviour by the team through a process of displacement of responsibility, while increased levels of challenge stressors lead to unethical behaviour by the team through a process of both moral justification and displacement of responsibility.

Seven elements of a managerial framework to support team creativity in engineering organisations are also recommended, based on the systems perspective on creativity, namely: person; process; place; product; leadership; persuasion; and potential.

## Opsomming

Kreatiwiteit vervul 'n rol deur die hele ingenieursontwerpproses, en dus ook in die probleemoplossingsaktiwiteit waarop ingenieurswerk berus. Weens die komplekse interaksie tussen kreatiwiteit en die verskeidenheid faktore wat dit beïnvloed, kan 'n mens nie sonder meer aanneem dat ingenieursorganisasies bevorderlike omgewings vir kreatiewe aktiwiteit is nie.

Die navorsing wat in hierdie verhandeling aangebied word, beoog om die grondslag te lê vir die ontwikkeling van 'n bestuursraamwerk om spankreatiwiteit in ingenieursorganisasies te ondersteun. Dít word hoofsaaklik gedoen deur die beskikbare kennis oor die antesedente en uitkomst van spankreatiwiteit te organiseer en uit te brei. 'n Kernperspektief wat in die navorsing gebruik word, is dat kreatiwiteit op sigself nie 'n gewenste uitkomst is waarna organisasies moet streef nie. Daarom behoort 'n raamwerk inligting in te sluit oor grenstoestande wat verseker dat spankreatiwiteit positiewe uitkomst het wat sinvol is vir die organisasie, en nie negatiewe uitkomst nie.

Die groot hoeveelheid bestaande empiriese navorsing oor antesedente van spankreatiwiteit word as ontwikkel genoeg beskou om die ontwikkeling van 'n raamwerk te ondersteun. Daarom word 'n meta-ontleding onderneem om die verwantskap tussen spankreatiwiteit en die verskillende voorgestelde antesedente in die literatuur op konstruivlak te bepaal.

Daarteenoor is die bestaande empiriese navorsing oor die uitkomst van spankreatiwiteit beperk en is daar merkbare leemtes, waaronder 'n tekort aan navorsing oor moontlike negatiewe uitkomst. Die navorsing is dus nie ontwikkel genoeg om die ontwikkeling van 'n raamwerk te ondersteun nie. Hierdie verhandeling lewer 'n aantal bydraes tot kennis oor die uitkomst van spankreatiwiteit:

So byvoorbeeld word die bestudeerde uitkomst saamgevat in 'n organiserende raamwerk van kennis oor antedente van spankreatiwiteit, en word empiriese navorsing oor 'n moontlike negatiewe uitkomst, synde onetiese spangedrag, onderneem.

Die bevindinge van die empiriese studie dui daarop dat spankreatiwiteit tot onetiese spangedrag kan lei, maar slegs indien spanlede verhoogde vlakke van hetsy uitdaging- of stremmingstressors beleef. Die meganisme van morele ont-koppeling wat hierdie onetiese gedrag in die hand werk, wissel na gelang van die tipe stressor wat ervaar word. Verhoogde vlakke van stremmingstressors lei tot onetiese spangedrag deur 'n proses van verplasing van verantwoordelikheid, terwyl verhoogde vlakke van uitdagingstressors tot onetiese spangedrag lei deur 'n proses van sowel morele regverdiging as verplasing van verantwoordelikheid.

Daarbenewens word sewe elemente van 'n bestuursraamwerk ter ondersteuning van spankreatiwiteit in ingenieursorganisasies aanbeveel. Dié elemente, wat op die stelselperspektief van kreatiwiteit gegrond is, is persoon, proses, plek, produk, leierskap, oorreding en potensiaal.

## Acknowledgements

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# Nomenclature

## Acronyms

%VE	Percentage variance explained
CI	Confidence interval
CV	Credibility interval
HR	Human resources
LMX	Leader-member exchange
MSEM	Multi-level structural equation modelling
PE-fit	Person-environment fit
RO	Research objective
TC	Team creativity

## Greek Symbols

$\gamma$	The standardised path coefficient
$\rho$	The estimated population correlation, corrected for sampling and measurement error

## Roman Symbols

k	The number of studies that are included in the meta-analysis
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## Nomenclature

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N	The sample size, i.e. the number of teams on which the meta-analysis is based
r	The estimated uncorrected population correlation, i.e. the weighted average correlation
$S^2_r$	The sample size-weighted observed variance of the correlations
$SD_\rho$	The estimated standard deviation of the corrected population correlation

### Terminology

Challenge stressors	Taxing demands that individuals view as opportunities for accomplishment and personal development (Ren & Zhang, 2015)
Cognitive evaluation theory	The theory that all contextual factors have both an informational and a controlling element and the relative salience of these elements determines whether the contextual factor has a positive or negative influence on intrinsic motivation (Shalley <i>et al.</i> , 2004)
Common method bias	Biases that are introduced by variability that is attributable to the measurement of a construct, rather than to the construct that is being measured itself
Complementary fit	A category of person-environment fit describing the extent to which a person's characteristics complement a shortcoming in the environment, or vice versa (Kristof-Brown <i>et al.</i> , 2005)
Complex adaptive system	A system in which the elements interact and are consequently continuously exerting influence on one another in a cyclical manner

## Nomenclature

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Conditional indirect effect	The indirect effect of an independent variable on a dependent variable through a mediator that is conditional on the value of a moderator
Confidence interval	In the context of a meta-analysis, the confidence interval gives an indication of the accuracy of the estimated corrected population correlation
Credibility interval	In the context of a meta-analysis, the credibility interval gives an indication of the variability of individual correlations, therefore it provides an indication of whether the corrected correlation can be generalised or whether it is, instead, situation-specific
Cronbach's $\alpha$	An indication of the degree of internal consistency in a scale used to measure a specific construct
Demands-abilities fit	A sub-category of the complementary fit category of person-environment fit describing the degree to which the individual's skills meet the environmental needs ( <i>Kristof-Brown et al., 2005</i> )
Displacement of responsibility	One of the mechanisms of moral disengagement, the process of attributing responsibility for one's actions to circumstances beyond one's control ( <i>Barsky, 2011</i> )
Ethical idealism	One of two ethical ideologies proposed by <i>Forsyth (1980, 1992)</i> , the ethical ideology of idealism describes an individual's concern for the welfare of others ( <i>Bierly et al., 2009</i> )
Ethical relativism	One of two ethical ideologies proposed by <i>Forsyth (1980, 1992)</i> , the ethical ideology of relativism describes the extent to which a person accepts universal moral principles ( <i>Bierly et al., 2009</i> )



## Nomenclature

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Hindrance stressors	Taxing demands that people view as obstructing opportunities for accomplishment and personal development (Ren & Zhang, 2015)
Level 1 variable	A variable for which the unit of analysis is at the individual-level
Level 2 variable	A variable for which the unit of analysis is at the team-level
Moral justification	One of the mechanisms of moral disengagement, the process of cognitively reframing unethical behaviour as serving a higher purpose (Moore <i>et al.</i> , 2012)
Need-supplies fit	A sub-category of the complementary fit category of person-environment fit describing the degree to which a person's needs are met by supplies that are available in the environment (Kristof-Brown <i>et al.</i> , 2005)
Person-environment fit metatheory	A meta-theory, premised on the impact of the compatibility that originates when the characteristics of an individual and those of a work environment are well matched (Kristof-Brown <i>et al.</i> , 2005)
Person-group fit	A type of person-environment fit relating to interpersonal compatibility between people and the groups in which they work (Kristof-Brown <i>et al.</i> , 2005)
Person-job fit	A type of person-environment fit describing the extent to which a person's abilities are aligned to the demands of a job or vice versa (Chuang <i>et al.</i> , 2016)
Person-organization fit	A type of person-environment fit describing the compatibility that occurs between individuals and organisations when at least one of the two provides that which the other needs or when they share important characteristics (Kristof, 1996)

## Nomenclature

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Person-supervisor fit	A type of person-environment fit related to the compatibility of an employee and a supervisor in terms of personality similarity, goal and value congruence, etc. (Kristof-Brown <i>et al.</i> , 2005)
Posterior predictive p-value	The recommended statistic for analysing model fit when using the Bayes estimator to perform multi-level structural equation modelling in MPlus
Proportional Scale Reduction factor	The recommended statistic for verifying model convergence when using the Bayes estimator to perform multi-level structural equation modelling in MPlus
Psychosocial	Elements that are at the nexus of: personal thoughts and behaviour; and elements of the social system
Social cognitive meta-theory	A meta-theory that proposes the significant role of continual self-influence in motivating and regulating human behaviour (Bandura, 1991)
Supplementary fit	A category of person-environment fit describing the level of similarity between a person and the environment (Kristof-Brown <i>et al.</i> , 2005)
Team mediators: Emergent states	Motivational, cognitive, and affective states within a team that develop with the changing dynamics in a team (Seeber <i>et al.</i> , 2014)
Team mediators: Team processes	Taskwork and teamwork processes that transform inputs into outputs
Theory of moral disengagement	An extension of the social cognitive meta-theory that proposes that individuals are able to engage in unethical acts when their cognitive links between unacceptable behaviour and the self-sanctioning that should prevent the behaviour become disabled (Moore <i>et al.</i> , 2012)

## **Part I**

# **Objective 1: Definition and rationale**

# Chapter 1

## Rationale for the research

Position of Chapter 1 in dissertation structure.		
Chapter	Chapter type	Chapter topic
<b>Part I: Research rationale (RO1)</b>		
1	Published article	Objective 1: Develop the rationale for the research presented in this dissertation, based on a narrative literature review and synthesis.
2	Bridging text	Formally define the research through the articulation of an aim and research objectives.
<b>Part II: Framework feasibility (RO2)</b>		
<b>Part III: Antecedents of team creativity (RO3)</b>		
<b>Part IV: Outcomes of team creativity (RO4)</b>		
<b>Part V: Conclusion</b>		

Part I of the dissertation provides an introduction to the research. This chapter consists mainly of the positional paper that was published in the South African Journal of Industrial Engineering, Volume 27, Number 1<sup>1</sup>, presented in Section 1.2. The article establishes the rationale for the research which is formally defined in Chapter 2 with the definition of the aim and objectives of the research, and a discussion of the research approach and structure of the dissertation document. The article is preceded by a brief motivation of its scope, presented in Section 1.1.

<sup>1</sup>This article ([Oosthuizen & Vlok \(2016\)](#)) was published under the candidate's maiden name, Oosthuizen, with the primary supervisor, Professor PJ Vlok, as co-author. The formal declaration of author contributions, as required for publications included in dissertations by Stellenbosch University, is provided in Appendix A.

## 1.1 Introduction

The contemporary global climate (whether organisational, economic, or political) is one of change and increasing competition. Disruptive technologies, unpredictable macro-economic events, globalisation, political power shifts and climate change require organisations to be innovative, agile, and resilient to become or remain competitive. A wide variety of business strategies (from servitisation to outsourcing) exist with the aim of increasing organisational competitiveness in a variety of ways. When reflecting on what sets truly exceptional organisations apart from their more run-of-the-mill competitors, the creativity of their products or services is certainly one factor that comes to mind. Therefore it can be argued that, increasing creative activity in an organisation is a key business strategy that should be considered by organisations seeking to increase their competitiveness. This raises the question: in what way do engineering organisations ensure that they are achieving creative outputs in a sustainable manner?

The positional paper presented in this chapter is specifically concerned with creativity in the engineering design process, rather than with creativity in the operation and management of engineering organisations in general. This focused scope of the article is briefly motivated through a high-level assessment of the research activity in the field that is presented in the remainder of this section.

### 1.1.1 High-level overview of research activity in the field of creativity in engineering

The topic of creativity has received significant research attention in recent years. Figure 1.1 illustrates the number of journal articles, published per annum, that contain the term “creativity” in the title, the abstract or the keywords<sup>1</sup>. The graph also shows the number of journal articles per annum that contain both the term “creativity” and the term “engineering” in at least one of the three fields. Unsurprisingly, only a small portion of the research into creativity has considered creativity within an engineering context.

A more focused search of the Scopus database was conducted to obtain a high-level overview of the research activity in the field of creativity in engineering in general, and creativity in engineering organisations in particular. In each search, the title, abstract and key words of the research product were searched for specified terms. When a combination of

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<sup>1</sup>This data was obtained from the Scopus database on 07 July 2015.

## 1.1 Introduction

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terms was searched for, the search was limited to instances where the terms are used within five words of one another (the most lax setting recommended by Scopus for searching for the use of terms within a single phrase). In all cases, only journal articles, reviews, books, book chapters and conference articles were considered (therefore other published material such as articles in the press were omitted from the search). The search produced the following findings:

- Searching for the terms “creativity” and “engineering” yielded 878 results, of which 550 were conference articles;
- Repeating the search for the terms “creativity” and “engineering” but omitting the term “education” yielded 482 results, of which 275 were conference articles; and
- Searching for the terms “creativity”, “engineering” and “organisation(s)” (or “organization(s)”) yielded 12 results, of which 7 were conference articles.

Thus (i) literature contains several publications considering creativity in engineering, though a significant percentage of these publications are conference articles rather than full journal articles; (ii) more than 50% of these publications are specifically concerned with creativity in engineering education; and (iii) there has been very limited research into creativity in engineering organisations.

A scan of the literature revealed that popular themes include: (i) an analysis of the engineering design process coupled with a suggestion for incorporating a specific method for increasing creativity into the engineering design process; (ii) an analysis of the manner in which the engineering design process is taught, with suggestions for incorporating a specific mechanism that has been proven to increase creative productivity into engineering education; and (iii) a study of engineering students to assess their creative potential or to understand their motivation for creativity.

### 1.1.2 Research topics considering creativity in engineering organisations

In order to provide more insight into the research that has considered creativity within engineering organisations specifically, the research topics of the 12 publications uncovered during the Scopus search for the terms “creativity”, “engineering”, and “organisations” are summarised in Table 1.1. Though some of the research that is summarised in Table 1.1 may be outdated, it is included here for the sake of providing a comprehensive overview.

## 1.1 Introduction

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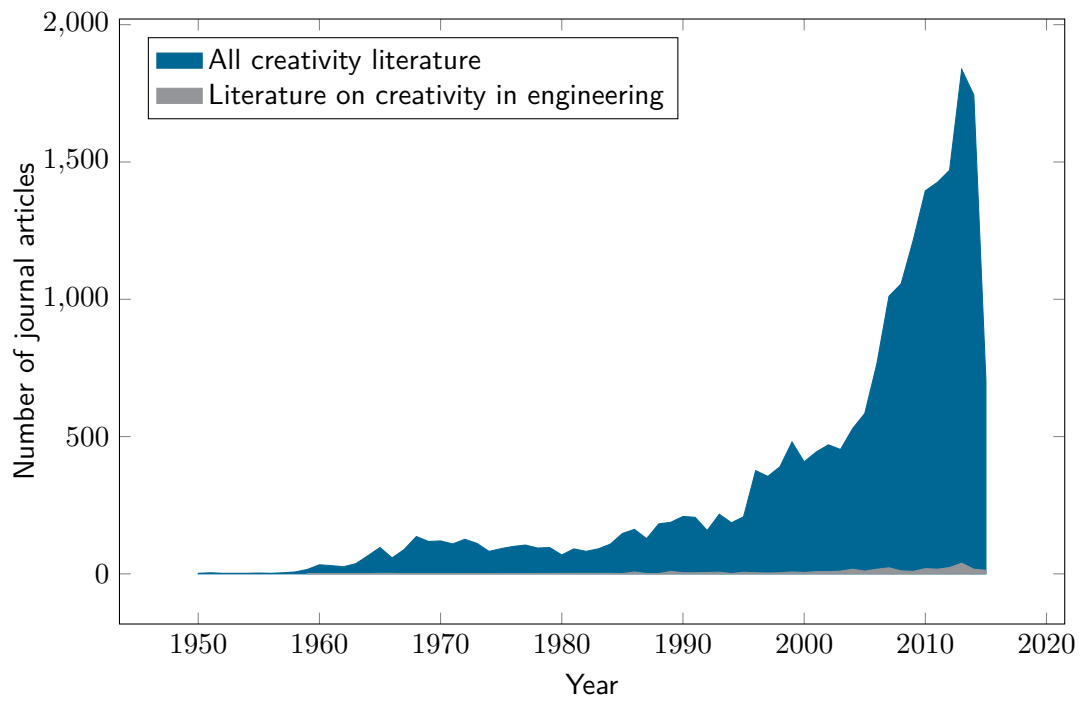


Figure 1.1: Annual number of academic publications on creativity.

## 1.1 Introduction

It is evident from the description of the research topics provided in Table 1.1 that the publications by Guastello (2011), Green & Green (2010), Skar & Sandberg (2009), Fischer (2006), Menezes & Singh (2004), Cui *et al.* (2003), Azani & Khorramshahgol (1991) and Price (1987) are not truly concerned with the subject of creativity in engineering organisations (where the term “organisations” is, in this case, intended to refer to institutions that provide engineering services of some description, rather than organisations that are concerned with educating engineers).

Thus this leaves four articles that have focussed on creativity within engineering organisations. As described in Table 1.1, both Savolainen & Cantamessa (1995) and Farid *et al.* (1993) investigate factors that may be inhibiting or preventing creative activity in engineering organisations. Burdon *et al.* (2013) and Qu *et al.* (2012) investigate specific concepts (cultural prerequisites for creativity and leader-member exchange respectively) that are related to creativity in engineering organisations.

Table 1.1: Summary of the publications containing the terms “creativity”, “engineering” and “organisations”.

Publication	Research topic
Burdon <i>et al.</i> (2013)	Designs and tests a framework for identifying and tracking “cultural prerequisites underpinning employees’ creative activities and how these align with the organisation’s readiness to enact innovative outcomes” in an engineering organisation.
Qu <i>et al.</i> (2012)	Investigates when leader-member exchange “in the workplace fosters employee creativity”. The study samples from employees in “high-tech enterprises” to conclude that leader-member exchange is positively correlated to follower creativity.
Guastello (2011)	Investigates the emergence of leaders in leaderless groups by studying engineering students engaged in a design activity and conclude that “the swallowtail model ... exhibited a strong advantage over the linear alternative model ... for predicting leadership emergence”.
Green & Green (2010)	Investigates ways in which engineering education institutions can “infuse their organizations with creativity, thereby producing innovative engineering students”.
Skar & Sandberg (2009)	Describes the design of a conference workshop for discussing mechanisms for improving the performance of teams, specifically teams that are geographically dispersed.

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## 1.1 Introduction

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<b>Publication</b>	<b>Research topic</b>
Fischer (2006)	This is a tutorial that is aimed at stimulating thought on “future challenges facing software engineering research and practice”. The specific themes that are addressed are (i) collaborative design; (ii) social creativity; and (iii) meta-design.
Menezes & Singh (2004)	Describes research on the use of nanotechnology to (i) develop a range of stain-resistant materials; (ii) improve the quality of dyes used for fabrics; and (iii) electro spinning techniques for creating “ ultra fine fibers of conducting and non-conducting polymers”.
Cui <i>et al.</i> (2003)	Explores “metasynthetic engineering” (combining the human mind and a computer’s capabilities to solve complex problems) “as a new intelligent field by means of artificial intelligence, knowledge engineering, system science, systems thinking, Dialogue (sic), knowledge management and www technology”.
Savolainen & Cantamessa (1995)	Presents “the need for creativity in manufacturing and some factors which, both at individual and organisation level, may help or obstruct it”. The article also explores the relationship between Common Information Model (a model that defines how objects in an IT environment are defined and what the relationship between these objects is) modelling and creativity.
Farid <i>et al.</i> (1993)	Defines the characteristics of a “creative professional” and organisational culture that stimulates creativity and articulates “blocks to creativity ... and ways to overcome them” in an organisational context.
Azani & Khorramshahgol (1991)	Investigates engineers’ “satisfaction with the tools and opportunities for creating technological changes” and “seeks to determine the prevailing state of mind of engineers concerning the potential threats from technological changes”.
Price (1987)	“A vision for the future”; “an effective organisation”; and “efficient implementation” are proposed as the three elements of an approach for managing and improving innovation.

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### 1.1.3 Scoping of the positional paper

The preceding high-level analysis of a sample of literature has revealed that it is not feasible to conduct a literature study to evaluate evidence of creativity in engineering organisations

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due to a lack of literature on this topic. In the absence of such literature, the scope of the positional paper is limited to the engineering design process. Therefore in the article that follows, literature on the engineering design process is synthesised with literature on creativity to determine to what extent (i) there is evidence of a creative focus in the engineering design process; and (ii) there are opportunities for incorporating an increased creative focus into engineering organisations.

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The ability to “solve complex engineering problems creatively and innovatively” is defined as one of the exit level outcomes of a Bachelor of Engineering programme by the Engineering Council of South Africa (Cato, 2018). In this article, the rationale for the research is set out by arguing that: (i) creativity plays a role in the engineering design process, and therefore in the problem-solving activity that lies at the root of engineering work; (ii) and proposing that organisations cannot simply be assumed to be conducive environments for creative activity. The specific focus on the engineering design process, rather than on the operation and management of engineering organisations in general, was motivated in Section 1.1.

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*South African Journal of Industrial Engineering May 2016 Vol 27(1), pp 137-150***THE ABSENCE OF A CREATIVE FOCUS IN THE CONVENTIONAL ENGINEERING DESIGN PROCESS:  
IDENTIFYING RESEARCH OPPORTUNITIES TO ADDRESS THIS**L. Oosthuizen<sup>1\*</sup> & P.J. Vlok<sup>1</sup>**ARTICLE INFO***Article details*

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**ABSTRACT**

This paper synthesises an overview of various models of the engineering design process with an overview of the most relevant theories within the field of creativity studies to conclude that (i) creativity plays a role throughout the engineering design process, and it is possible to incorporate creativity into the engineering design process in a systematic manner; (ii) doing so, at the very least, holds significant potential for economic benefit; and (iii) due to the complex interplay between creativity and the wide range of factors that influence it, organisational climates and management practices cannot simply be assumed to support creativity effectively. It is proposed that organisations be managed proactively to support creativity in engineering design. For this study, a structured literature search protocol was implemented to determine whether there is any evidence in the literature that engineering organisations are being managed proactively with this in mind; none was found. Two opportunities for future research are suggested based on these findings: (i) the development of a framework to guide the proactive management of engineering organisations to support creativity; and (ii) the development of mechanisms for measuring creativity in engineering organisations and engineering design.

**OPSOMMING**

Hierdie navorsing kombineer 'n oorsig van die verskillende modelle van die ingenieursontwerp-proses met 'n oorsig van die mees relevante teorieë binne die veld van kreatiwiteitsstudies en kom tot die gevolgtrekking dat (i) kreatiwiteit deur die volledige gang van die ingenieursontwerp-proses 'n rol speel, en dit moontlik is om kreatiwiteit op 'n sistematiese wyse in die ingenieursontwerp-proses in te lyf; (ii) so 'n benadering minstens die potensiaal vir beduidende ekonomiese voordeel inhou; en (iii) weens die komplekse interaksie tussen kreatiwiteit en die breë stel faktore wat dit beïnvloed, dit onakkuraat is om aan te neem dat organisasies se klimate en bestuurspraktyke noodwendig kreatiwiteit ondersteun. Daar word voorgestel dat organisasies proaktief bestuur behoort te word om kreatiwiteit in ingenieursontwerp te ondersteun. 'n Gestruktureerde protokol word gevolg om vas te stel of daar in die literatuur bewyse is dat ingenieursorganisasies tans so proaktief bestuur word. Geen bewyse word gevind nie. Twee geleenthede vir verdere navorsing word na gelang van hierdie bevindinge voorgestel: (i) die ontwerp van 'n raamwerk om riglyne te bied vir die proaktiewe bestuur van ingenieursorganisasies om kreatiwiteit te ondersteun; en (ii) die ontwikkeling van meganismes om kreatiwiteit in ingenieursorganisasies en in ingenieursontwerp te meet.

## 1 INTRODUCTION

The primary skill of the engineering profession is complex problem-solving, which is achieved through the design of a solution. The nature of the problems that are to be solved (and the solutions that are to be designed) varies widely both within the various disciplines of engineering and within different fields of application. Examples of the large variety of problems that could be considered within the engineering discipline include: solutions for airborne travel that range from a spaceship to a drone, solutions for generating and distributing electricity that range from tidal turbines to a bicycle dynamo, and solutions for containing a body of water that range from a dam wall to a bucket.

Creativity plays a vital role in ensuring that the solutions that are generated are of a high quality; solution quality would not only be evaluated in terms of durability or cost-effectiveness, but also in terms of ease of use, ease of maintenance or repair, potential speed of implementation, etc. A classic example of the contribution that creativity can make to engineering design is the case of the microwave oven [1]. It is easy to imagine that, up to the point where the accidental discovery that microwaves melt chocolate was made by an engineer working on an active radar set, designers considering the problem of heating food focused exclusively on different mechanisms for generating heat. These engineers may have generated a great number of ideas for converting various forms of energy into heat (and the generation of a large set of these ideas may have been considered creative), but if they all converged around the topic of heat generation, then no consideration was given to using something other than heat to solve the problem of heating food. This example highlights the significant contribution that creativity in the form of divergent, novel ideas can make to engineering design. It also highlights the importance of accurately measuring or understanding creativity: one divergent, useful idea may hold significantly more value than a large number of convergent ideas.

The literature contains several publications that consider creativity within engineering. The existing research can essentially be divided into:

1. Creativity in engineering education - specifically, how the engineering design process is taught, with suggestions for incorporating a specific mechanism into engineering education that has been proven to increase productivity; and
2. An analysis of the engineering design process, coupled with a suggestion for incorporating a specific method from creativity theory into the engineering design process.

Though models for increasing productivity in the engineering domain are frequently proposed in the literature, very little evidence can be found of mechanisms for measuring creativity in engineering design (especially within the context of engineering organisations). It follows that the literature proposing models for increasing creativity does not contain data proving the efficacy of these models in engineering organisations. This paper takes a different approach, recognising that a large number of different approaches to developing theories of creativity exist, and that creativity is a complex field. Therefore it is the position of this paper that selecting a specific technique for stimulating creativity, and proposing that this should be applied as a mechanism for increasing creativity in the engineering domain, is too narrow an approach. Instead, this paper aims to present a comprehensive yet succinct overview of the most prominent theories of creativity, with the aim of identifying potential areas of research where the application of theories of creativity to the engineering domain can offer benefit. This paper is contextualised through a brief, general overview of the literature in Section 2.

The literature contains several different models of the engineering design process, and Section 3 introduces the concept of engineering design and presents a comparison of the most prominent prescriptive models of the engineering design process. Section 4 provides a high-level overview of research into the field of creativity and the creative process, in order to provide the necessary background for the discussion in Section 5, about whether creativity theory does or should play a role in the engineering design process. Section 6 makes recommendations for further research based on these findings.

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### 2 CONTEXTUALISATION

It is commonly accepted in the literature that problem restructuring (i.e., reaching a novel understanding of or insight into the problem itself) is required when individuals solve problems that require insight [2,3]. Martinsen [2] studied different cognitive styles to determine how this problem restructuring takes place, and how skills are transferred after solving these problems. He identified two cognitive styles that perform well in problems requiring insight:

1. Assimilators - individuals who “give priority to upholding cognitive economy”; and
2. Explorers - individuals who “seek new types of solutions and new ways of solving problems”.

Martinsen [2] concludes that creativity plays a key role in both of these cognitive styles, as it “is associated with the ability to handle high task novelty”. Referring back to the microwave oven example, it is likely that the design team may have benefitted from employing more rigorous problem restructuring in order to confirm that the problem is not the generation of heat (which will in turn be used to heat food), but rather that the problem is the heating of the food itself.

The microwave oven example illustrates the potential economic benefit that can be associated with a novel idea. In a book that has been cited more than 12,000 times to date, Florida [4] describes creativity as the most important economic resource of this century. Runco [5] agrees that creativity should be viewed as a resource and a form of capital, but cautions that it is important to understand that investing in creative potential involves risk. This risk stems primarily from the novel nature of creative ideas; therefore, investing in creativity implies investing in (the generation or development of) ideas that are untested. This concept is explained more fully by the psycho-economic theory of creativity that is introduced in Section 4. The risk involved offers possible mechanisms for explaining why, despite the close link between proficiency in problem-solving and creativity, and the clear potential for economic benefit associated with creative behaviour, creativity is not generally a trait that is given prominence within the engineering profession.

The topic of creativity within the context of education (from pre-school through to the tertiary level) has been a popular topic of academic discourse in recent years [6-13]. Robinson [7] in particular has argued that creativity is not actively encouraged by organisations that govern education (this statement was made in the UK context), and that creativity has become (inaccurately) stereotyped with only a very narrow set of activities and collection of individuals being viewed as creative. In studies of creativity specifically within engineering education, Berglund and Wennberg [14] found that engineering students had significant creative potential. As mentioned in Section 1, a number of studies have proposed methods for incorporating specific creative methods into engineering education or that seek to understand motivation for creativity in engineering students [15-17].

### 3 THE ENGINEERING DESIGN PROCESS

In this section, the term ‘design’ is defined before different models of the engineering design process are compared and analysed.

#### 3.1 Defining design

Dym *et al.* [18] state that engineering design is specifically concerned with problems that are:

1. Ill-structured or ill-defined, which means that the solution cannot be found by applying algorithms or mathematical formulas in a routine or structured manner; and
2. Open-ended, which means that several, divergent, and valid solutions to the problem could exist.

Cross [19] further expands on the characteristics of ill-defined problems by stating that:

1. No definitive formulation of the problem exists;
2. Any formulation of the problem may contain internal inconsistencies that often only become apparent during the solution process; and

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3. The process of proposing solutions to the problem is a method of improving the understanding of the problem.

Hubka and Eder [20] make a distinction between the narrower definition of design and the wider definition of design. In the narrower definition, the design process is initiated by a set of demands (requirements, needs, or constraints) on a technical system, and it culminates in some description (e.g., design drawings and specifications) from which the technical system can be manufactured or implemented. For the purposes of this discussion, ‘design’ according to this narrower definition will be termed ‘technical design’. In the wider definition, additional problem-solving activities (for example, product planning) are undertaken before (and sometimes also after) the technical design process.

The term ‘design’ is used within a broad variety of fields, from fashion to vehicles, and from electronic devices to large structures. Childs [21] gives the following definition of design in a broad context: “Design can be considered to be the process of conceiving, developing, and realising products, artefacts, processes, systems, services, and experiences with the aim of fulfilling identified or perceived needs or desires typically working within defined or negotiated constraints.” Engineering is commonly defined as the discipline, art, and profession of acquiring and applying scientific, mathematical, economic, social, and practical knowledge to design and build structures, machines, devices, systems, and processes that safely realise solutions to the needs of society. This definition is representative of definitions of design in the engineering context found in literature. Both the definition of design given by Childs [21] and the commonly used definition of engineering are aligned to the wider definition of design. Kryssanov *et al.* [22] define the discipline of design studies as the “study of the thought process comprising the creation of an artefact in a given (social, technical, economical, etc.) environment”.

### 3.2 The engineering approach to design

No single cross-disciplinary definition of the engineering design process exists; this is not surprising because, as Dym *et al.* [18] state, there is no single engineering design community that transcends the different engineering disciplines. However, the study and documentation of the design process has been a topic of research for several decades, and various authors have proposed maps or models of the process. Cross [19] distinguishes between two types of models: descriptive models that simply attempt to describe the sequence of activities that typically occur in the design process, and prescriptive models that attempt to prescribe a specific sequence of activities that should be employed to arrive at a superior design. Cross [19] then proposes a novel model (defined as an integrative model) that does not attempt to describe or prescribe any specific sequential steps in the design process, but rather attempts to portray the symmetrical relationships between four elements of design: the overall problem, the sub-problems, the sub-solutions, and the overall solution.

It would not be feasible to provide a succinct overview of the various models of the engineering design process here. Rather, in an attempt to provide sufficient background for a discussion of whether creativity plays a role in the engineering design process, the sequential steps described by some prominent linear prescriptive models are compared in Figure 1. Such comparisons are rare in the literature, but the interested reader is referred to Howard *et al.* [23] for a similar comparison of a larger number of less recent models. It is important to note that the intention is not to imply that design is a linear process; all of the models presented in Figure 1 describe an iterative process with several feedback loops both between consecutive steps and between steps that are separated by several intermediate steps. Instead, linear models are selected for presentation, and the feedback loops are not depicted in the comparison because the focus here is solely on identifying and comparing the elements (steps) of the engineering process that are defined by each model. The comparison does not include any generic design process models or any descriptive engineering design process models. These models are generally more basic, and tend not to contain any key elements that are not already described by the prescriptive models that are included in the comparison.

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Element Identifier	Archer [24]	Total design - core only [25]	Engineering design process [26]	Systematic approach [27]	VDI 2221 model (as given by Cross [19])	Design for six sigma [21]
A	Programming	Market	Recognition of need		Clarify and define task	New product introduction
B	Data collection					Measure customer needs
C	Analysis	Specification		Specification	Determine functions and their structures	Define
D	Synthesis	Conceptual design	Conceptualisation	Concept	Search for solution principles and their combinations	Concept
E			Feasibility assessment			Analysis of conceptual design
F			Work breakdown structure		Divide into realisable modules	
G	Development	Detailed design	Preliminary design	Preliminary layout	Develop layouts of key modules	Technical design
H			Detailed design	Definitive layout	Complete overall layout	
J			Qualification testing			
K	Design communication		Production planning and tooling design	Documentation	Prepare production and operating instructions	
M		Manufacture				Implement
N		Market				Handover

Figure 1: Comparison of the elements defined in various prescriptive models of the engineering design process

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With reference to Figure 1, the various prescriptive models show significant variation in the elements that they consider to form part of the engineering design process. In summary, the following elements are defined:

- **Elements A & B:** Identifying and understanding the need;
- **Element C:** Compiling a specification for the design;
- **Element D:** Conceptual design or ‘synthesis’ (one of only two elements that are included in all the models in Figure 1);
- **Element E:** Evaluating the feasibility of the conceptual design, included only in the models of Ertas and Jones [26] and Childs [21];
- **Element F:** Dividing the design task into a set of smaller design tasks, included only in the models of Ertas and Jones [26] and Cross [19];
- **Elements G & H:** Detail / technical design (the second element that is included in all the models in Figure 1);
- **Element J:** Evaluating the suitability of the detail design, included only in the model of Ertas and Jones [26];
- **Element K:** Documenting the design. According to the majority of the models presented, this is the concluding step of the engineering design process;
- **Element M:** Implementing the solution; and
- **Element N:** Handing the solution over to the market.

The models differ in terms of what they define as the start and end of the design process. For example, the systematic approach [27] focuses solely on the technical design process (or the narrow definition of engineering design), while all of the other models presented here contain at least some description of an initial, exploratory phase (wider definition of design). As mentioned, the majority of the models define design documentation as the last step in the engineering design process; however, both Pugh [25] and Childs [21] do not specifically mention the documentation step, but go beyond documentation to include implementation and handover as forming part of the design process.

When attempting to compare different models of the engineering design process, it is important to take into consideration the notion that models that have been developed in different cultures have different denotations and levels of expressiveness. It is not feasible to take this complexity into consideration in this brief overview. Nevertheless, it is interesting to take note of the language used in describing the various steps. For example, where all of the other models describe the concept design step (Element D) using non-prescriptive language, leaving the user open to interpret the meaning of ‘synthesis’, ‘conceptualisation’, ‘concept’, or ‘conceptual design’, the VDI 2221 model reduces this step to “search for solution principles and their combinations” [19]. In their analysis of various models of the engineering design process, Howard *et al.* [23] conclude that “engineering design process models are poor with regards [sic] to representing creative processes”.

## 4 CREATIVITY

This section starts with a discussion of the meaning of the term ‘creativity’, both within a general context and more specifically within an organisational context. This is followed by a brief overview of the most relevant theories within the field of creativity research.

### 4.1 What is creativity?

A commonly-accepted definition of creativity in organisational theory is the production of novel (or original) and useful ideas within any domain [28,29]. The definition given by Plucker *et al.* [30] has a slightly different approach, which incorporates a focus on the mechanism for the production of a creative idea: “Creativity is the interaction among aptitude, process, and environment by which an individual or group produces a perceptible product that is both novel and useful as defined within a social context”. Runco [5] defines originality as the critical contemporary identifier of creativity. According to Kaufman and Sternberg [31], creative ideas have three key characteristics:

1. They are new, different, or innovative;
2. They are of a high quality; and



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3. They are appropriate to the purpose for which they were created, or to some redefinition of that purpose.

Creativity is closely associated with:

1. Fluency (i.e., the number of raw ideas that are generated, irrespective of their originality and quality);
2. Originality, which is the degree of novelty of an idea; and
3. Flexibility, which is the degree to which an individual is open to new knowledge [5].

Several authors have proposed definitions of creativity. Gurteen [32] views creativity as the process of generating ideas through divergent thinking, while Cheng [33] defines it as the ability to generate novel ideas. Fernandes *et al.* [34] describe it as a complex phenomenon encompassing four key elements: the creative process, the creative agent, the creative situation, and the creative product.

Amabile *et al.* [28] define innovation as the successful implementation of creative ideas within an organisation. Similarly, Gurteen [32] defines innovation as the sifting, refining, and implementation of creative ideas. From this perspective, creativity (by individuals or teams) is a necessary element for innovation, but creativity alone is not sufficient for successful innovation. A key difference between creativity and innovation is that innovation is directly associated with economic benefit to an organisation, while this is not necessarily the case for creativity.

Rasulzada [35] defines a creative organisation as one that “has the ability and capacity to tap the creative potential of their employees into novel, original and valuable products, services, processes, strategies, or other values”.

### 4.2 Theories of creativity

The topic of creativity has received widespread research attention over hundreds of years, and there are several distinct theories of creativity. It is not feasible to provide a comprehensive introduction to the field here, but the interested reader is referred to Runco and Albert [36] for such an introduction, and to Kozbelt *et al.* [37] for a review of ten distinct, modern theories of creativity. As an illustration of how theories of creativity differ in their primary assertions, their key concepts, the aspects of creativity that they emphasise (process, product, person, place, persuasion, and potential), and the levels of magnitude that they take into account, Table 1 provides a description of six theories of creativity that were identified by Kozbelt *et al.* [37].

With reference to Table 1, there are similarities in the perspective taken by the economic theory of creativity and the systems theory of creativity. Both employ a holistic view, which takes into consideration the environment or ‘place’ (where environment is defined broadly to incorporate both physical aspects of offices, buildings, and cities, and psychosocial aspects such as organisational culture, management philosophies, and reward structures) within which creative activity takes place, as well as the individual or ‘person’ involved in the creative activity. In contrast to economic and systems theories, the stage and componential process, cognitive, problem-solving and expertise-based, and problem-finding theories employ a narrower focus, and specifically concern themselves with the creative process itself. The processes described by these theories consider different combinations of:

- (i) General cognitive processes, which include those based on domain-specific expertise;
- (ii) Exploratory behaviours and subjective creative processes, which include divergent thinking and remote association; and
- (iii) ideational thought processes, such as metaphorical thinking, problem representation and heuristics, on-line discovery, and other techniques that generate insight.

When considering the presence of creativity in the engineering design process, it is logical that the theories that focus on the creative process should be considered in more detail. However, the engineering design process does not occur in a vacuum. It can therefore be argued that theories incorporating a more holistic approach should also be taken into account, in order to understand the effect of the environment in which the engineering design process functions and of the individual executing the engineering design process.

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Table 1: Applicable theories of creativity (excerpted from a table by Kozbelt *et al.* [37])

Theory of creativity	Primary assertion	Key concepts	Emphasised aspect(s) of creativity	Level of magnitude
Economic	Creative ideation and behaviour is influenced by 'market forces' and cost-benefit analyses.	Influence of macro-level factors; Psycho-economic perspective; markets of creativity; and investment decisions.	Person; Place; Product; and Persuasion.	Little-c to Big-C.
Stage and componential process	Creative expression proceeds through a series of stages or components; the process can have linear and recursive elements.	Preparation stages; incubation and insight; verification and evaluation; and component mechanism.	Primarily process.	Mini-c to Big-C.
Cognitive	Ideational thought processes are foundational to creative persons and accomplishments.	Remote association; divergent/convergent thinking; conceptual combination, expansion; metaphorical thinking, imagery; and metacognitive processes.	Person; and Process.	Little-c to Big-C.
Problem-solving and expertise-based	Creative solutions to ill-defined problems result from a rational process that relies on general cognitive processes and domain expertise.	Ill-defined problems; cognitive, computation approach; expertise-based approaches; and problem representation and heuristics.	Person; Process; and Product.	Little-c to Big-C.
Problem finding	Creative people engage proactively in a subjective and exploratory process of identifying problems to be solved.	Subjective creative processes; exploratory behaviours; and on-line discovery.	Process; Person; and Potential.	Primarily mini-c.
Systems	Creativity results from a complex system of interacting and interrelated factors.	Evolving systems; network of enterprises; domain and field; gatekeepers; collaborative creativity; and chaos and complexity.	Varying emphasis across all six aspects.	Little-c to Big-C.

When considering the presence of creativity in an organisational context, it is important to take a holistic approach. This approach recognises that all of the elements of creativity, as defined by Kozbelt *et al.* [37], are present in an organisational context, and must therefore be taken into consideration when attempting to assess whether an organisational environment supports creative activity. As an illustration of some of the dynamics that could influence creativity in an organisational context, the psycho-economic theory of creativity (referred to as the 'economic' theory in Table 1) is singled out for a more in-depth presentation. Inter-disciplinary research in economics and psychology has produced several useful descriptions for understanding the dynamics of various concepts in creativity [5]. It is not feasible to present a comprehensive overview of the psycho-economic perspective on creativity (the interested reader is referred to Runco [5] for a more detailed introduction); instead, some of the most relevant concepts are briefly introduced here [5]:

1. The concept of 'a market for creativity' holds that "social settings can be arranged such that original behaviour has both predictable benefits and minimal costs, [with] the result being a tendency towards creative action".

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2. Economic theory is largely devoted to the distribution and allocation of resources. In the creative field, the term 'resources' should be interpreted broadly to include time, psychic energy, money, and physical resources. Psycho-economic theory provides two perspectives on resources in creativity:
  - a. Creative potential (whether this be in the form of creative individuals or a work environment that stimulates creativity) as a resource that should be managed appropriately; and
  - b. Resources invested in creative work. Specifically, the concept of risk is used to explain why it is often viewed as risky to invest in creative potential (because creativity is associated with that which is novel and therefore untested; this example was given in Section 2). Psycho-economic theory then draws on concepts related to risk tolerance and the minimisation of risk to propose how such a reluctance to invest in creative potential may be overcome.
3. The concept of 'depreciation' is used to explain how an investment in creativity may lead to a reduction in creative potential if it decreases ideational flexibility (in an attempt to reduce the risk of depreciating the value of an existing idea).

In addition to the examples given above, the psycho-economic theory of creativity is also most notably used to explain concepts related to the value of creativity and the relationship between quantity and quality within creativity [5].

When classifying the level of magnitude of creativity, Kozbelt *et al.* [37] make use of the Four C model of creativity proposed by Kaufman and Beghetto [38]:

1. Mini-c: subjective forms of the creativity of everyday life, specifically related to the learning process and the development of creativity;
2. Little-c: objective forms of the creativity of everyday life;
3. Pro-c: professional level creators, in any creative area, who are not or may never become eminent creators; and
4. Big-C, eminent, unambiguous examples of creativity.

A cursory review of these four categories would most likely lead to the conclusion that professional engineers fall into the Pro-c category. Indeed, this paper agrees that Pro-c is the most appropriate category for fully qualified professional engineers.

### 5 CREATIVITY AND THE ENGINEERING DESIGN PROCESS

This raises two questions: Does creativity play a role in the engineering design process; and if it does, are we (and should we be) proactively managing engineering organisations in such a manner as to ensure that they support creativity in engineering design?

#### 5.1 Does creativity play a role in the engineering design process?

Cox [39] described the relationship between design, creativity, and innovation as follows: "Design is what links creativity and innovation. It shapes ideas to become practical and attractive propositions for users or customers. Design may be described as creativity deployed to a specific end." This description highlights the need for the design process to interact effectively with or incorporate creativity in order successfully to realise the economic benefits associated with innovation.

Creativity (in the form of ideational thought processes such as problem representation) plays an essential role in the problem restructuring that is required when solving complex problems (introduced in Section 2). This problem restructuring phase is represented by the problem definition steps, Elements A, B and C, in Figure 1.

With reference to the iterative nature of the design process, Ertas and Jones [26] note that repeating an earlier step to consider a new alternative becomes increasingly costly as an individual progresses through the process. In addition to the cost element, designers become increasingly less likely to abandon a particular design once it has been chosen as the preferred solution and some effort has been put into developing the design beyond the initial concept phase. Ertas and

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Jones [26] also note that any persons involved in a design process tend to lose their objectivity with regard to alternative designs once a particular concept has been chosen. These findings highlight the value of thinking widely early in the design process (for example, in the concept design/synthesis step, which is Element D in Figure 1), in order to generate a large variety of unique, divergent alternatives from which to select.

Creativity does not only add value early in the design process. As engineering design projects progress, more preconditions may emerge that require divergent thinking to address the potential challenges associated with these preconditions.

From the preceding discussion, as well as from the literature accompanying models of the engineering process, it is clear that although models of the engineering process may not explicitly portray creative processes, there is an implicit requirement for creativity throughout the engineering design process.

Several authors have stated that creativity is essentially a systematic process and as such, it can be managed [33,40,34]. From this, it can be concluded that it should be possible to manage the engineering design process proactively so that it supports increased creativity. Incorporating creativity into the engineering design process in a systematic manner could enable the routine generation of higher-quality solutions. Furthermore, from the widely cited work by Florida [4], it is reasonable to conclude that doing so does, at the very least, have the potential to offer significant economic benefit.

### 5.2 Are we (and should we be) managing for creativity in engineering design?

From the brief overview of the field of creativity in Section 4, it is apparent that, while creativity could be viewed as a systematic process, it would be inaccurate to assume that creative processes are not also influenced by a number of other factors, which include the environment in which they take place and the level of motivation of the individual(s) involved. Against this background, it is proposed that incorporating research on psychosocial approaches that are proven to support creativity within organisations would be a necessary element for enabling increased creativity within engineering organisations. Specifically, it is proposed that an approach that focuses purely on incorporating creativity into the engineering design process without considering factors such as organisational culture, management styles, and reward structures that stifle or encourage creativity within engineering organisations will have limited efficacy.

The overview in Section 4 illustrated that creativity is a complex phenomenon with many different perspectives that need to be taken into account when attempting to understand it fully. It follows that attempting to manage an organisational environment to ensure creativity would be a complex endeavour that requires that the several factors and dynamics that may influence creativity be taken into account. It is reasonable to conclude that organisational climates and practices cannot simply be assumed to be conducive to creativity. Rather, it should be considered that, as with other elements such as the motivation of employees, an organisation must proactively manage if it wants to increase its performance. It is therefore proposed that engineering organisations need to be proactively managed to support creativity in engineering design.

This proposal leads to the final question of this paper: Is there evidence in the literature that engineering organisations are currently being proactively managed to support creativity in engineering design? Appendix A describes a customised search protocol that was conducted to identify the literature on creativity in engineering organisations and discusses the findings in more detail. To summarise, although there is certainly research that considers various aspects of creativity in engineering organisations, there is no evidence in the literature of the existence of a framework, model, or similar defined approach to inform and/or guide management practice to ensure sustained, creative activity in engineering organisations.

## 6 CONCLUSION

The research produced the following deliverables:

1. It provided a comparison of the elements defined in some prominent models of the engineering design process;

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2. It provided a brief introduction to the field of creativity, highlighting aspects that may be relevant to increasing the prominence of creativity in the engineering field;
3. It illustrated that creativity is a complex field, and that it is therefore short-sighted to consider merely one technique for enhancing creativity when researching methods for increasing creative activity within the engineering context;
4. It used findings from the engineering design and creativity literature to hypothesise that (i) creativity does play a role in engineering design; (ii) organisational practices cannot simply be assumed to be conducive to creativity, but rather that engineering organisations should be proactively managed to support creativity in engineering design; and (iii) doing so would (at the very least) hold significant potential for economic benefit; and
5. It concluded that there is no evidence in the literature that engineering organisations are currently being managed proactively to support creativity in engineering design.

It is proposed that the most prudent way of taking these research findings forward would be to develop a framework for managing engineering organisations in a way that actively supports creativity. It is proposed that such a framework should not be overtly onerous to implement (a factor that would most likely render it impractical for managers of engineering organisations). Rather, it should distil the literature on creativity into an understandable set of guidelines that managers could incorporate into their existing operational management practices. Incorporating an understanding of the impact of psychosocial factors into the management of engineering organisations could enable the existing creative potential of these organisations to be unlocked more effectively. Furthermore, developing mechanisms for effecting behavioural change in engineering organisations based on psycho-economic theory could offer solutions to overcome stubborn behavioural problems in these organisations, potentially stretching beyond those affecting creative activity.

Referring back to the lack of measurement techniques for creativity in an engineering context highlighted in Section 1, a second suggested area for future research is the development of appropriate measuring mechanisms. This would enable empirical research on whether interventions to increase creativity in engineering organisations have a measurable impact.

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### APPENDIX A: CUSTOMISED LITERATURE SEARCH PROTOCOL

A customised protocol for searching for literature on creativity in engineering organisations was developed and followed in order to ensure a rigorous search of the literature. The following five databases were searched:

- the Scopus database provided by Elsevier;
- the Web of Science database provided by Thomson Reuters;
- the Academic Search Premier database provided by EBSCO Publishing;
- the Taylor and Francis online database provided by Taylor and Francis; and
- the Google Scholar database provided by Google.

Since the search functionality of each of the databases differs, a customised approach was followed during the search of each database. However, all of the searches were aligned to the same basic logic, which was to search for a combination of three terms: ‘creativity’ AND ‘engineering’ AND [‘organisation’ OR ‘institution’ OR ‘company’ OR ‘firm’ OR ‘corporation’], in reasonably close proximity to one another, in the title or abstract. The search uncovered 183 research items (mostly articles and conference proceedings) that were investigated to determine whether the literature provides evidence that engineering organisations are being managed proactively to support creativity in engineering design. As stated in Section 5.2, no such evidence was found.

The search did uncover a variety of literature that may be useful when attempting to build on the research presented in this paper. Examples of such literature include the following: Kukushkin and Churlyayeva [41] present an interesting case study, discussing possible reasons for a lack of technological creativity in Russia; Lin [42] presents research on the influence of individuality relatedness and cognitive flexibility on team creativity in an engineering context; Eckert *et al.* [43] use a case study to investigate the effect of an averseness to risk on creativity in engineering design, and concludes that “the emphasis on reliable and repeatable processes causes creativity to be displaced backwards into R&D and forwards into ‘emergency innovation’ during integration”; Jagodzinski *et al.* [44] use case study research to demonstrate “the adverse effect of organisational and technological change on the creativity of design engineers”; Wang [45] investigates factors influencing the adoption and use of creativity techniques by individuals, specifically in an organisational context, with the aim of informing the use of these techniques in an engineering context; Chakrabarti [46] analyses biographical information of a number of eminent engineering designers to identify the common influences and factors that are likely to have led to their success; and Yilmaz *et al.* [47] present a tool (Design Heuristics) aimed at supporting engineers in considering a larger number of diverse concepts during the idea generation phase of design.

Two publications that are particularly important to note are Menzel *et al.* [48] and Yannou [49]. Menzel *et al.* [48] investigate methods to make engineers active as ‘intrapreneurs’ in large organisations. Among other questions, the research investigates managerial and organisational factors that assist engineers to function as intrapreneurs. Yannou [49] describes a large research initiative to study “design creativity and innovation from practical perspectives”; the research initiative is specifically aimed at the work of engineers. Although this research initiative has produced a number of roadmaps and frameworks for managing innovation within organisations, no framework focusing on increased creative activity has been proposed.



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### 1.3 Conclusion: Rationale for the research

### 1.3 Conclusion: Rationale for the research

The rationale for the PhD research was provided in the positional paper presented in this chapter. As stated in the abstract of the article, this was done by synthesising “an overview of various models of the engineering design process with an overview of the most relevant theories within the field of creativity studies to conclude that (i) creativity plays a role throughout the engineering design process, and it is possible to incorporate creativity into the engineering design process in a systematic manner; (ii) doing so, at the very least, holds significant potential for economic benefit; and (iii) due to the complex interplay between creativity and the wide range of factors that influence it, organisational climates and management practices cannot simply be assumed to support creativity effectively.”

The “development of a framework to guide the proactive management of engineering organisations to support creativity” is proposed as an opportunity for future research in the article. The research focus of this dissertation is formally defined in the next chapter.

## Chapter 2

# Definition of the research

Position of Chapter 2 in dissertation structure.		
Chapter	Chapter type	Chapter topic
<b>Part I: Research rationale (RO1)</b>		
1	Published article	Objective 1: Develop the rationale for the research presented in this dissertation, based on a narrative literature review and synthesis.
2	Bridging text	Formally define the research through the articulation of an aim and research objectives.
<b>Part II: Framework feasibility (RO2)</b>		
<b>Part III: Antecedents of team creativity (RO3)</b>		
<b>Part IV: Outcomes of team creativity (RO4)</b>		
<b>Part V: Conclusion</b>		

An introduction to the dissertation as well as the rationale for the research were presented in Chapter 1. In this second chapter of Part I of the dissertation, the research is formally defined with the provision of an aim and research objectives. The scope of the research is delimited, and the overarching research design is described. The structure of the dissertation document is also described and a high-level overview of the various research methods that are employed, is provided.

The research matured significantly as the understanding of the Organisational Behaviour literature applied in this research deepened, with an important delimitation of the research emerging in the process. The direction of the research also evolved based on interim findings from the publications presented in the dissertation. As such, this introductory chapter breaks from the customary format to include a summary of salient interim findings that will be presented in the dissertation. This enables the reader to follow the logic underlying the definition of subsequent research objectives.

## 2.1 Contextualisation and delimitation

Due to the complex interplay between creativity and the wide range of factors that influence it, organisational climates and management practices in engineering organisation (and in organisations in general) cannot simply be assumed to support creativity effectively. Though, as motivated in the preceding chapter, there is reason to expect that creativity plays a role in the engineering design process and it is possible to incorporate creativity into the engineering design process in a systematic manner; the structured search of five academic databases presented in the preceding chapter did not uncover evidence that engineering organisations are being proactively managed to do so.

A perspective that plays an important role in shaping this research is that creativity, in itself, is not a meaningful outcome for an organisation to pursue. Rather, organisations would be expected to be interested in pursuing potential outcomes of creativity, such as increased productivity, innovation that leads to commercial advantage, and positive outcomes for employees such as reduced turnover. It is also possible that, under certain circumstances, creativity could lead to negative outcomes for organisations, such as increased unethical behaviour. As such, it is reasonable to argue that any attempt to increase creativity in organisations should also incorporate mechanisms to: (i) guard against potential negative consequences of such increased creativity; and (ii) channel creativity towards meaningful positive outcomes.

Within an organisational context, literature distinguishes between creativity at an individual-, team-, and organisational-level (Woodman *et al.*, 1993). In a 1950 address to the American Psychological Association, JP Guilford specified “the vague but intriguing notion of creativity according to distinct constructs that define individual creative thinking” (Kurtzberg & Amabile, 2001) and in so doing is generally acknowledged to have initiated creativity as a research topic. Thus creativity research initially focussed on the traits, motivations, and behaviours of individuals (Kurtzberg & Amabile, 2001). Over time, research on creativity at the team- and organizational-level began to emerge. Team creativity refers to a “team-level creative synergy, in which creative ideas are generated by groups instead of being generated by one mind” (Kurtzberg & Amabile, 2001). Creativity at a group (or team) level “is a function of individual creative behaviour and situational factors, such as the interaction of individuals within the group, group characteristics, group processes, and

## 2.1 Contextualisation and delimitation

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contextual influences from the larger organisation” (Sundgren *et al.*, 2005). In contrast, organisational creativity is concerned with the creation of creative outputs within a “complex social system” (Woodman *et al.*, 1993). Therefore organisational creativity is a function of the creativity of the individuals and groups in the organisation “and of contextual influences from, among other things, organizational culture, resource factors, and the environment of the organization” (Sundgren *et al.*, 2005).

Teamwork is widely acknowledged as a key skill within the engineering profession. The ability to “work effectively as an individual, in teams and in multidisciplinary environments” is one of the 11 learning outcomes that a Bachelor of Engineering programme must achieve in order to be accredited by the Engineering Council of South Africa (Cato, 2018). Similarly, “an ability to function effectively on a team” is one of seven learning outcomes that an engineering programme must achieve in order to be accredited by the US-based Accreditation Board for Engineering and Technology (Accreditation Board for Engineering and Technology, 2018). This is not surprising when one considers the complex nature and large scope of many of the projects that are being executed in engineering organisations.

Given the essential role of teamwork within the engineering profession, this research focuses specifically on team creativity, rather than on individual or organisational creativity. This delimitation was not defined at the outset of the research, rather it was incorporated as the understanding of the field of creativity research matured and it became apparent that individual creativity, team creativity, and organisational creativity represent distinct constructs with a significant body of literature that is associated with each of these constructs. The delimitation is incorporated in order to limit the scope of the research to that which could feasibly be considered in a dissertation.

A final delimitation that is relevant to this research, is to define what is meant by term “engineering organisation” as it is used in this dissertation. As stated in the previous chapter, the focus is on organisations that provide engineering services rather than on organisations that are primarily concerned with educating engineers. Furthermore, the focus is on organisations that employ engineers to solve complex problems, which, according to the Engineering Council of South Africa, is a key attribute of all engineering graduates, regardless of the discipline of specialisation.

## **2.2 Research aim and objectives**

In broad terms, the aim of this research is to contribute towards incorporating managerial practices that promote team creativity which results in positive, meaningful outcomes within engineering organisations. Though a framework to guide such managerial practices is not developed within this dissertation, a number of research outputs are produced that lay the foundation for the development of such a framework, most importantly by contributing to the maturity of the body of knowledge that would underpin such a framework. Thus, a more narrow definition of the aim of this research is to lay the foundation for the development of a managerial framework to support team creativity in engineering organisations, primarily by organising and expanding the body of knowledge on antecedents and outcomes of team creativity. Such a framework is henceforth simply referred to as “the framework” or “a framework”.

Though the research originated within the field of engineering, specifically by interrogating the engineering design process to build an argument for the role of creativity in engineering organisations, a number of the research outputs that are produced are in fact more widely applicable to organisations in general. Thus, though this was not originally defined as an aim of the research, the dissertation does, in the process of laying a foundation for a managerial framework for use in engineering organisations, also make a more general contribution to literature on team creativity.

The research objectives (ROs) and sub-objectives are summarised in Table 2.1. As described in the introduction to this chapter, the objectives of the research are path dependent, with the third and fourth objectives having been defined based on the outcomes from the second objective. For this reason, the findings from the second objective are briefly reported in the table before the third and fourth objectives are defined. Furthermore, as discussed in Section 2.1, the delimitation to focus on team creativity specifically, rather than on creativity in general, was only defined as the understanding of the literature matured. As this dissertation contains published articles, it was not possible to retrospectively incorporate this delimitation throughout the dissertation, hence the point from which this delimitation was incorporated is clearly indicated in Table 2.1.

Table 2.1: Research objectives

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## 2.2 Research aim and objectives

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**RO1:** Establish the rationale for the role of creativity in the engineering design process, and by implication in engineering organisations, based on a review and synthesis of literature.

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**RO2:** Evaluate the feasibility of developing a framework.

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**RO2.1:** Evaluate the feasibility based on the anticipated scope by determining the elements of creativity that should be included in the framework and defining the scope of each of these elements for the purpose of the framework development.

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***Delimitation incorporated:*** *The delimitation to focus specifically on team creativity, rather than on creativity in general, is incorporated from this point onwards.*

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**RO2.2:** Conduct a structured search and classification of literature to determine whether there is a sufficient body of empirical knowledge to enable the development of a framework. Specifically consider the body of knowledge on: (i) antecedents that lead to increased team creativity; and (ii) boundary conditions that cause team creativity to result in either positive or negative outcomes.

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***RO2 Interim finding:*** *The development of a framework does not appear to be feasible at this point in time. The anticipated scope of such a framework appears feasible. There also appears to be a sufficient body of empirical knowledge on antecedents of team creativity, however, the body of empirical knowledge on boundary conditions that cause team creativity to result in either positive or negative organisational outcomes does not appear to be sufficiently mature to enable the development of a framework.*

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**RO3:** In order to lay the foundation for the future development of a framework, conduct a meta-analytic review on existing empirical knowledge on the antecedents of team creativity to obtain an estimate of the construct-level relationships in the population.

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## 2.2 Research aim and objectives

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- RO3.1:** Based on the set of literature identified and classified in RO2.2, construct: a database containing a qualitative summary of all statistically significant findings reported in the set of empirical research on antecedents of team creativity; and a database containing a quantitative summary of all correlations with team creativity reported in the set of empirical research on antecedents of team creativity.
- RO3.2:** Identify antecedents to include in the meta-analysis and conduct the meta-analysis using appropriate statistical methods.
- RO3.3:** Summarise the findings of the meta-analysis into a format that can be utilised by future researchers as an input for the development of a framework.

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## 2.3 Document structure and methodology

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**RO4:** Contribute to the maturity of the body of knowledge on boundary conditions and buffers that cause team creativity to result in either positive or negative outcomes by: (i) summarising outcomes that have been studied into an organising framework; and (ii) conducting empirical research on the relationship between team creativity and a potential outcome.

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**RO4.1:** Summarise the empirical knowledge on the outcomes of team creativity, via a narrative review approach.

**RO4.2:** Construct an extension to an existing organising framework for antecedents of team creativity that have been the subject of empirical research to also incorporate a summary of outcomes of team creativity that have been the subject of empirical research.

**RO4.3:** Develop a conceptual model that can facilitate theorising on potential positive and negative outcomes of team creativity in an organisational context at the organisational, team and individual employee level.

**RO4.4:** Develop a detailed conceptual model linking team creativity to a potential outcome that has not yet been investigated empirically and formulate hypotheses based on this conceptual model.

**RO4.5:** Utilise non-experimental, hypothesis-testing research to evaluate the hypotheses that are generated based on the conceptual model developed in RO4.4. This includes: identifying appropriate data sources and data gathering mechanisms for each variable; gathering the data; and applying appropriate statistical analysis techniques to analyse the data and test the hypotheses.

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## 2.3 Document structure and methodology

As mentioned previously, this dissertation consists of a combination of published and unpublished articles and chapters that have been combined to form an overarching narrative. The document structure is set out in Table 2.2. As shown in the table, the document contains three published journal articles (Chapters 1, 3, and 6), one author original manuscript that has not yet been published (Chapter 7), and one substantive chapter (Chapter 5), in addition to bridging text that constitutes short chapters where the research is formally defined (Chapter 2), the narrative is bound together (Chapter 4), and a formal conclusion to the dissertation is provided (Chapter 8).



## 2.3 Document structure and methodology

Table 2.2: Document structure

Chapter	Chapter type	Chapter topic	Methodology
<b>Part I: Research rationale (RO1)</b>			
1	Published article	Objective 1	Develop rationale based on narrative literature review and synthesis.
2	Bridging text	Definition of research	Not applicable.
<b>Part II: Framework feasibility (RO2)</b>			
3	Published article	Objective 2.1	Inductively propose framework elements based on narrative literature review and synthesis.
4	Bridging text	Objective 2.2	Structured literature search and high-level classification of literature.
<b>Part III: Antecedents of team creativity (RO3)</b>			
5	Chapter	Objectives 3.1–3.3	Meta-analytic literature review of antecedents of team creativity.
<b>Part IV: Outcomes of team creativity (RO4)</b>			
6	Published article	Objectives 4.1–4.3	Literature review of outcomes of team creativity and conceptual model development incorporating meta-theory perspective.
7	Unpublished article	Objectives 4.4–4.5	Detailed conceptual model development and non-experimental hypothesis-testing research on a potential outcome of team creativity utilising a correlational design and multi-level structural equation modelling.
<b>Part V: Conclusion</b>			
8	Bridging text	Conclusion of research	Not applicable.

## 2.4 Research design

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A succinct description of the research methods utilised in each chapter is also given in Table 2.2. The methods are discussed in more detail within each chapter. Overarching philosophies that guided the selection of research methods are discussed in the following section.

### 2.4 Research design

A pragmatic research design is followed in this dissertation, with approaches that are deemed appropriate to answering each research objective being selected on a case-by-case basis, as evidenced by the “methodology” column in Table 2.2. As such, the research follows a mixed-methods design. There are, however, two overarching philosophies that guide the selection of research methods utilised to address each research objective.

The overarching philosophy that has been followed in this research is to utilise statistical analysis based on empirical data rather than narrative review or other more qualitative approaches whenever deemed feasible and appropriate. This does not reflect a belief that quantitative approaches are inherently superior to qualitative approaches, instead it reflects a personal preference. Furthermore, qualitative (narrative review) approaches significantly outnumber quantitative (meta-analytic review) approaches in the existing body of review literature on team creativity specifically and on creativity in general. Hence, utilising a quantitative approach when conducting reviews is deemed likely to make a more consequential contribution to the existing body of knowledge.

A second overarching philosophy that is applied in this research is to utilise meta-theory perspectives when developing conceptual models in order to anchor the theorising in well-established existing theoretical viewpoints. This approach is not only well-established in literature, but it is also deemed particularly useful as a framing mechanism to a candidate that does not have previous experience in theorising within the field of Organisational Behaviour.

At the outset of the research, narrative literature review approaches are followed to develop the rationale for the research and to inductively deduce the proposed framework elements. Such narrative review approaches are considered appropriate for these purposes and the narrative review format is also well suited to the secondary purpose of these chapters, namely to contextualise the research by providing an introductory overview of the relevant literature.

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## 2.5 Conclusion: Definition of the research

For the review of the existing knowledge on antecedents of team creativity, a meta-analytic review approach is deemed more appropriate than a narrative review approach, in line with the overarching philosophy applied in this research. It is deemed feasible to apply the meta-analytic approach in this instance due to the large body of empirical research that exists on the topic. The meta-analytic review approach is considered particularly useful in reviewing such a large body of literature as it is well-suited to resolving inconsistencies in previous findings utilising statistical methods.

For the review of the existing knowledge on outcomes of team creativity, a narrative review approach is followed because a meta-analytic review approach is deemed infeasible due to the small body of empirical research that exists on the topic.

A conceptual model is developed to assist with theorising on potential outcomes of team creativity that have not yet been investigated empirically. In line with the second overarching philosophy applied in this research, a meta-theory perspective is applied during the development of this conceptual model.

In order to make a contribution to the existing body of knowledge on the outcomes of team creativity, an empirical study approach is followed, in line with the overarching philosophy of preferring statistical analysis based on empirical data to more qualitative approaches, where appropriate. A detailed conceptual model is developed for the purpose of the empirical study on an outcome of team creativity. Once again, a meta-theory perspective is applied during the development of this conceptual model, in line with the second overarching philosophy applied in this research.

## 2.5 Conclusion: Definition of the research

The research was formally defined in this chapter through the articulation of research objectives and a salient delimitation of the research, and by describing the document structure and overarching research design. This chapter concludes Part I of the document which provided an introduction to the dissertation. Part II of the document is concerned with RO2, namely establishing the feasibility of developing a framework.

## **Part II**

# **Objective 2: The feasibility of developing a framework**

## Chapter 3

# Establishing feasibility: The anticipated scope of a framework

Position of Chapter 3 in dissertation structure.		
Chapter	Chapter type	Chapter topic
<b>Part I: Research rationale (RO1)</b>		
<b>Part II: Framework feasibility (RO2)</b>		
3	Published article	Objective 2.1: Inductively propose framework elements based on a narrative literature review and synthesis, thereby establishing whether the anticipated scope of a framework is feasible as the topic of a dissertation.
4	Bridging text	Objective 2.2: Draw a conclusion on the maturity of the body of knowledge that would underpin the development of a framework, thereby establishing the second aspect of the feasibility of developing a framework.
<b>Part III: Antecedents of team creativity (RO3)</b>		
<b>Part IV: Outcomes of team creativity (RO4)</b>		
<b>Part V: Conclusion</b>		

Part II of the dissertation is concerned with establishing the feasibility of developing a framework. As a first step towards establishing this feasibility, the scope of such a framework is established in this chapter by defining the elements of creativity that are recommended for inclusion in the framework. The chapter consists primarily of a article that was published in the South African Journal of Industrial Engineering, Volume 27, Number 2<sup>1</sup>.

<sup>1</sup>The primary supervisor, Professor PJ Vlok, is the co-author of the article ([Bam & Vlok \(2016\)](#)). The formal declaration of author contributions, as required for publications included in dissertations by Stellenbosch University, is provided in Appendix [A](#).

## 3.1 Framing the article

The research contained in this article and the subsequent text addresses RO2.1 by establishing the elements of creativity that are recommended for inclusion in a framework.

As discussed in Chapter 2, the delimitation to focus specifically on team creativity emerged as the research progressed, this development was driven by interim findings and a maturing understanding of the relevant literature. At the time that the article that is included in this chapter was published, this scope delimitation had not yet been defined. Furthermore, upon re-reading the article with a more mature understanding of the literature, a weak point of the article is the failure to clearly distinguish between different types of creativity, e.g. between individual-, team-, and organisational creativity throughout the text.

The term “organisational creativity” is frequently used in the article. As discussed in Section 2.1, organisational creativity is a function of both the creativity of individuals and teams within organisations and of contextual influences from complex social systems. As such, organisational creativity can be viewed as encapsulating team creativity, amongst other constructs.

### 3.1.1 Applying a complex adaptive systems perspective

According to [Ilgen et al. \(2005\)](#), researchers have conceptually “converged on a view of teams as complex, adaptive, dynamic systems”. From this perspective, teams exist in contexts where they interact both amongst themselves and with others over time and “(t)hese interactions change the teams, team members, and their environments in ways more complex than is captured by simple cause and effect perspectives” ([Ilgen et al., 2005](#)). This perspective of teams as complex adaptive systems necessitates an acknowledgement of the existence of feedback loops that influence team behaviours and outcomes over time and it is employed in this dissertation as it is considered to more accurately reflect reality than a simple cause and effect perspective.

In a review of literature on the inputs of team creativity, [Cirella et al. \(2014\)](#) state that knowledge on the topic is highly fragmented. The authors proceed to apply a complex adaptive systems perspective to map the available body of knowledge within a proposed framework. From [Cirella et al.'s 2014](#) complex adaptive systems perspective, team creativity “is perceived as the product of micro-social units within the context of macro-social

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### 3.2 RO2.1: SAJIE Vol.27(2), pp. 95–108

systems". *Cirella et al. (2014)* employ an interpretive model, developed by *Ilgen et al. (2005)*<sup>1</sup>, to conceptualise two layers of inputs that affect the outcome of team creativity. At the micro-social system layer, team creativity is viewed as an outcome that results from properties and behaviour belonging to both the team and the individual members of the team. At the macro-social level, the focus is on: "the properties that the environmental, organizational and social contexts should have to trigger creative behaviour and teamwork; and the properties and goals that managers should have so that the suitable conditions are created to establish creative teams, as well as for their work to be effective" (*Cirella et al., 2014*).

#### 3.1.2 Applicability of the article's findings to team creativity

In spite of the fact that the article that is presented in this chapter does not focus on team creativity specifically, the seven elements that are identified in the article are deemed to be equally applicable to team creativity as they are to organisational creativity. When a complex adaptive systems perspective is applied to team creativity, so that team creativity is understood as being a function not only of the properties and behaviour of the team and its individual members, but also of the properties of the environment within which teams operate, it is evident that this is the case.

### 3.2 RO2.1: SAJIE Vol.27(2), pp. 95–108

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<sup>1</sup>*Ilgen et al. (2005)* applied the complex adaptive systems perspective to team effectiveness to propose an input-mediator-output-input model that "explicitly invokes the notion of cyclical causal feedback". This input-mediator-output-input model can be viewed as an extension of the input-mediator-output model, also referred to as the input-process-output model, that is widely used in team research (*Hülshager et al., 2009*).

**TOWARDS A FRAMEWORK FOR SYSTEMIC CREATIVITY IN ENGINEERING ORGANISATIONS**L. Bam<sup>1\*</sup> & P.J. Vlok<sup>1</sup>**ARTICLE INFO****Article details**

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**ABSTRACT**

This article builds on earlier research that made the case for developing a framework to ensure increased, sustained, creative activity in engineering organisations. A milestone in the development of such a framework is the identification of the elements of creativity that need to be considered. This research reviews the literature on the systems perspective on creativity to identify seven elements of creativity that have been proposed in the literature. A literature review on each of these seven elements is presented to (i) determine whether the element should be included in the framework; (ii) define the element for the purpose of the framework; and (iii) determine whether any author proposes an aspect of creativity that cannot be accommodated under one of the seven elements as they have been defined here.

**OPSOMMING**

Hierdie artikel volg op vroeër navorsing wat 'n saak gemaak het vir die ontwikkeling van 'n raamwerk om verhoogde, volgehoue, kreatiewe aktiwiteit in ingenieursorganisasies te verseker. 'n Mylpaal in die ontwikkeling van so 'n raamwerk is die identifisering van die elemente van kreatiwiteit wat in ag geneem moet word. Hierdie navorsing hersien die literatuur oor die stelselperspektief op kreatiwiteit om sewe elemente van kreatiwiteit wat in die literatuur voorgestel word te identifiseer. 'n Literatuuroorsig van elkeen van hierdie sewe elemente word aangebied om (i) te bepaal of die element in die raamwerk ingesluit moet word; (ii) die element te definieer vir die doel van die raamwerk; en (iii) vas te stel of enige outeur 'n aspek van kreatiwiteit voorstel wat nie onder een van die sewe elemente soos wat hul hier definieer is bygewerk kan word nie.

**1 INTRODUCTION**

This article builds on earlier research [1] that made the case that (i) creativity plays a role throughout the engineering design process, and that it is possible to incorporate creativity into the engineering design process in a systematic manner; (ii) doing this at the very least, holds significant potential for economic benefit; and (iii) due to the complex interplay between creativity and the wide range of factors that influence it, organisational climates and management practices cannot simply be assumed to support creativity effectively. The article proposes that organisations should be managed proactively to support creativity in engineering design.

The earlier work has given rise to the following research question: Can a framework for systemically increasing and measuring creativity in engineering organisations be developed? A sub-research question that originates from this is: What are the key elements that should be taken into account when attempting to develop such a framework for engineering organisations? This sub-research question is the focus of this article.

The article starts with an exploration of the systems perspective on creativity in general, and on organisational creativity in particular, to identify seven elements of creativity defined by various



authors. At present, there is no literature explicitly linking these seven elements of creativity to engineering organisations. An overview of research findings on each of these seven elements is then presented to provide a more complete understanding of their functioning and of the complexities inherent in each. The findings of this literature review are considered to determine whether the seven elements that have been identified provide a sufficient basis for the development of a framework for systemic creativity in engineering organisations.

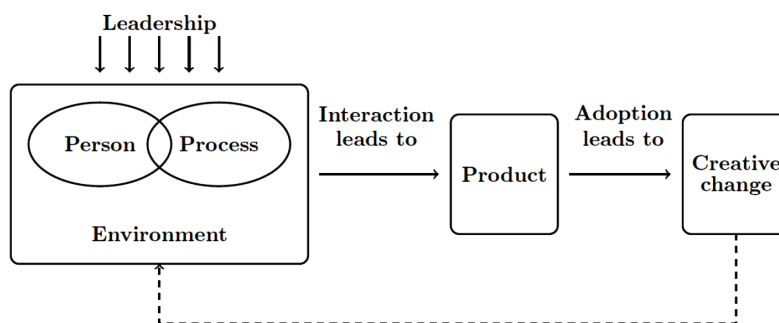


Figure 1: A systems model for understanding organisational creativity (adapted from Puccio & Cabra [2])

## 2 CONTEXTUALISATION: THE SYSTEMS PERSPECTIVE ON CREATIVITY

Puccio *et al.* [3] employed a systems perspective on creativity to generate the model to understand organisational creativity, shown in Figure 1. In the model, the person and the process interact within an environment and under the influence of leadership to produce a creative product. When this product is adopted it leads to creative change, which in turn has an influence on the person, the process, the environment, and the leadership. Research supports the appropriateness of a systems approach when considering organisational creativity [2]. According to Sawyer [4], a systems approach to studying creativity “combines individualist perspectives with analyses of the social organisation of creative fields, and the symbolic structure of creative domains.” In the model presented in Figure 1, Puccio *et al.* [3] identified the elements involved in organisational creativity as person, process, environment (also commonly referred to as “place” in the creativity literature), leadership, and product.

A second systems view model of creativity in general (rather than organisational creativity in particular) is presented in Figure 2. In an overview of the systems perspective on creativity, Moran [5] states that this is the most widely-used systems model of creativity. The model was originally developed by Csikszentmihalyi in 1988; an updated version is presented here [6]. The model defines three elements (individual, domain, and field) that interact to produce novelty (the creative product). As shown in Table 1, the ‘individual’ element can be understood to be equivalent to the ‘person’ element defined by Puccio *et al.* [3]. The ‘domain’ element refers to the cultural or symbolic environment within which the individual attempts to produce the creative product. In this case, it can be viewed as the first component of the ‘environment’ or ‘place’ element defined by Puccio *et al.* [3]. The field is defined by Csikszentmihalyi [6] as “the social organisation of the domain”. It can therefore be viewed as the second component of the ‘environment’ or ‘place’ element defined by Puccio *et al.* [3]. Csikszentmihalyi [6] describes the interaction between the individual, the domain, and the field to produce a creative product as follows: “What we call creativity is a phenomenon that is constructed through an interaction between producer and audience”. Though it is not explicitly portrayed in the model in Figure 2, Csikszentmihalyi [6] also defines persuasion (which forms part of the interaction between the producer and the audience) as a key element of creativity.

Citing a number of literature reviews, Moran [5] concludes that “the creativity research community has settled on studying creativity based on four components, often referred to as the ‘four Ps’: person, process, press and product”. These four elements of creativity were originally defined by Rhodes [7] as process, product, personality (or person), and place. More recently, Runco [8] proposed the ‘six P’ framework, including persuasion and potential as elements of creativity. Kozbelt *et al.* [9] use the “six Ps of creativity” framework to define the aspects of creativity that have been

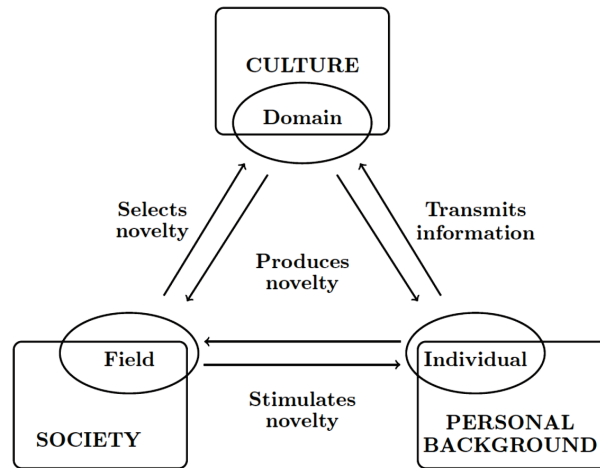


Figure 2: A systems view of creativity (reproduced from Csikszentmihalyi [6])

considered by various theories of creativity since 1926. Table 1 compares the elements of organisational creativity as identified by both Puccio *et al.* [3] and Csikszentmihalyi [6], with both the four Ps and the six Ps. As shown, the original four Ps correspond directly with four of the five elements identified by Puccio *et al.* [3], and with three of the four elements identified by Csikszentmihalyi [6]. The ‘persuasion’ element is identified by both Runco [8] and Csikszentmihalyi [6], while the ‘potential’ and ‘leadership’ elements are only proposed by one author each.

In this article, the literature on each of the seven elements will be presented, synthesised, and discussed with the aim of identifying the key factors that need to be taken into account when attempting to develop a framework for increasing systemic creativity in engineering organisations. Though each of the seven elements presented in Table 1 will be explored, emphasis will be placed on the four elements that are common to at least three of the perspectives presented. Except for the leadership element, all other elements will be referred to, using the ‘six P’ naming convention.

Table 1: Perspectives on the elements of creativity

<i>Systems model of organisational creativity [3]</i>	<i>Systems model of creativity [6]</i>	<i>Four Ps [5]</i>	<i>Six P framework [8]</i>
Person	Individual	Person	Personality
Process		Process	Process
Environment	Domain & Field	Press	Place
Product	Novelty	Product	Product
Leadership			
	Persuasion		Persuasion
			Potential

### 3 THE SEVEN ELEMENTS

#### 3.1 The ‘person’ element of organisational creativity

Puccio and Cabra [2] state that the person element in Figure 1 refers to “individual skills, background, experience, personality, knowledge, motivation and so forth”. This description implies that the person element is intended to represent a single individual, or collection of individuals, executing the creative activity.

Engineering projects are often too large in scale or multi-disciplinary in nature for an individual to design the solution in isolation. Teamwork is therefore a characteristic feature of engineering organisations. If one were simply to consider these teams as consisting of a collection of individuals (and by implication, a collection of skills, background, experience, personality, etc.) one would be neglecting to consider the effect of the social dynamics inherent in team work.

In an overview of the literature on individual and group creativity, Sawyer [4] described the basic question of creativity research as follows: “What is the best scientific explanation of how new things are created?” From this basic question, he derived the applied question: “How can we use these explanations to provide advice to people, groups, and organisations about how to increase their ability to generate new and useful things?” Sawyer [4] proposes that there are three potential solutions to this applied question, each taking a different perspective on group and individual creativity:

1. The individual explanation takes the perspective that creativity is most effectively described in terms of the mental states, behaviours, and personality traits of each of the individuals involved in the creative act;
2. The collective explanation works from the assumption that creative activity is best described in terms of social and cultural contexts and in terms of group dynamics;
3. As one can conclude from the name, the hybrid explanation proposes that one should consider both the properties of the individuals involved and those of the group to explain creativity scientifically.

Sawyer [4] supports the hybrid explanation approach, proposing that “the best scientific explanations of creativity will involve multiple levels of analysis: They will incorporate properties and laws associated with individuals and with groups”. An example of a theory of creativity that is based on a hybrid approach is the concept of distributed creativity, which proposes that complex social systems generate the novelty that is associated with creativity [10]. The concept of distributed creativity is based on complexity theory, and it requires a detailed explanation of both psychological and social mechanisms to explain creativity. Finally, Sawyer [4] takes the perspective that each case of creativity is unique, with either the individual-level explanation or the group-level explanation being more significant, depending on the circumstances. Sawyer [4] proceeds to propose a framework – collaborative emergence – that can be used to analyse a specific instance of creativity to determine the relative importance of individual-level and group-level explanations.

From the preceding discussion, it is clear that a framework for incorporating creativity into engineering organisations would need to consider both (i) the individual members of the engineering teams or groups, and (ii) the dynamics of the teams and groups themselves (including their social and cultural context).

### 3.1.1 *Individuals in an organisational context*

A large portion of early creativity research was dedicated to determining the factors that set creative individuals apart [2]. A few of the prominent findings are summarised here:

- **The role of motivation:** Sternberg and Kaufman [11] state that “creativity is as much attitudinal as it is cognitive”. An individual’s motivation towards a task can be classified as (i) no motivation, (ii) intrinsic motivation (i.e., pursuing a task purely for the sake of the satisfaction associated with the task), or (iii) extrinsic motivation (i.e., pursuing a task with a focus on expected rewards that are external to the task). Research has highlighted the importance of intrinsic motivation in encouraging creative activity ([12], [2]). Though the impact of external rewards on an individual’s creativity has received significant research attention, Shalley *et al.* state that “there is little agreement among scholars concerning the likely direction of the effects of such rewards” [13]. More recently, prominent researchers have reviewed earlier research to conclude that, under specific conditions, extrinsic motivation can serve to support intrinsic motivation, thereby positively influencing creative activity [2]. The componential model of creative activity [14] gives motivation as one of the three necessary components that must be present for individual creativity to take place.
- **The impact of intelligence:** Several studies have concluded that creativity and intelligence have low correlations. Some prominent authors have supported a ‘threshold theory’ of intelligence, which states that above a threshold IQ value of 120, intelligence has no influence on creativity; however several studies have found little or no evidence to support this theory [15]. It is therefore valid to work from the assumption that creativity and intelligence are two separate constructs. Though intelligence can be safely left out of consideration, the componential model of creativity [14] gives domain-relevant skills as the second of the three necessary components for individual creativity. Domain relevant skills refer to “knowledge, technical skills and special talents” associated with an individual’s field of work [2].

- **The influence of personality:** Research shows that personality influences creativity. For example, a person whose personality makes them unwilling to take a risk or defy conventions may never successfully translate their creative potential into creative activity [11]. Research on the influence of personality has identified specific traits that either enable or disable creativity. Feist [16] organised these traits into four groups: cognitive, social, motivational-affective, and clinical traits. The componential model of creativity [14] gives creativity-relevant skills (such as nonconformity, suspending judgement, perseverance, and self-discipline – ‘skills’ that are closely associated with personality) as the third and final necessary component for individual creativity.

In addition to the role of personal characteristics such as personality and intelligence, social and contextual factors are widely recognised to have an impact on individual creativity. Factors that have been researched to determine their impact on individual creativity include: goal setting ([17], [13]), the expectation of evaluation ([17], [13]), feedback from co-workers [18] or from supervisors [19], perceived organisational support for creativity [18], supervisor close monitoring [19], social relationships [20], and job complexity [21].

In closing, research on the role of bilingualism and multicultural experiences is briefly presented here. This research is particularly relevant when considering creative activity within the South African context.

- **The role of bilingualism:** Bilingualism is hypothesised to enhance creativity because of how bilingual individuals ‘double code’ concepts in their memory [22]. Each language in which an individual is proficient therefore provides subtly different perspectives on the same concept. This is hypothesised (i) to facilitate associations and blends of different concepts; and (ii) to enhance mental flexibility [22].
- **The influence of multicultural experiences:** Leung and Maddux [23] found that exposure to different cultures enhances creative activity. The hypothesis is that this benefit derives from an exposure to (i) knowledge about new or diverse ideas; and (ii) different patterns of thought and action. This allows individuals to overcome their own cultural habits, leaves them open to new experiences, makes them more likely to seek information from unfamiliar sources, and encourages a tendency to synthesise diverse ideas.

### 3.1.2 Groups and teams in an organisational context

Paulus *et al.* [24] state that “the overwhelming thrust of the literature on groups is that groups are bad for creativity”. In fact, in summarising the literature on brainstorming in groups, Paulus *et al.* [24] state that groups are consistently found to “generate fewer ideas and fewer high-quality ideas compared with individual ideation conditions”. In contrast to this, the literature tends to agree that *teams* can have a “positive impact on productivity and innovation” [24] under the right conditions. Teams are differentiated from groups by factors such as [24]: (i) the length of their existence (teams exist for a longer period of time than groups); (ii) their definition of the roles that are to be fulfilled by each member (in teams, these roles are more formally defined); (iii) the formalisation of the goal that they are working towards (for teams, the goal is more formalised); and (iv) the extent to which they operate as part of a larger organisation (this is more often the case for teams than for groups).

Explanations for the poor creative performance of groups include [24]: (i) the phenomenon of groupthink and other factors that may contribute to inhibit group members from sharing thoughts that go against the dominant train of thought; (ii) social interference or production blocking where the constraints of sharing ideas one at a time leads to lost productivity and the potential loss of creative ideas that cannot be expressed immediately; and (iii) the influence of group members’ performance on one another; as group performance generally tends to be low, this may influence individual group members to lower their own performance. Explanations for the innovative potential of teams include [24]: (i) the motivating role of belonging to a team, especially if that team has a significant amount of autonomy; and (ii) the ability to draw on diverse sets of skills and knowledge in developing ideas.

Similar to individual creativity, a variety of social and contextual factors such as diversity, conflict, and the degree to which the environment is perceived to be emotionally supportive are understood to influence team or group creativity [25]. Many researchers have investigated the specific conditions that are conducive to creative productivity in teams. Based on a meta-analysis, Hülsheger *et al.* [26] conclude that the following team process variables have the most significant impact: (i)

communication (this links to the impact of social relationships on individual creativity); (ii) vision (this links to the impact of motivation and goal-setting on individual creativity, and to the role of leadership in team creativity); (iii) support for innovation (this links to aspects of the ‘place’ element of organisational creativity discussed in Section 3.3); (iv) task orientation (this links to the impact of motivation and feedback on individual creativity); and (v) cohesion (this links to the impact of an emotionally-supportive environment). Team input variables such as (i) goal interdependence, (ii) job-relevant diversity, and (iii) team size are also found to play a lesser role [26].

Paulus *et al.* [24] observe that group creativity research has focused on idea-generation, while team creativity research has focused on innovation (thus, on the implementation of creative ideas). When considering this observation, it is interesting to note the proposal that innovation is “a two-component, nonlinear process encompassing both creativity and innovation implementation” [27]. Furthermore, West *et al.* [27] propose that the innovation process is cyclical, and that there is a greater need for creativity during the early stages of the innovation process.

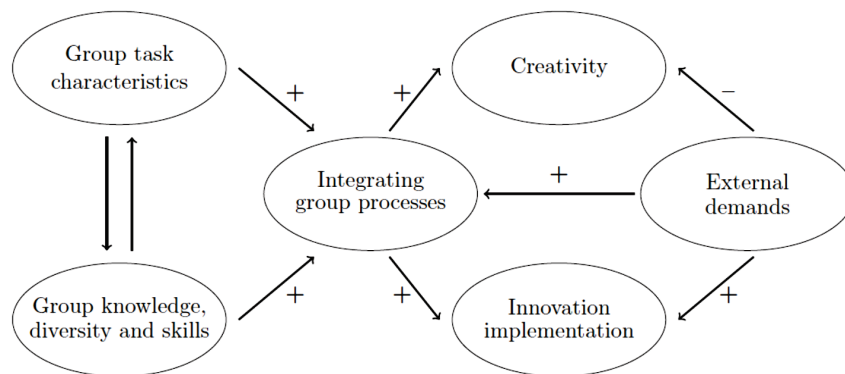


Figure 3: A model of creativity and innovation in work teams (adapted from West *et al.* [27])

West *et al.* [27] state that three themes dominate the research on creativity and innovation in work teams. They then propose that a fourth theme, the influence of external demands, should also be added to the themes being investigated. Each of these research themes can be understood to represent an element of work team creativity. Figure 3 depicts the manner in which West *et al.* [27] propose that each of the key elements influences both creativity and innovation implementation. Each of the four elements is briefly described:

- **Group task characteristics:** includes the importance and the difficulty of the task or goal;
- **Group knowledge, diversity, and skills:** refers to the diversity of the characteristics, knowledge, and skills of the team members;
- **Integrating group processes:** refers to the team processes that facilitate collaboration described earlier in this section; and
- **External demands:** refers to the context in which the work team operates, and includes the organisational climate and the market environment (the ‘place’ element of organisational creativity is described more fully in Section 3.3).

While the importance and difficulty of the group task, the diversity of knowledge and skills in the team, and integrating group processes all have a positive influence on both creativity and innovation implementation, West *et al.* [27] propose that external demands have opposite effects on creativity and innovation respectively, with increased external demands negatively influencing creativity and positively influencing innovation.

Finally, Hargadon and Bechky [28] propose that, at times, “the locus of creative problem solving shifts... from the individual to the interaction of collectives”. This perspective takes the teamwork perspective on creativity a step further, moving the focus from “the group and organizational variables that make up the *ongoing* context for creativity” to “the fleeting coincidence of behaviors that triggers *moments* when creative insights emerge” [28] to propose that creative insights are, at times, the result of team-level creative synergy that takes place at the collective level.

### 3.2 The ‘process’ element of organisational creativity

Puccio and Cabra [2] define the process element in Figure 1 as “the stages of thought people engage in when working alone or with others to creatively address predicaments and opportunities at work”.

Divergent thinking is the mental process that is most widely associated with creative thinking [29]. Sternberg and Kaufman [11] define divergent thinking as the “open-ended generation of ideas in response to some kind of task or stimulus”. In a work that is still cited in contemporary creativity literature, Sternberg and Davidson [30] define the three most important processes in creative thinking as:

- **Selective encoding:** the process of discerning between relevant and irrelevant information;
- **Selective combination:** described by Sternberg and Kaufman [11] as the process of “combining what might originally seem to be isolated pieces of information into a unified whole that may or may not resemble its parts”; and
- **Selective comparison:** the process of relating newly-acquired information to existing information.

Various researchers have developed methodologies that are intended to provide structured mechanisms for employing creative thinking processes in organisations. Puccio and Cabra [2] define the most prominent methodologies as:

- **Creative problem-solving:** the method defines a number of steps in the problem-solving process; these steps are designed to mirror an individual’s natural problem-solving process [2]. Each step starts with a divergent phase, where a large number of potential solutions are developed, before proceeding to a convergent phase where the most promising solutions are identified and developed in more detail. The methodology also includes one metacognitive step, called ‘assessing the situation’, to help users determine where to start applying the methodology to their particular problem-solving situation.
- **de Bono techniques:** de Bono has designed a number of methods to train individuals to think more creatively. Examples include the concept of lateral thinking that “involves deliberate mental efforts to change more automatic or habitual responses that have been shaped through perceptual frameworks” [31], and the ‘six thinking hats’, described as “direction labels for thinking” [32]. The methods are based on the principle that individuals can be trained to be creative, and the “practical and effective application” [31] of the methods is strongly emphasised.
- **Appreciative inquiry:** this methodology works from the perspective that it is easier to develop the positive further [2]. The methodology is concerned with developing the organisation and sustaining high performance levels. Similar to the creative problem-solving methodology, appreciative inquiry defines a number of steps that are to be followed, with the first step identifying organisational practices that are working well (hence the positive approach).
- **Design thinking:** this methodology also comprises a number of steps that are to be followed in the creative process. The emphasis is on thoroughly understanding the user (of the product of creativity) and how the user interacts with the product to identify further opportunities for innovation [2].
- **Synectics:** this methodology is based on the perspective that creative individuals engage in non-rational, free-thinking thought patterns [2]. Synectics seeks to formalise this way of thinking by encouraging users to engage in a number of different metaphors such as personal analogy (the individual imagines themselves as the problem) or fantasy analogy (the individual imagines the most outrageous, perfect solution and then works towards something more feasible from this starting point).
- **TRIZ / theory of inventive problem-solving:** The methodology is based on “objective and repeatable engineering principles and practices” [2]. It originated in the 1940s, and was developed by analysing thousands of patents and identifying patterns among these inventions. From the analysis, 40 principles of invention were identified. The “principles are intended to enable individuals to resolve engineering contradictions that are at the essence of the problem” [2]. The 40 principles are incorporated into a methodology that guides users through the process of selecting the most appropriate principle to apply to the problem being considered.

### 3.3 The ‘place’ element of organisational creativity

*“... there is a road to be travelled from simply talking about creativity or the potential for creativity to real, functionally creative products. What has changed the world is not merely the potential for creativity, but creativity as manifested in functional products. A constraint on creative products however, is that there are many environmental factors that can make it more or less difficult to translate creative ideas into functionally creative products” [11].*

Csikszentmihalyi [6] defines the ‘field’ element in Figure 2 as the social environment, and the ‘domain’ element as the culture within which creative activity takes place. Puccio and Cabra [2] define the ‘place’ element in Figure 1 as referring to both the psychological and the physical environment in which an individual or a team works. Though a large number of researchers have attempted to define specific environmental conditions that are conducive to creative activity, Hoff [33] proposes that, of the four Ps of creativity, the ‘place’ element has received the least research attention. Various measures to evaluate the organisational environment have been developed. Most notable are the KEYS measure developed by Amabile *et al.* [34] to “evaluate the factors perceived as stimulants or obstacles to creativity in organizational work environments” [35], the Creative Climate Questionnaire developed by Ekvall [36], and the Team Climate Inventory developed by Anderson and West [37].

Hoff [33] distinguishes broadly between the impact of the cultural and psychosocial environment on creativity and the impact of the physical environment on creativity. Puccio and Cabra [2] distinguish between the following aspects of the ‘place’ element of organisational creativity:

- **The organisational culture:** refers to the “beliefs and values held by management and communicated to employees through norms, stories, socialization processes, and observations of managerial responses to critical events” [38];
- **The organisational structure:** refers to the hierarchy within an organisation; it includes lines of authority and responsibility [2];
- **The organisational climate:** the term is often used interchangeably with organisational culture. However, Tesluk [38] explains that the organisational climate is shaped by both the organisational culture and the organisational structure, and that it communicates “both the organization’s goals regarding creativity and the means to achieve those goals” [38] to employees;
- **The physical space** (within the context of organisational creativity): refers to the physical work environment (typically the office or laboratory space) and the way in which it is configured and decorated;
- **The external environment:** refers to external forces that exert an influence on the organisation, including financial market conditions, political or social systems, and technological developments [2]; and
- **The national culture:** this has been shown to have a significant impact on creativity. National cultures have a strong influence on individuals’ psychological make-up, which in turn influences their creative activity; specific management styles lead to different results in different cultures; and geopolitical circumstances have also been shown to influence creative activity. Simonton [39] found that societies that are located at the intersection of various cultures have a higher creative output, while research by both Simonton [39] and Therivel [40] shows that a division of political power (i.e., more than one political power or entity) is beneficial to creative activity.

### 3.4 The ‘product’ element of organisational creativity

*“In the world many of us imagine when we first start thinking about creativity and its role in society, the more creative a contribution is, the more it is welcomed. In fact, though, the opposite is often the case. Creative contributions defy the crowd and hence are discouraged, sometimes actively. The more creative a contribution is, the more likely it is to engender resentment and opposition” [11].*

Within the context of an organisation, the creative product can take the form of a new process, a new business strategy, a new product that the organisation can market, or any other novel, useful

contribution to the operation of the organisation. According to Sternberg *et al.* [41], eight types of creative products can be defined<sup>1</sup>:

- **Replication:** a contribution that confirms that the field is in the right place;
- **Redefinition:** a contribution that attempts to “redefine where the field is” [11];
- **Forward incrementation:** a contribution that attempts to “move the field forward in the direction it is already going” [11];
- **Advance forward incrementation:** a forward incrementation that attempts to move the field “beyond where others are ready for it to go” [11];
- **Redirection:** a contribution that attempts to direct the field “toward a different direction” [11];
- **Reconstruction/redirection:** a contribution that requires a backward motion before redirecting the field;
- **Reinitiation:** a contribution that attempts to move the field to a new starting point; and
- **Synthesis:** a contribution that attempts “to meld together or otherwise synthesise different existing paradigms and merge them into a new one” [11].

The definition of creative product types in relation to an ‘existing pattern’ is central to the systems view of creativity proposed by Csikszentmihalyi [6], who uses this as motivation for the inclusion of the ‘domain’ element in the systems view of creativity.

Csikszentmihalyi [6] places a strong focus on the role of society in determining whether a product is in fact creative: “Creativity is not the product of single individuals, but of social systems making judgements about individuals’ products”. Though the topic has not received a significant amount of attention, a number of researchers have investigated the evaluation of creative products. According to Kwon *et al.* [42], the three most widely-used measures of product creativity are:

- **The consensual assessment technique** [43]: This technique involves the creation of a specific type of creative product by a group of participants. The creativity of the products is then evaluated by a group of judges who are deemed to have expertise in the type of product. The judges are given minimal guidance on how they should judge the creativity of the product, and they are also not asked to explain or defend their evaluation method [44]. Therefore, the consensual assessment technique suggests that the best assessment of creativity is the combined, subjective opinion of a number of experts in a particular field. The validity of the consensual assessment technique has been confirmed by large a number of studies [45].
- **The creative product semantic scale** ([46], [47]; [48], [49]): This is an assessment instrument that uses a structured questionnaire to analyse a product’s creativity. Three main factors: (i) novelty (including consideration of new materials, new processes, new concepts, etc.), (ii) resolution (i.e., how well the product serves its intended purpose), and (iii) elaboration and synthesis, also known as style (i.e., how well/elegantly the product concept is realised), are assessed. Each of the three main factors is divided into a further nine categories, and a total of 55 adjective pairs (for which a user selects a rating on a 7-point scale) are used in the assessment.
- **The product creativity model** [50]: The tool is designed to measure product creativity from the consumer’s perspective. Three aspects of product creativity are analysed: (i) attribute (defined as the perception of product creativity, and based on the creative product semantic scale (CPSS) assessment described previously); (ii) affect (defined as the emotional impact of product creativity, measured in terms of the pleasure and arousal that it generates in the judge – i.e., the consumer); and (iii) preference (this evaluates the consumer’s interest in creativity as well as the importance of creativity to the consumer). Like the CPSS, 41 adjective pairs are answered using a 7-point Likert scale.

As a closing thought on the evaluation of creative products, recent research has highlighted the influence of cultural perspectives on defining and valuing creative products [51]. Lan and Kaufman [51] found that, while the explicit beliefs about creativity of the American and Chinese cultures share many similarities, there is some divergence when it comes to their implicit beliefs about creativity. As an example, while Americans attach a large amount of value to novelty (a ground-

<sup>1</sup> The definitions given here use the term ‘field’; the term is also used in Figure 2. However, the term ‘field’ as used by Sternberg and Kaufman [11] is equivalent to the term ‘domain’ used by Csikszentmihalyi [6] in Figure 2, not to the term ‘field’ as used in this figure.



breaking concept, for example), the Chinese tend to show a greater appreciation for creativity within constraints (for an existing concept that has been re-imagined, for example) [51].

### 3.5 The influence of leadership on organisational creativity

*“... leadership behaviour has emerged as the [sic] one of the most potent variables in predicting creativity in teams and organisation” [2].*

There is a wealth of literature on the impact of leadership on organisational creativity. One perspective is that leadership has a strong influence on the work environment, and therefore on the ‘place’ element of organisational creativity [2]. Recent research by Hill *et al.* [52] supports this perspective by proposing that the central task that a leader must fulfil, if an organisation is to be innovative, is not to create or to sell a vision, but rather to create an organisational context that supports innovation.

A second perspective, suggested by Puccio *et al.* [3], is that the link between leadership and creativity is change [2]. As illustrated in Figure 1, organisational creativity culminates in change – whether it be social change, personal change, innovation, or whatever. According to Puccio *et al.* [3], leaders often need to act as the catalyst for change in an organisational context [2].

A third perspective is that leadership has a significant influence on the ‘person’ element of organisational creativity. In relation to leadership style, many researchers have found that transformational leadership in particular has a positive impact on organisational creativity ([53], [54], [55], [56]). Transformational leadership has four key characteristics [57]: charisma (providing vision and mission); inspiration (communicating high expectations); intellectual stimulation (promoting intelligence and careful problem solving); and individualised consideration (treating each employee individually). Transformational leadership is understood to influence individuals’ creativity through psychological empowerment [58]. This is enacted through a wide variety of mechanisms, including: encouraging individuals to take risks, thereby encouraging divergent thinking [56]; assuring individuals that their ideas are valued, thereby encouraging them to voice creative ideas [56]; and increasing motivation [59]. Shin *et al.* [59] argue that “among the team contextual factors, leadership plays the dominant role in workplaces”. From the aforementioned, it is evident that leadership is understood to have an impact on the holistic understanding of the ‘person’ element (as it has been defined in this article), incorporating both the individual and the team or group in the organisational context.

Some interesting findings on the relationship between transformational leadership and creativity include the following:

- Gumusluoglu and Ilsev [58] found that there is a relationship between transformational leadership and an organisation’s level of innovation;
- Wang and Rode [60] found that the relationship between transformational leadership and employee creativity was only significant when the employee identified with the leader, and when there was an innovative work climate;
- Shin *et al.* [59] found that “cognitive team diversity was positively related to individual creativity only when transformational leadership was high”; and
- Of particular interest to engineering organisations where work is performed by multi-disciplinary teams, Shin and Zhou [54] found that there is an interaction between the educational diversity of team members and transformational leadership, with team creativity increasing when both variables are present.

### 3.6 The persuasion element of organisational creativity

The persuasion element of creativity was defined by Simonton [61]. It refers to the phenomenon of creative individuals changing the way that those around them think, thus influencing the creative product that is produced [9].

In his systems view model of creativity, Csikszentmihalyi [6] offers a different perspective on persuasion. His model emphasises the role of society (or the ‘audience’) in determining whether a product is perceived as creative. He argues [6] that, by implication, persuasion to convince the audience that a product is creative plays a central role in the existence of creativity.

### 3.7 The 'potential' element of organisational creativity

The 'potential' element of creativity was defined by Runco [62] specifically in an educational context. Here, it is argued, a clear distinction should be made between "unambiguous creative performance" and creative potential [62]. Subsequently, Runco [63] suggested that adding 'potential' to the six P model allows the model to be re-organised, with one branch of it focusing on creative performance and the other on creative potential. The creative performance branch incorporates the 'product' and 'persuasion' elements of creativity, as well as any other unambiguous manifestations of creativity. In contrast, the creative potential branch incorporates the 'person' and 'place' elements, as well as any other perspective that "appreciates yet unfulfilled possibilities and subjective processes" [9]. The creative potential branch can also be understood to incorporate the 'process' element.

## 4 SYNTHESIS

The 'person' element of creativity should be understood to refer to both the individuals involved in the creative activity and the group or team involved. Both the systems view model, developed by Csikszentmihalyi [6], and the six P framework define 'persuasion' as a distinct element of creativity. However, it could be argued that, in a framework that takes an organisational perspective, and where the 'person' element is defined as encompassing both the individual involved in the creative activity and the social dynamics of the group or team involved, 'persuasion' can be viewed as part of the 'person' element. An individual's ability to persuade can be linked to that individual's personality, and even their domain-relevant skills, while the influence of the persuasive ability on the rest of the group or team is considered as part of the social dynamics involved in group or team work.

The literature points to strong links between the 'leadership', 'place', and 'person' elements of creativity. It has been proposed that the significant impact of leadership on creativity can (at least in part) be ascribed to the large influence that leadership has on both the 'place' and the 'person' elements.

The 'potential' element of creativity was developed for use specifically in an educational environment. It is primarily concerned with validating creative potential (as opposed to actualised creative productivity). The primary objective of a framework for systemic creativity in engineering organisations would be to translate the creative potential that is present in an organisation to actual creative productivity in a sustainable manner. The literature proposes that the 'potential' element of creativity can be understood to incorporate the 'person', 'place', and 'process' elements of creativity.

## 5 CONCLUSION

From a synthesis of two systems-view models of creativity and the four P and the six P definitions of the aspects of creativity, seven elements of creativity that have been defined by various authors were identified: the person, process, place, product, the influence of leadership, persuasion, and potential. The literature on each of these elements was presented in an attempt to provide a more complete understanding of their functioning and of the complexities inherent in each. This literature overview has also served to define the scope of each of the elements in order to develop a framework for systemic creativity in engineering organisations.

The seven elements that were investigated were identified based on an investigation of several sources in the review literature. The literature presented on each of the elements was the result of a thorough investigation of the literature on creativity. Though there are undoubtedly multiple alternative suggestions for the elements of creativity in the literature, none of the literature that was investigated throughout the course of this research described any facet of creativity that could not be accommodated under the seven elements of creativity as they have been defined here. It is therefore proposed that the seven elements that have been defined in this study form a sufficient basis for the development of a framework for systemic creativity in engineering organisations.

Furthermore, as argued in Section 4, it is proposed that the 'persuasion' element could also be included under the 'person' element in the way that it has been defined here; and that the

‘potential’ element could either be viewed as a distinct component, or it could be understood as part of the ‘person’, ‘place’, and ‘process’ elements.

This study has answered the sub-research question: What are the key elements that should be taken into account when attempting to develop a framework for systemic creativity in engineering organisations? In doing so, it has mapped the solution space for a framework for systemic creativity in engineering organisations, and so has made progress towards answering the main research question: Can a framework for systemically increasing and measuring creativity in engineering organisations be developed?

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### 3.3 Conclusion: The scope of a framework

### 3.3 Conclusion: The scope of a framework

The article contained in this chapter comprised primarily of a narrative literature review. Based on this literature review, the seven elements of a framework were proposed and defined in sufficient detail to confirm that the development of such a framework would be feasible for a PhD study. In the following chapter, the second element of feasibility is considered, namely whether the available body of knowledge is sufficiently mature to support the development of a framework.

## Chapter 4

# Establishing feasibility: The available body of knowledge

Position of Chapter 4 in dissertation structure.		
Chapter	Chapter type	Chapter topic
<b>Part I: Research rationale (RO1)</b>		
<b>Part II: Framework feasibility (RO2)</b>		
3	Published article	Objective 2.1: Inductively propose framework elements based on a narrative literature review and synthesis, thereby establishing whether the anticipated scope of a framework is feasible as the topic of a dissertation.
4	Bridging text	Objective 2.2: Draw a conclusion on the maturity of the body of knowledge that would underpin the development of a framework, thereby establishing the second aspect of the feasibility of developing a framework.
<b>Part III: Antecedents of team creativity (RO3)</b>		
<b>Part IV: Outcomes of team creativity (RO4)</b>		
<b>Part V: Conclusion</b>		

In this second chapter of Part II of the dissertation, the feasibility of developing a framework is further explored. As a first step towards establishing feasibility, the anticipated scope of such a framework was established in the previous chapter by proposing the framework elements. In this chapter, a second element of feasibility is considered, namely the availability of empirical knowledge on: the antecedents of team creativity; and the outcomes of team creativity. RO2.2 is therefore addressed in this chapter.

An important aspect of a framework for managing creativity in engineering organisation, is an understanding of how to increase creative activity in these organisation. Specific

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#### 4.1 High-level literature overview: Antecedents and outcomes

antecedents have been identified as either supporting or decreasing team creativity. In addition, boundary conditions that influence the relationship between certain antecedents and team creativity have also been identified in literature. One aspect of the objective of this chapter, is to determine whether there is a sufficient body of empirical knowledge on antecedents of team creativity to inform the development of a framework.

Furthermore, as described in Section 2.1, a key perspective in this research is that creativity in itself is not a meaningful outcome for an organisation to pursue. Rather, organisations are expected to be interested in pursuing positive outcomes that may result from increased creativity, such as increased innovation, improved financial performance, or improved job satisfaction. Consequently, a framework that advises organisations to engage in specific activities that encourage team creativity should also incorporate advise on boundary conditions that are likely to channel this team creativity towards meaningful positive outcomes. Conversely, it is plausible that creativity may also lead to negative outcomes. If this were the case, it would be important to understand the boundary conditions under which this is more likely to happen so that a framework could also incorporate information on boundary conditions that increase the risk of negative outcomes resulting from such increased team creativity. The second aspect of the objective of this chapter is therefore to determine whether there is a sufficient body of empirical knowledge on outcomes of team creativity to inform the development of a framework.

The chapter does not contain an article, but rather consists of bridging text that serves the purpose of binding the narrative of the dissertation together. As such, the chapter is more limited in scope and represents a significantly smaller contribution than the substantive chapter or those that contain articles.

#### 4.1 High-level literature overview: Antecedents and outcomes

From initial ad-hoc reading on the topic, no generalised search terms that could be used to classify literature as positioning team creativity as either an outcome or input in empirical studies could be identified. Consequently, a more general search of literature was performed, followed by a manual classification process. More specifically, a Scopus search was performed for the term “team creativity”. This search uncovered 249 research products, as these research products mainly constituted journal or conference articles, these are



#### 4.1 High-level literature overview: Antecedents and outcomes

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simply referred to as “articles” in the remainder of the document. The abstracts of these articles were reviewed and the articles were classified into one of five categories:

- Empirical research where team creativity is (one of) the *outcome* variable(s) being studied (i.e. research that contributes to empirical knowledge on *antecedents* that influence team creativity);
- Conceptual research where team creativity is (one of) the *outcome* variable(s) being studied (i.e. research that makes a conceptual contribution to understanding *antecedents* that are likely to influence team creativity);
- Empirical research where team creativity is (one of) the *input* variable(s) being studied (i.e. research that contributes to empirical knowledge on *outcomes* of team creativity);
- Conceptual research where team creativity is (one of) the *input* variable(s) being studied (i.e. research that makes a conceptual contribution to understanding *outcomes* of team creativity); and
- Research that does not fall into one of the aforementioned categories.

The results of this high-level literature overview are summarised in Figure 4.1<sup>1</sup>. In the remainder of this chapter, the maturity of the body of knowledge on antecedents and outcomes of team creativity, respectively, is considered.

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<sup>1</sup>For one of the 249 articles uncovered via the Scopus search described, neither the abstract nor the full article could be accessed, this article was therefore not classified as falling into one of the five categories defined. Though all of the articles that contained empirical research also contained conceptual contributions, these were placed in the empirical research categories.

## 4.2 The body of knowledge on antecedents

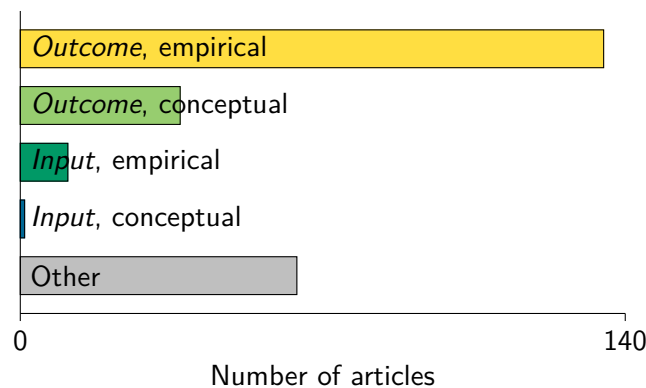


Figure 4.1: Number of articles on different aspects of team creativity.

## 4.2 The body of knowledge on antecedents

As illustrated in Figure 4.1, the vast majority of literature uncovered in this initial high-level overview of research on the topic of team creativity has been concerned with empirically researching antecedents that influence the outcome of team creativity. The large number of empirical studies on the topic (135 of the 248 articles that were classified fell into this category), is an initial indication that the body of knowledge on the antecedents that influence team creativity as an outcome may be sufficient to inform the development of a framework. In the remainder of this chapter, the scope of this body of knowledge will be probed.

### 4.2.1 A typology of the available body of knowledge on antecedents

A typology of antecedents of team creativity can be derived from the organising framework for the body of knowledge on the antecedents that impact the outcome of team creativity developed by [Cirella et al. \(2014\)](#). This typology is depicted in Figure 4.2. This typology is a useful mechanism for conceptualising the antecedents of team creativity from the complex adaptive systems perspective which was introduced in Section 3.1.1. In line with the complex adaptive systems perspective, the typology incorporates both properties and dynamics of the micro-social system and properties of the macro-social system.

The properties of the micro-social system category is further divided into team inputs and team mediators. Team inputs include both: characteristics of the individual team members, such as the “diversity and combination of individuals with different characteristics”; and team-level inputs, such as the resources that are available to the team ([Cirella et al.](#),

## 4.2 The body of knowledge on antecedents

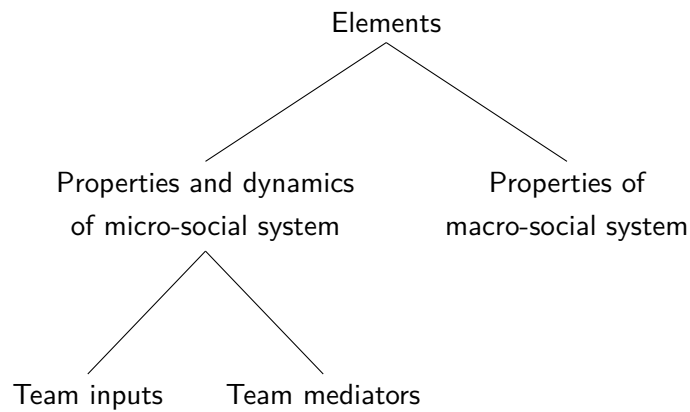


Figure 4.2: Typology of the inputs that affect team creativity. (Based on the organising framework developed by [Cirella et al. \(2014\)](#).)

[2014](#)). Team mediators include both team processes and emergent states ([Cirella et al., 2014](#)). Team process mediators include taskwork and teamwork processes that transform inputs into outputs, while emergent state mediators “describe cognitive, motivational, and affective states of teams, which develop over time as the dynamics in teams change” ([Seeber et al., 2014](#)). The properties of the macro-social system incorporates the environmental and organisational context, including leadership approaches<sup>1</sup>.

### 4.2.2 The maturity of the available body of knowledge on antecedents

From the literature scan described in Section 4.1, it is evident that a large volume of research on antecedents of team creativity has been conducted. Furthermore, from the typology of the available body of knowledge discussed in Section 4.2.1, the scope of the research that has been conducted appears to cover a large spectrum of influencing factors from both the micro-social and the macro-social system. It is not, however, clear how balanced this research has been—therefore it is possible that the majority of the research that has been conducted has focused on only a specific category of antecedents (for example, individual-level inputs). Additionally, the level of concordance in the findings reported in the body of research is unclear.

<sup>1</sup>[Cirella et al. \(2014\)](#) appear to provide contradicting perspectives on where team leadership fits into the typology, describing it both as a team-level input variable and as a property of the macro-social system. This dissertation aligns with descriptions offered by other authors, including [Hülsheger et al. \(2009\)](#), in viewing leadership as a property of the macro-social system.

### 4.3 The body of knowledge on outcomes

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Determining whether the body of knowledge is sufficiently mature to support the development of a framework is, unavoidably, highly subjective. Furthermore: due to the nature of the construct, it is not possible to determine whether or when the body of research on the antecedents of team creativity is fully saturated; and at a point, further research on antecedents of team creativity may add only incremental understanding to the body of knowledge and may therefore not be the most impactful use of available research capacity. Based on the evidence presented thus far, the body of knowledge on the antecedents of team creativity is deemed sufficiently mature to support the development of a framework.

Chapter 5 of this dissertation contains a meta-analytic review of the antecedents of team creativity. From this meta-analysis it is clear that, based on the existing body of knowledge, statistically significant, generalisable conclusions can be drawn on a wide variety of antecedents. The findings of this meta-analysis therefore appear to support the conclusion that the body of knowledge on the antecedents of team creativity is sufficiently mature to support the development of a framework.

### 4.3 The body of knowledge on outcomes

As illustrated in Figure 4.1, the literature scan uncovered only a small body of empirical research where team creativity is positioned as an antecedent. More specifically, in contrast to the 135 articles in the dataset that contain empirical investigations of antecedents of team creativity, only 11 articles contain empirical investigations of outcomes of team creativity. A potential explanation for this observation is that a fundamental, and potentially unconscious, assumption that may be employed in much of the research on the topic is that team creativity in itself is a desirable outcome to pursue. Another potential explanation for this observation could be the apparent positive bias in research on creativity (Peralta *et al.*, 2015; Shalley *et al.*, 2004), where team creativity may be viewed as being an antecedent of exclusively positive outcomes. This idea is explored in more detail in the article included in Chapter 6.

Unsurprisingly, given the small number of articles that appear to have been published on the topic, no organising framework for the body of knowledge on the outcomes of team creativity was uncovered in literature. Such a framework is proposed in the article included in Chapter 6.

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#### **4.4 Conclusion: Maturity of the body of knowledge**

As stated in the previous section, determining whether a body of knowledge is sufficiently mature to support the development of a framework is highly subjective. Given the limited number of studies that have been conducted on outcomes of team creativity, however, it is recommended that it would be prudent to explore potential outcomes of team creativity more thoroughly before developing a framework. Thus the body of knowledge on outcomes of team creativity is not deemed sufficiently mature to support the development of a framework.

#### **4.4 Conclusion: Maturity of the body of knowledge**

In this second chapter of Part II of the document, a second question related to the feasibility of developing a framework was considered, namely whether the body of knowledge is sufficiently mature to support the development of a framework. In summary, the body of knowledge on antecedents of team creativity is deemed sufficiently mature, but the body of knowledge on outcomes of team creativity is not deemed sufficiently mature. Part III of the dissertation is concerned with obtaining an estimate of the construct-level relationship between various antecedents and team creativity.

## **Part III**

# **Objective 3: Antecedents of team creativity**

## Chapter 5

# Meta-analytic review on antecedents of team creativity

Position of Chapter 5 in dissertation structure.		
Chapter	Chapter type	Chapter topic
Part I: Research rationale (RO1)		
Part II: Framework feasibility (RO2)		
Part III: Antecedents of team creativity (RO3)		
5	Chapter	Objectives 3.1–3.3: Generate a summary of the estimated construct-level relationship between various antecedents and team creativity in the population.
Part IV: Outcomes of team creativity (RO4)		
Part V: Conclusion		

One of the conclusions that were reached in Part II of the dissertation, is that the body of knowledge on the antecedents of team creativity appears to be sufficiently mature to support the development of a framework. Consequently, in Part III of the dissertation, the objective is to obtain estimates of the construct-level relationships between various potential antecedents and team creativity in the population as a whole, based on the significant number of available empirical findings.

This part of the dissertation contains a single chapter that is concerned with RO3. A meta-analysis is conducted whereafter the results are summarised into a format that is intended to serve as a succinct summary of the existing body of knowledge on statistically significant, generalisable antecedents of team creativity.

## 5.1 Introduction: Meta-analytic review on antecedents

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### 5.1 Introduction: Meta-analytic review on antecedents

Summarised findings on the antecedents of team creativity have previously been published by *Shalley et al. (2004)*, *Hülshager et al. (2009)*, and *Cirella et al. (2014)*. *Shalley et al.'s (2004)* work comprises a narrative review that is primarily concerned with antecedents of individual creativity, though a brief summary of empirical findings on the antecedents of team creativity is also provided. *Hülshager et al.'s (2009)* work comprises a meta-analytic review of team-level predictors of both creativity and innovation, at both the individual and team level. The findings don't, however, distinguish between creativity and innovation, therefore it is unclear whether variables are found to have a relationship with team creativity, with team innovation, or with both team creativity and team innovation. As discussed previously in this dissertation, creativity is a necessary, though not sufficient, condition for innovation and, though innovation is undoubtedly one of the outcomes that an organisation would wish to attain when encouraging team creativity, it is not the only outcome that an organisation could be seeking by encouraging team creativity. Consequently, the perspective of the current research is that it is useful to distinguish between antecedents of team creativity, antecedents of innovation, and antecedents of both team creativity and innovation. In line with this perspective, the current research is concerned with antecedents of team creativity specifically, while innovation is conceptualised as one of the potential outcomes of team creativity. Finally, *Cirella et al.'s (2014)* work comprises a narrative review of the antecedents of team creativity, accompanied by an organising framework for the body of research on antecedents of team creativity that was described in Section 4.2.1.

A search protocol<sup>1</sup> executed in Scopus did not uncover any other meta-analysis that focuses broadly on antecedents of team creativity, except for the one by *Hülshager et al. (2009)*, discussed in the preceding paragraph. The search did, however, uncover a number of meta-analyses where the relationship between team creativity and a specific antecedent is evaluated, typically as part of a broader study of the outcomes of the specific antecedent.

In the introductory chapter of their book on methods of meta-analyses, *Schmidt & Hunter (2015)* provide a compelling illustration of the value of employing a meta-analytic approach when reviewing a body of evidence. Specifically, the authors present a table containing a set of 30 findings on the relationship between job satisfaction and organisational commitment, accompanied by demographic data relating to organisation size, average age of

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<sup>1</sup>“(“meta-analy\*” OR “meta analy\*”) AND “creativity” AND (“team” OR “group”)



## 5.1 Introduction: Meta-analytic review on antecedents

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employees, and geographical location. 19 of the 30 findings indicate a statistically significant relationship while the remaining 11 findings indicate no relationship between job satisfaction and organisational commitment. Readers are subsequently requested to formulate a set of hypotheses on the relationship between job satisfaction and organisational commitment and on the variables that moderate this relationship. Examples of observations from the dataset include that, if studies that comprise of samples of exclusively older workers are excluded, 19 of the remaining 23 studies indicate a significant relationship. Furthermore, within this reduced data set that excludes studies exclusively done on older populations, all 10 of the studies that were conducted in large organisations found a significant relationship. Schmidt & Hunter (2015) then proceed to reveal that all of the 30 correlations given in the table had in fact been randomly extracted from a single statistical distribution, and that the organisational characteristics, such as the age of the workers or the size of the organisation, had been randomly assigned to the 30 correlation values. Thus all of the patterns that appeared to emerge from the dataset, were in fact the result of chance alone, and all of the variation in the reported correlations were the result of sampling error. This example illustrates that traditional narrative reviews are most likely not the most appropriate mechanism for inferring conclusions from a large body of empirical findings.

A large body of empirical findings is very likely to contain various contradictory findings. In contrast to a narrative review, the purpose of a meta-analysis goes beyond summarising and describing the existing research on a topic to estimating “as accurately as possible the construct-level relationships in the population” (Schmidt & Hunter, 2015) in order to determine the “results that would be obtained in an infinitely large, perfectly designed study or sequence of such studies” (Rubin, 1990). A meta-analysis is therefore useful in attempting to resolve contradictory findings.

### 5.1.1 Literature search and database construction

The dataset that is described in Section 4.1 was used as basis for the meta analysis. Thus the 135 articles that were identified as containing empirical research where team creativity is (one of) the *outcome* variable(s) being studied were used as the initial data-set for the meta-analysis. Additional relevant articles that were uncovered serendipitously were also added to the data-set. The articles were then analysed to create two databases: one containing a quantitative summary of all correlations with team creativity reported in the

## 5.1 Introduction: Meta-analytic review on antecedents

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articles; and the other comprising of a qualitative summary of all statistically significant findings reported in the articles.

The quantitative database contains 59 articles while the qualitative database contains 90 articles. The reasons for the disparity in the figures are that: (i) some of the empirical studies were not suitable for inclusion in the meta-analysis as they did not employ a correlational design (the selection of the correlation coefficient as basis for the meta-analysis is motivated in the following section); and (ii) not all studies that followed a correlational design reported the intercorrelations between the variables.

### 5.1.2 Meta-analytic procedure

Psychometric meta-analyses (also referred to as validity generalisation meta-analyses or Hunter-Schmidt meta-analyses), denotes an approach that specifically places emphasis on correcting for the methodological limitations of the studies that are included in the analysis (Borenstein *et al.*, 2009). The method is therefore well-suited to meta-analyses where there is a desire to estimate the construct-level relationship as it provides methods for correction for potential methodological imperfections in individual studies (Borenstein *et al.*, 2009). Consequently, the method is deemed an appropriate choice for achieving the research objective of obtaining an estimate of the construct-level relationship between various antecedents and team creativity.

As is evidenced by the name, two authors (Schmidt and Hunter) have been instrumental in the development of the approach. Consequently, a single source, namely the latest edition of Schmidt & Hunter's (2015) book, is frequently cited in this section.

In line with the approach recommended by Schmidt & Hunter (2015) and followed by Hülshager *et al.* (2009), the meta-analysis on the antecedents of team creativity incorporates corrections for both sampling error and measurement error. Two alternative approaches can be followed when correcting for artefacts in a meta-analysis, namely: (i) correcting each study individually; or (ii) generating artefact distributions to apply to all studies collectively (Schmidt & Hunter, 2015). The first approach is selected for two reasons: (i) the statistics required for individual artefact correction are reported in the majority of studies included in the analysis, thus making individual artefact correction feasible; and (ii) the mechanism used to measure the variables of interest differs between the various studies, meaning that the appropriate metric on which to base the correction for measurement error differs. Three mechanisms of measuring variables of interest are observed, namely: (i) self-rating by either

## 5.1 Introduction: Meta-analytic review on antecedents

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the team or team manager, a measure of internal consistency reliability is used to correct for measurement error in this case; (ii) ratings, for example from an independent group of raters, interrater reliability is used to correct for measurement error in this case; and (iii) objective measures, in which case no correction for measurement error is made. The correction for measurement error is applied to both the predictor and criterion variables. In a small number of studies, the appropriate metric to use in correcting for measurement error is not reported, in these cases the meta-analysis sample mean of the appropriate statistic (either the internal consistency reliability or the interrater reliability) for the specific construct is used. These approaches for correcting for measurement error align with those recommended by [Schmidt & Hunter \(2015\)](#).

The meta-analysis is based on the cumulation of the correlation coefficient. Literature contains suggestions on various alternative statistics on which to base a meta-analysis, such as the regressions coefficient and the Fisher z transformation of the correlation coefficient ([Schmidt & Hunter, 2015](#)). The most salient advantage of using the correlation coefficient rather than the regression coefficient in this meta-analysis of antecedents of team creativity, is that its value is comparable across studies that use different scales to measure the same construct ([Schmidt & Hunter, 2015](#)), resulting in a larger potential pool of primary empirical findings to include in the meta-analysis. In the case of the Fisher z transformation, extensive testing has demonstrated that the use of the transformed correlations does not improve the accuracy of a meta-analysis (in comparison to a meta-analysis conducted with an untransformed correlation coefficient), though it does, in some cases, reduce the accuracy of the meta-analysis ([Schmidt & Hunter, 2015](#)).

A random rather than a fixed meta-analysis model is used as the confidence intervals are likely to be inaccurately narrow when a fixed meta-analysis model is applied ([Schmidt & Hunter, 2015](#)). In combining metrics across studies, a weighting mechanism that takes both the sample size and the artefact attenuation factor for each study into account is used. This approach is selected as it gives more weight to findings from studies that contain more information—i.e. studies that combine larger sample sizes with lower errors of measurement ([Schmidt & Hunter, 2015](#)).

For constructs (for example trust) where a generalised measure (for example team trust) was utilised in some studies whilst a measure that considers only a specific aspect (e.g. cognitive trust) of the more general construct was used in others, the following approach is followed. The meta-analysis is performed on a dataset consisting of all variations of the

## 5.1 Introduction: Meta-analytic review on antecedents

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construct (e.g. on a dataset that contains measures of team trust in general, as well as measures of the level of cognitive trust and affective trust specifically, in the team). The meta-analysis is also performed on subsets of the total dataset (e.g. on a dataset that contains only measures of the level of cognitive trust in a team). The meta-analysis results for the entire data-set as well as for each of the subsets are reported.

A number of cases of conceptual replication are observed in the dataset. In all instances, this conceptual replication takes the form of replicated measurement. As the data points (correlations) generated by these replicated measurements are not statistically independent, these data points are not separately entered into the meta-analysis. Schmidt & Hunter (2015) describe three potential approaches for handling replicated measurements, of which the approach of combining the data points to form a composite measure is the recommended option as it leads to the most accurate meta-analysis results. As all of the data that is required to combine the data points to form a composite measure is available in all of the studies in the quantitative database that contain replicated measurements, this is the approach that is implemented. The following example illustrates the approach that is followed. A study reports the correlation between a generalised measure of trust and the novelty of the ideas generated by a team, as well as the correlation between a generalised measure of trust and the usefulness of the ideas generated by a team, separately. The approach described by Schmidt & Hunter (2015) is then followed to generate a correlation between a generalised measure of trust and a composite measure of team creativity that takes both novelty and usefulness of ideas into account. Furthermore, the approach described by Schmidt & Hunter (2015) is followed to generate an estimate of the measurement error of the composite measure of team creativity that takes both novelty and usefulness of ideas into account.

The following statistics are reported for each meta-analysis:

- $k$  — the number of studies that are included in the meta-analysis;
- $N$  — the sample size, i.e. the number of teams on which the meta-analysis is based;
- $r$  — the estimated population correlation, i.e. the weighted average correlation;
- $S^2r$  — the sample size-weighted observed variance of the correlations;
- $\rho$  — the estimated corrected population correlation, i.e. the estimated population correlation incorporating the corrections for sampling error and for measurement error;

## 5.1 Introduction: Meta-analytic review on antecedents

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- $SD_{\rho}$  — the estimated standard deviation of the corrected population correlation;
- %VE — the percentage of variance that is explained by the artefact correction for sampling error and measurement error;
- 80% CV — the 80% credibility interval for the estimated corrected population correlation; and
- 95% CI — the 95% confidence interval for the estimated corrected population correlation.

The 95% confidence interval conveys information on the accuracy of the corrected correlation—if it does not contain zero, the corrected correlation can be considered statistically significant (Schmidt & Hunter, 2015). The 80% credibility interval gives an indication of the variability of individual correlations, therefore it provides an indication of whether the corrected correlation can be generalised or whether it is situation specific. If the 80% credibility interval does not contain zero, the corrected correlation can be generalised (Schmidt & Hunter, 2015).

As part of the discussion of the findings of each of the analyses, results from all previous meta-analyses (uncovered via the search protocol set out in Section 5.1) on the same set of variables are also disclosed.

### 5.1.3 Organisation of discussion

All variables for which intercorrelations were reported by at least two studies in the quantitative database, and for which existing theorising positioning the variable as an antecedent of team creativity was provided by at least one study in the total dataset, were included in the meta-analysis.

The discussion of the various topics that are reviewed as part of the meta-analysis is organised according to the typology derived from Cirella *et al.*'s (2014) work that was presented in Section 4.2.1. With the exception of the addition of the “properties of the macro-social system” element, this structure is identical to the one employed by Hülsheger *et al.* (2009) in their meta-analysis of team-level antecedents of innovation and / or creativity.

In summary, the following variables that are classified as properties and dynamics of the micro-social system were reviewed as part of the meta-analysis:

## 5.2 Meta-analysis of team inputs

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- Team inputs, namely:
  - Team background diversity;
  - Team job-relevant diversity; and
  - Team member individual creativity.
  
- Team mediators, namely:
  - Team climate for innovation<sup>1</sup>;
  - Team trust;
  - Team efficacy;
  - Team conflict;
  - Team communication;
  - Team state regulatory focus;
  - Team affective tone;
  - Team absorptive capacity; and
  - Team task interdependence.

Only one variable that is classified as a property and / or dynamic of the macro-social system is included in the review, namely, leadership.

## 5.2 Meta-analysis of team inputs

As described in the preceding section, two team inputs are considered in the meta-analysis, namely the level of diversity in the team and the creativity of the individual team members.

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<sup>1</sup>The meta-analysis of the team climate for innovation includes four facets, namely vision, participative safety, task orientation, and support for innovation, as well as two more detailed components, namely: (i) psychological safety (a component of participative safety); and (ii) team reflexivity (a component of task orientation).

## 5.2 Meta-analysis of team inputs

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### 5.2.1 Team diversity

The impact of various aspects of diversity on team creativity have been studied in literature. In their meta-analyses on team-level antecedents of innovation, [Hülshager et al. \(2009\)](#) align with other prominent researchers (e.g. [Shalley et al. \(2004\)](#)) to distinguish between background diversity and job-relevant diversity. Background diversity refers to heterogeneity in terms of aspects that are not relevant to the tasks being performed by a team, for example heterogeneity in terms of age or gender. Job-relevant diversity refers to diversity that is relevant to the tasks being performed by a team, for example heterogeneity in terms of education (such as degree specialisation), or heterogeneity in terms of functional background (e.g. the functional unit of the organisation that the team member belongs to). In the meta-analysis, diversity-related antecedents of team creativity are organised into these two broad categories which are evaluated separately.

Various aspects of background diversity have been proposed as beneficial for team creativity. Exposure to different backgrounds and perspectives, associated for example with teams that are diverse in terms of nationality or gender, are thought to facilitate divergent and flexible thinking, which in turn facilitates creativity ([Homan et al., 2015](#); [Pearsall et al., 2008](#)). Previous research has, however, also found that background diversity can negatively affect team creativity by causing teams to divide into sub-groups. When diversity causes friction between various sub-groups, this prevents the exchange of diverse perspectives and ideas between team members and therefore has a negative impact on team creativity ([Homan et al., 2015](#); [Pearsall et al., 2008](#)).

The meta-analysis results for background diversity are presented in [Table 5.1](#). There is only one study in the quantitative database of 59 articles that utilises a generalised measure of background diversity, incorporating diversity in terms of age, gender, nationality, and race. As this subset of the data contains only one study, the findings for this subset cannot truly be described as those of a meta-analysis. Meta-analyses conducted on subsets of studies that consider diversity in terms of gender, age, culture, and team tenure in isolation indicate no statistically significant relationships with team creativity, as evidenced by the confidence intervals that contain zero.

The findings from all studies that consider the relationship between at least one aspect of background diversity and team creativity can also be pooled to form a total dataset. Doing so is considered valid as the use of a generalised measure of background diversity is

## 5.2 Meta-analysis of team inputs

observed in literature (Bodla *et al.*, 2018). This also aligns to the approach employed by Hülshager *et al.* (2009) in their meta-analysis of team-level antecedents of creativity and / or innovation. In a number of studies that report on more than one aspect of background diversity, for example, age diversity and gender diversity, there is a negative correlation between the two background diversity variables. This generates a negative reliability coefficient for the composite background diversity score, which makes a meta-analysis infeasible. This occurs in three of the studies included in the quantitative database. These three studies have therefore been excluded from the meta-analysis performed on the total background diversity dataset. As shown in Table 5.1, when the total dataset of 12 studies incorporating data from 703 teams is considered, the relationship between background diversity and team creativity is also not statistically significant. This finding differs from that reported in a meta-analysis by Stahl *et al.* (2010) who, based on data from 160 teams, find that there is a weak, positive relationship (at  $\rho \approx 0.2$ ) between cultural diversity and team creativity which is statistically significant, but likely to be subject to moderation (thus, not generalisable). The three other meta-analyses (Bell *et al.*, 2011; Hülshager *et al.*, 2009; Schneid *et al.*, 2016) that have reported on the relationship between various aspects of background diversity and creativity and innovation (operationalised as a single variable) have, however, obtained a similar result as that reported in Table 5.1, namely that the relationship is not statistically significant.

Table 5.1: Meta-analysis results for background diversity.

	k	N	r	S <sup>2</sup> r	$\rho$	SD <sub><math>\rho</math></sub>	%VE	80% CV	95% CI
<b>Total dataset</b>	12	703	0.05	0.05	0.09	0.33	14%	-0.33 — 0.50	-0.11 — 0.29
<b>Generalised</b> <sup>[1]</sup>	1	60	-0.18	0.00	-0.20	0.00	N/A	-0.20 — -0.20	-0.20 — -0.20
<b>Gender</b> <sup>[1]</sup>	7	471	0.07	0.02	0.07	0.10	58%	-0.06 — 0.20	-0.05 — 0.19
<b>Age</b> <sup>[1]</sup>	5	302	0.01	0.01	0.01	0.00	100%	0.01 — 0.01	-0.10 — 0.12
<b>Cultural</b> <sup>[1]</sup>	5	228	0.19	0.08	0.22	0.27	21%	-0.13 — 0.57	-0.05 — 0.49
<b>Tenure</b> <sup>[1]</sup>	3	156	-0.01	0.01	-0.02	0.00	100%	-0.02 — -0.02	-0.11 — 0.07

**Note:** [1] This constitutes a subset of the total dataset, where the results for the total dataset are given in the top row of the table.

Literature contains many arguments stating that diversity in terms of perspectives and knowledge stimulates team creativity, however empirical findings on this relationship are inconsistent (Hoever *et al.*, 2012). An explanation for the inconsistent findings on the relationship between job-relevant diversity and team creativity is that job-relevant diversity



## 5.2 Meta-analysis of team inputs

provides teams with a cognitive resource that can be beneficial for team creativity, but only if the resource is utilised (Shin & Zhou, 2007), for example by the pro-active implementation of perspective-taking (Hoever *et al.*, 2012).

The meta-analysis results for job-relevant diversity are presented in Table 5.2. As indicated, when a meta-analysis is performed on a subset of the studies that consider job-relevant diversity, the correlation narrowly misses being significant in three of the four subsets. More specifically, based on data from 96 teams that considers a generalised measure of job-relevant diversity including aspects such as educational, functional and professional background, the meta-analysis indicates a correlation with team creativity that is both significant and generalisable. Based on data from 178 teams, the meta-analysis indicates that the relationship between functional diversity (i.e. the variety of organisational functions, e.g. marketing, or accounting that are represented in a team) and team creativity is not statistically significant. Based on data from 434 teams, the meta-analysis indicates that the relationship between diversity in terms of team members' knowledge or perspectives and team creativity is not statistically significant. Finally, based on data from 445 teams, the meta-analysis indicates that the relationship between diversity in terms of team members' educational background and team creativity is not statistically significant.

Table 5.2: Meta-analysis results for job-relevant diversity.

	k	N	r	S <sup>2</sup> r	$\rho$	SD <sub><math>\rho</math></sub>	%VE	80% CV	95% CI
<b>Total dataset</b>	19	1153	0.10	0.03	0.11	0.16	39%	-0.09 — 0.32	0.02 — 0.21
<b>Generalised</b> <sup>[1]</sup>	2	96	0.22	0.00	0.25	0.00	100%	0.25 — 0.25	0.11 — 0.40
<b>Functional</b> <sup>[1]</sup>	2	178	0.13	0.01	0.13	0.04	85%	0.08 — 0.19	-0.02 — 0.29
<b>Knowledge</b> <sup>[1]</sup>	8	434	0.15	0.04	0.16	0.20	31%	-0.10 — 0.42	-0.01 — 0.33
<b>Educational</b> <sup>[1]</sup>	7	445	0.07	0.01	0.07	0.01	100%	0.06 — 0.08	-0.02 — 0.16

**Note:** [1] This constitutes a subset of the total dataset, where the results for the total dataset are given in the top row of the table.

At least two of the studies that are included in the meta-analysis utilise a generalised measure of job-relevant diversity, thus it is considered valid to pool studies that consider various aspects of job-relevant diversity to form a larger dataset. This approach was also followed by Hülshager *et al.* (2009) in their meta-analysis of team-level antecedents of innovation and / or creativity. When the findings from all 19 studies that consider an aspect of job-relevant diversity are pooled, the meta-analysis indicates that the relationship between job-relevant diversity and team creativity is statistically significant. This finding

## 5.2 Meta-analysis of team inputs

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differs from that which was obtained when three subsets of the data were considered in isolation. As this finding is based on the simultaneous consideration of data from 1153 teams, however, the conclusion that a statistically significant relationship does exist is more compelling than the lack of such a finding based on smaller subsets of the data considered in isolation. As indicated by the credibility interval that contains zero, this finding of a significant relationship between job-relevant diversity and team creativity is not generalisable. Therefore, boundary conditions exist that cause this relationship to become insignificant. This finding aligns to ideas proposed by authors such as [Shin & Zhou \(2007\)](#) and [Hoever \*et al.\* \(2012\)](#), that job-relevant diversity provides a cognitive resource for team creativity, but that it does not automatically translate to team creativity under all conditions. For example: [Shin & Zhou \(2007\)](#) identify transformational leadership as a boundary condition for the impact of educational specialization heterogeneity on team creativity; [Hoever \*et al.\* \(2012\)](#) identify perspective taking as a boundary condition for the impact of perspective diversity on team creativity; and [Bodla \*et al.\* \(2018\)](#) identify an inclusive team climate<sup>1</sup> as a moderator of the relationship between the perceived deep-level diversity of a team and team creativity. The finding of a statistically significant weak, positive correlation (at  $\rho \approx 0.1$ ) between job-relevant diversity and team creativity, concurs with meta-analysis findings reported by both [Hülshager \*et al.\* \(2009\)](#) and [Bell \*et al.\* \(2011\)](#). [Hülshager \*et al.\*'s](#) analysis also indicates that the finding is not generalisable, while the credibility interval is not reported in [Bell \*et al.\*'s](#) study.

In summary, based on data from 703 teams and 1153 team respectively, the meta-analysis indicates that background diversity is not significantly correlated with team creativity whilst job-relevant diversity is significantly correlated with team creativity. Furthermore, the meta-analysis indicates that the significant relationship between job-relevant diversity and team creativity is not generalisable under all conditions.

When constructing a framework to support team creativity, the meta-analysis indicates that there is no justification for including recommendations for striving for background diversity in teams. It is less apparent whether the framework should include recommendations for striving to ensure job-relevant diversity in teams, combined with an indication that the relationship between job-relevant diversity and team creativity does not exist under all con-

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<sup>1</sup>An inclusive team climate comprises three components, namely: inclusion in decision-making; equitable employment practices; and integration of differences ([Bodla \*et al.\*, 2018](#); [Li \*et al.\*, 2015](#)).

### 5.3 Meta-analysis of team mediators

ditions. The question of whether findings that are not generalisable should be included in a framework is considered in more detail in Section 5.5.

#### 5.2.2 Team member individual creativity

The individual creativity of team members has been found to be an antecedent of team creativity in a number of previous studies. Two perspectives can be discerned, namely that the creativity of a team can be explained solely by the level of creativity of the team members (Pirola-Merlo & Mann, 2004), or that, in addition to the sum of the creativity of individual team members, there is also a team-level element of creativity that emerges synergistically (Hargadon & Bechky, 2006; Taggar, 2001).

As indicated in Table 5.3, based on a meta-analysis of five studies incorporating data from 435 teams, it can be concluded that the relationship between the individual creativity of team members and team creativity is both statistically significant and generalisable.

As such, it is recommended that a framework for supporting team creativity in engineering organisations should indicate that the level of creativity of individual team members is an antecedent of team creativity that does not appear to be subject to boundary conditions. The significant role that individual creativity plays in predicting team creativity (at  $\rho \approx 0.6$ ) also raises questions regarding the logic of constructing a framework to support team creativity in isolation from individual creativity. This question is considered in more detail in Section 5.5.

Table 5.3: Meta-analysis results for individual creativity.

	k	N	r	S <sup>2</sup> r	$\rho$	SD <sub><math>\rho</math></sub>	%VE	80% CV	95% CI
<b>Individual creativity</b>	5	435	0.17	0.05	0.64	0.10	30%	0.51 — 0.76	0.53 — 0.74

### 5.3 Meta-analysis of team mediators

As set out in Section 5.1.3, a wide variety of team mediators are included in the meta-analysis. The discussion follows the order given in Section 5.1.3.

## 5.3 Meta-analysis of team mediators

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### 5.3.1 Team climate for innovation

The theory of team climate for innovation<sup>1</sup>, proposed by West (1990), states that four facets of team climate facilitate innovation, namely: vision, participative safety, task orientation, and support for innovation (Anderson & West, 1998). The theory has been applied extensively in team innovation research and both primary studies as well as Hülshager *et al.*'s (2009) meta-analysis have found support for the theory (Anderson *et al.*, 2014).

The results for the meta-analysis of the correlation between team climate for innovation and team creativity are shown in Table 5.4. Four studies utilised a generalised measure that tapped all four facets of the team climate for innovation whilst other studies measured some or all of the four facets separately. If a study did not assess all four facets of the team climate for innovation, the study was excluded from the total dataset as it was not considered appropriate to generate a composite score<sup>2</sup>. As shown in Table 5.4, the results for the meta-analysis of the generalised measure are both significant and generalisable when the total dataset incorporating 205 teams is considered. This conclusion should be interpreted with caution, however, as when the study that did not use a single generalised measure is omitted, the meta-analysis indicates that the correlation between the team climate for innovation and team creativity is no longer generalisable.

As the team climate for innovation consists of four distinct facets, it is insightful to also consider the relationship between each of these and team creativity separately.

The vision facet has four components, namely: (i) the extent “to which the vision is readily understandable”; (ii) the extent to which the vision has an outcome that is valued and therefore engenders commitment; (iii) the extent to which the vision is accepted in the team; and (iv) the perceived attainability of the vision (Anderson & West, 1998). Taken together, vision is proposed to focus and direct efforts while motivating team members (Anderson & West, 1998). As shown in Table 5.4, a meta-analysis based on data from 150 teams indicates that the correlation between the vision facet of the team climate for innovation and team creativity is not significant. This finding differs from that reported

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<sup>1</sup>The team climate for innovation is distinct to the concept of an inclusive team climate, which was briefly mentioned in Section 5.2.1 and has been identified as a moderator of the relationship between team member diversity and team creativity.

<sup>2</sup>This differs from the approach that was employed in the meta-analyses for background diversity and job-relevant diversity. This is because the climate for innovation is specifically defined as consisting of the four facets mentioned in the text above, whilst background diversity or job-relevant diversity are not made up of a rigidly defined set of components.

### 5.3 Meta-analysis of team mediators

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in [Hülshager et al.'s \(2009\)](#) meta-analysis, where, based on data from 457 teams, the relationship between vision and team creativity and innovation (operationalised as a single variable) is found to be positive, statistically significant, and generalisable. As discussed previously, the dependent variable that is utilised in [Hülshager et al.'s](#) study differs from that employed in the meta-analysis reported in [Table 5.4](#) as team innovation is included. Therefore, though [Hülshager et al.'s](#) findings are based on a significantly larger number of teams, it is recommended that the results as reported in [Table 5.4](#) be used as basis for the development of a framework as these results pertain specifically to team creativity. It is also prudent to note that the confidence interval reported in [Table 5.4](#) very narrowly includes zero.

The participative safety facet has two components, namely: (i) the degree of participation in decision-making; and (ii) the (psychological) safety in the team ([Anderson & West, 1998](#)). Psychological safety as a stand-alone construct is evaluated in [Section 5.3.1.1](#). Participation in decision-making, facilitated by psychological safety, is proposed to make individuals more invested in the outcomes of decisions and to make them more likely “to offer ideas for new and improved ways of working” ([Anderson & West, 1998](#)). As shown in [Table 5.4](#), a meta-analysis based on data from 205 teams indicates that the correlation between the participative safety facet of the team climate for innovation and team creativity is not significant. This finding differs from that reported in [Hülshager et al.'s \(2009\)](#) meta-analysis, where, based on data from 2168 teams, the relationship between participative safety and team creativity and innovation (operationalised as a single variable) is found to be positive and statistically significant, though not generalisable. The same comments as those provided in the discussion of [Hülshager et al.'s](#) findings for the vision facet of the team climate for innovation apply, although the confidence interval for participative safety reported in [Table 5.4](#) convincingly includes zero.

The task orientation facet has two components, namely: (i) the climate for excellence, which incorporates an emphasis on accountability, and appraising and reflecting on performance; and (ii) constructive controversy, which refers to open-minded consideration of opposing positions ([Anderson & West, 1998](#)). Task orientation therefore refers to both a commitment to excellence and willingness to adopt improved approaches to performing work ([Anderson & West, 1998](#)). As shown in [Table 5.4](#), a meta-analysis based on data from 150 teams indicates that there is a significant, generalisable correlation between the task

### 5.3 Meta-analysis of team mediators

Table 5.4: Meta-analysis results for team climate for innovation.

	k	N	r	S <sup>2</sup> r	$\rho$	SD <sub><math>\rho</math></sub>	%VE	80% CV	95% CI
<b>Total dataset</b>	5	305	0.32	0.07	0.37	0.27	15%	0.03 — 0.71	0.12 — 0.63
<b>Generalised</b> <sup>[1]</sup>	4	251	0.31	0.09	0.36	0.29	13%	-0.02 — 0.73	0.05 — 0.66
<b>Vision</b> <sup>[1]</sup>	2	150	0.10	0.01	0.12	0.04	91%	0.07 — 0.17	-0.05 — 0.29
<b>Participative safety</b> <sup>[1]</sup>	3	205	-0.01	0.03	0.00	0.15	41%	-0.19 — 0.19	-0.22 — 0.22
<b>Task orientation</b> <sup>[1]</sup>	2	150	0.19	0.01	0.24	0.05	83%	0.17 — 0.30	0.07 — 0.40
<b>Support</b> <sup>[1]</sup>	3	250	0.26	0.04	0.30	0.20	20%	0.04 — 0.56	0.05 — 0.56

**Note:** [1] This constitutes a subset of the total dataset, where the results for the total dataset are given in the top row of the table.

orientation facet of the team climate for innovation and team creativity. This finding concurs with that reported in [Hülshager et al.'s \(2009\)](#) meta-analysis, where, based on data from 496 teams, the relationship between task orientation and team creativity and innovation (operationalised as a single variable) is found to be positive, statistically significant, and generalisable.

Finally, the support for innovation facet refers to the extent that support for attempts to introduce improved approaches to performing work is articulated, as well as the extent to which this support is practically enacted ([Anderson & West, 1998](#)). As shown in [Table 5.4](#), a meta-analysis based on data from 250 teams indicates that there is a significant, generalisable correlation between the support for innovation facet of the team climate for innovation and team creativity. This finding concurs with that reported in [Hülshager et al.'s \(2009\)](#) meta-analysis, where, based on data from 367 teams, the relationship between support for innovation and team creativity and innovation (operationalised as a single variable) is found to be positive, statistically significant, and generalisable.

In summary, it is recommended that, when constructing a framework for supporting team creativity in engineering organisations, both the task orientation and support for innovation facets of the team climate for innovation should be taken into account as the meta-analysis indicates that both of these have a statistically significant relationship with team creativity that is not subject to boundary conditions.

#### 5.3.1.1 Psychological safety: A component of participative safety

Psychological safety refers to “taken-for-granted beliefs that others will respond positively when one exposes one’s thoughts” ([Edmondson & Mogelof, 2006](#)) and are characterised

### 5.3 Meta-analysis of team mediators

by “collective confidence that members will not deliberately undermine or embarrass each other” (Spoelma & Ellis, 2017). It is one of two components of the participative safety facet of the team climate for innovation discussed earlier in Section 5.3.1. Activities that support innovation inherently involve risk and the possibility of failure. A team climate that is characterised by psychological safety has been shown to be “conducive to interpersonal risk taking and hence to creativity and innovation in teams” (Edmondson & Mogelof, 2006). Team members’ hesitance to propose creative ideas may be linked to a fear of evaluation or of becoming “a victim of free-riding attempts from others”. In teams that are safe for interpersonal risk-taking, both of these fears may be allayed (Spoelma & Ellis, 2017).

Psychological safety is distinct from other constructs that have also been associated with team creativity such as trust and efficacy (which are discussed in Sections 5.3.2 and 5.3.3 respectively). Psychological safety is viewed as fulfilling a “unique mediating function” in the relationship between various antecedents and team creativity (Edmondson & Mogelof, 2006). An example of this mediating function is the role of psychological safety in allowing for conflict to be “managed more productively”, without reducing the levels of conflict (Edmondson & Mogelof, 2006). Psychological safety has also been proposed to facilitate the management of diverse or conflicting perspectives within a team, and to make team members more likely to “carefully evaluate the effectiveness of new ideas in their teamwork” as they have confidence that their opinions will be respected (Hu *et al.*, 2018).

Table 5.5: Meta-analysis results for psychological safety.

	k	N	r	S <sup>2</sup> r	$\rho$	SD <sub><math>\rho</math></sub>	%VE	80% CV	95% CI
<b>Psychological safety</b>	5	387	0.31	0.02	0.41	0.13	36%	0.24 — 0.57	0.27 — 0.55

The results of the meta-analysis of the relationship between psychological safety and team creativity is shown in Table 5.5. Based on data from 387 teams, the meta-analysis indicates that the relationship between psychological safety and team creativity is both significant and generalisable. This conclusion differs from the finding (shown in Table 5.4) that the relationship between the participative safety facet of the team climate for innovation and team creativity is not significant. However, as psychological safety is only one of the two components of participative safety, it is not implausible that the meta-analysis findings could differ.

## 5.3 Meta-analysis of team mediators

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In summary, as discussed previously, the results of the meta-analysis presented in Table 5.4 does not provide grounds for including the participative safety facet of the team climate for innovation as an antecedent of team creativity. Based on the meta-analysis results presented in Table 5.5, however, it is recommended that the psychological safety component of the participative safety facet of the team climate for innovation should be incorporated into a framework for supporting team creativity in engineering organisations. Psychological safety is an antecedent of team creativity that does not appear to be subject to boundary conditions.

### 5.3.1.2 Team reflexivity: A component of task orientation

The meta-analysis incorporates both team reflexivity and team learning into a single analysis, as the manner in which these two variables are defined and the essence of the scales that are used to assess these two variables in the three studies included in the meta-analysis are deemed to be sufficiently similar. Team reflexivity, or team learning, as defined in the studies included in the meta-analysis, refers to the extent to which team members: collectively reflect on their work; learn from this process of reflection; and consequently adjust their objectives, processes, and strategies (Hu *et al.*, 2018; Li & Zhang, 2016; Shin, 2014). Hülshager *et al.* (2009) included data on team reflexivity in their meta-analysis of the task orientation facet of the team climate for innovation. As discussed in Section 5.3.1, task orientation has two components, namely climate for excellence and constructive controversy. In line with the approach employed by Hülshager *et al.* (2009), team reflexivity and team learning, as defined in the three studies included in the meta-analysis, can be viewed as equivalent to the climate for excellence component of task orientation.

The role of team reflexivity as an antecedent of team creativity has been demonstrated in a number of primary empirical studies (Shin, 2014). Team reflexivity or learning is proposed to enhance team creativity by facilitating a process of learning from others' views, adapting one's own views when appropriate, and creating "a shared understanding that can guide team processes and outputs more effectively" (Shin, 2014). Team reflexivity is also proposed to facilitate both information sharing and information integration (Li & Zhang, 2016). A meta-analysis of information sharing and information integration as antecedents of team creativity is presented in Section 5.3.5.

The results of the meta-analysis of the relationship between team reflexivity and team creativity is displayed in Table 5.6. As indicated, based on data from 232 teams, the



### 5.3 Meta-analysis of team mediators

Table 5.6: Meta-analysis results for team reflexivity.

	k	N	r	S <sup>2</sup> r	$\rho$	SD <sub><math>\rho</math></sub>	%VE	80% CV	95% CI
<b>Team reflexivity</b>	3	232	0.51	0.01	0.59	0.12	27%	0.43 — 0.75	0.43 — 0.75

meta-analysis indicates that the correlation between team reflexivity and team creativity is positive, significant, and generalisable.

It has already been recommended that a framework for supporting team creativity in engineering organisations should incorporate the task orientation dimension of the team climate for innovation. The meta-analysis presented in this section further supports this recommendation and indicates that the team reflexivity component of task orientation has a strong positive relationship with team creativity that does not appear to be subject to boundary conditions.

#### 5.3.2 Team trust

Trust “is a psychological state comprising the intention to accept vulnerability based upon positive expectations of the intentions or behaviour of another” (Barczak *et al.*, 2010). Though it has been described as being concerned with “the degree of emotional safety in relationships” (Isaksen & Lauer, 2002), it is distinct from the concept of psychological safety (Edmondson, 1999), which was discussed in Section 5.3.1.1. Literature has proposed that trust facilitates collaboration in teams, increases team members’ motivation to participate towards the achievement of shared goals, and facilitates communication and the sharing of knowledge (Barczak *et al.*, 2010; Isaksen & Lauer, 2002). This in turn has been proposed to facilitate team creativity (Barczak *et al.*, 2010). Some of the aforementioned mechanisms through which trust has been proposed to facilitate team creativity are similar to the mechanisms through which the vision facet of the team climate for innovation has been proposed to operate (refer to Section 5.3.1).

A contrasting perspective has also been proposed in literature, namely that members of teams that have high levels of team trust may be reluctant to express thoughts that differ from those of fellow team-members as this may be regarded as a violation of team trust, and that high levels of team trust may therefore not be “optimal in terms of generating creative ideas” (Tsai *et al.*, 2012).

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Table 5.7: Meta-analysis results for team trust.

	k	N	r	S <sup>2</sup> r	$\rho$	SD <sub><math>\rho</math></sub>	%VE	80% CV	95% CI
<b>Total dataset</b>	5	253	0.47	0.05	0.54	0.23	17%	0.25 — 0.83	0.32 — 0.76
<b>Generalised</b> <sup>[1]</sup>	3	131	0.31	0.02	0.35	0.11	59%	0.21 — 0.49	0.15 — 0.55
<b>Cognitive trust</b> <sup>[1]</sup>	2	122	0.64	0.02	0.68	0.14	19%	0.50 — 0.86	0.46 — 0.90
<b>Affective trust</b> <sup>[1]</sup>	2	122	0.52	0.03	0.58	0.16	23%	0.38 — 0.78	0.33 — 0.83

**Note:** [1] This constitutes a subset of the total dataset, where the results for the total dataset are given in the top row of the table.

The meta-analysis results for team trust are presented in Table 5.7. A generalised measure of team trust is used in the three of the five studies included in the meta-analyses, whilst a distinction between cognitive trust and affective trust is made in the remaining two studies. The meta-analysis results for the three subsets of data, correspond to the results that are obtained for the total dataset. More specifically, based on data from 253 teams, the meta-analysis indicates that there is a positive relationship between team trust and team creativity that is both significant and generalisable.

In summary, it is recommended that a framework for supporting team creativity in engineering organisations should incorporate team trust as an antecedent of team creativity that does not appear to be subject to boundary conditions.

#### 5.3.3 Team efficacy

Both team efficacy in general, and team creative efficacy specifically, have been proposed as antecedents of team creativity. Perceived efficacy at the team level should be viewed as an emergent team-level attribute, rather than as the aggregation of perceived individual efficacy, thus it is a collective belief that emerges based on social interactions within the team (Kim & Shin, 2015; Shin & Zhou, 2007; Yang *et al.*, 2017). Literature has proposed that “team efficacy is critical for team creativity”, however, “prior research has suggested that to truly understand whether efficacy beliefs contribute to a given domain in terms of both content and level of analysis, one needs to examine the corresponding domain-specific efficacy beliefs, not general efficacy” (Shin & Zhou, 2007). The meta-analysis uncovered four studies that considered team creative efficacy specifically and three studies that considered team efficacy in general. As shown in Table 5.8, these two data subsets have been combined to form a total team efficacy dataset, though, in line with Shin & Zhou’s reasoning, the results for the two subsets are also reported separately.

### 5.3 Meta-analysis of team mediators

Team (creative) efficacy is proposed to have a positive impact on team creativity via the role that it plays in increasing team members' motivation and in increasing team creativity-related processes (Shin & Zhou, 2007; Yang *et al.*, 2017). Efficacy beliefs have been identified "as one of the most important determinants of work motivation" (Shin & Zhou, 2007). Motivation in turn determines how team members act, whether they are willing to take risks, and importantly, whether they persevere when obstacles arise (Shin & Zhou, 2007; Yang *et al.*, 2017). Motivation is proposed to influence whether team members engage in processes such as the exchange of ideas and interaction that are conducive to creativity (Shin & Zhou, 2007).

Table 5.8: Meta-analysis results for team efficacy.

	k	N	r	S <sup>2</sup> r	$\rho$	SD <sub><math>\rho</math></sub>	%VE	80% CV	95% CI
<b>Total dataset</b>	8	580	0.36	0.02	0.42	0.11	45%	0.28 — 0.56	0.31 — 0.52
<b>Generalised efficacy</b> <sup>[1]</sup>	4	292	0.43	0.00	0.49	0.00	100%	0.49 — 0.49	0.42 — 0.57
<b>Creative efficacy</b> <sup>[1]</sup>	4	288	0.29	0.02	0.34	0.12	45%	0.19 — 0.49	0.18 — 0.49

**Note:** [1] This constitutes a subset of the total dataset, where the results for the total dataset are given in the top row of the table.

The meta-analysis results for team efficacy are presented in Table 5.8. As shown, both team efficacy in general and team creative efficacy specifically are positively and significantly correlated with team creativity, and the relationship is generalisable. As expected, this positive, significant, generalisable finding holds when a total dataset incorporating both team efficacy in general and team creative efficacy specifically is formed.

In summary, it is recommended that a framework for supporting team creativity in engineering organisations should incorporate team (creative) efficacy as an antecedent of team creativity that does not appear to be subject to boundary conditions.

#### 5.3.4 Team conflict

Research has focused on the impact of two types of conflict within teams on team creativity, namely relationship conflict and task conflict. In contrast to the approach that is followed with trust, none of the studies included in the meta-analysis conceptualised conflict as a generalised construct, rather all studies measured task and / or relationship conflict as distinct constructs. Consequently, it is deemed inappropriate to perform a meta-analysis on a merged dataset containing measures of both relationship conflict and task conflict.

### 5.3 Meta-analysis of team mediators

Relationship conflict, also referred to as emotional conflict or interpersonal conflict, is affective in nature, it stems from personal disaffection and results in anger and mistrust (Chen, 2006; Pearsall *et al.*, 2008). It is proposed to be “particularly detrimental to team creativity, as it encourages cynical attributions regarding the ideas and contributions of team members, thwarting productive discussion” (Pearsall *et al.*, 2008).

Task conflict constitutes task-related disagreement over aspects such as procedures, ideas, the interpretation of facts, and the distribution of resources (Farh *et al.*, 2010; Hülsheger *et al.*, 2009). Empirical findings on the relationship between task conflict and team creativity have been inconsistent (Farh *et al.*, 2010; Hoever *et al.*, 2012). Task conflict has been proposed to have a positive impact on team creativity as it triggers information exchange, causes team members to scrutinise task issues and to reconsider the status quo which in turn leads to the generation of new ideas and approaches (Chen, 2006; Farh *et al.*, 2010; Hülsheger *et al.*, 2009). An alternative view is offered by Hoever *et al.* (2012) who state that “the case for task conflict as precursor to creativity is less clear upon closer inspection”. Hoever *et al.* (2012) propose that, particularly at high levels, task conflict may elicit reactions that lead to relationship conflict and consequently have a negative impact on team creativity. Farh *et al.* (2010) propose that there may be a curvilinear relationship between task-conflict and team creativity, a proposition for which they found support in a primary empirical study.

Table 5.9: Meta-analysis results for team conflict.

	k	N	r	S <sup>2</sup> r	$\rho$	SD <sub><math>\rho</math></sub>	%VE	80% CV	95% CI
<b>Relationship</b>	9	803	-0.29	0.05	-0.33	0.23	15%	-0.62 — -0.04	-0.49 — -0.17
<b>Task</b>	9	757	-0.02	0.09	-0.04	0.35	9%	-0.49 — 0.41	-0.28 — 0.20

The meta-analysis results for relationship conflict and task conflict are presented in Table 5.9. A meta-analysis based on data from 803 teams, indicates a negative correlation between relationship conflict and team creativity which is both significant and generalisable. In contrast to this, a meta-analysis based on data from 757 teams indicates that the correlation between task conflict and team creativity is not significant. In interpreting this finding of statistical insignificance, it is prudent to bear Farh *et al.*'s finding of a curvilinear relationship between task conflict and team creativity in mind. In the case of task conflict, it is also prudent to consider the potential role of psychological safety in mediating the

### 5.3 Meta-analysis of team mediators

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relationship between conflict and team creativity, discussed in Section 5.3.1.1<sup>1</sup>.

The results presented in Table 5.9 differ from those reported in Hülshager *et al.*'s (2009) meta-analysis. Based on data from 70 and 302 teams respectively, Hülshager *et al.* find that neither relationship conflict nor task conflict have a statistically significant relationship with team creativity and innovation (operationalised as a single variable). This seeming incongruence in the findings on the statistical significance of the correlation with relationship conflict in the meta-analyses is not viewed as cause for concern: (i) as discussed, the dependent variable utilised in Hülshager *et al.*'s meta-analysis differs from that implemented in the study reported in Table 5.9 through the inclusion of team innovation; and (ii) the number of studies included in the meta-analyses differ, with the results reported in Table 5.9 being based on a significantly larger dataset.

In summary, it is recommended that a framework for supporting team creativity in engineering organisations should incorporate an awareness of the negative impact of relationship conflict on team creativity that does not appear to be subject to boundary conditions.

#### 5.3.5 Team communication

Various aspects of communication have been conceptualised as antecedents of team creativity in a large number of studies. Four aspects of team communication, listed in Table 5.10, have been identified in the studies included in the quantitative database and a meta-analysis is performed on each of these aspects separately. Similar to the approach employed for the meta-analyses on task conflict and relationship conflict presented in the previous section, it is deemed inappropriate to perform a meta-analysis on a merged dataset consisting of these four aspects of team communication.

Information sharing has been proposed as an antecedent of team creativity in a large number of studies. The sharing of information is proposed to broaden the team's knowledge base, to spark the generation of new insights, to facilitate the generation of new ideas, and to stimulate cognitive flexibility (Gong *et al.*, 2013; Hoever *et al.*, 2012; Hu *et al.*, 2018). Knowledge has also been conceptualised as one of the building blocks of creativity (Gong *et al.*, 2013). As shown in Table 5.10, a meta-analysis based on data from 787 teams indicates that the correlation between information sharing and team creativity is positive, significant, and generalisable.

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<sup>1</sup>This comment is not applicable to relationship conflict, however, as the meta-analysis indicates that the negative correlation between relationship conflict and team creativity is not subject to boundary conditions.

### 5.3 Meta-analysis of team mediators

*Hoever et al. (2012)* propose that, though the sharing of information is beneficial to creativity, sharing alone is not sufficient to promote creativity as team members could simply disregard shared information, or in some cases even react negatively to it. Instead, *Hoever et al. (2012)* propose that “the exchange, discussion, and integration of ideas, knowledge, and insights relevant to the team’s task”, referred to as information elaboration or information integration, is necessary for information sharing to have a positive impact on team creativity. *Men et al. (2017)* align with this perspective of knowledge integration as a mediator between knowledge sharing and team creativity. As shown in Table 5.10, a meta-analysis based on data from 330 teams indicates that the correlation between information integration and team creativity is positive, significant, and generalisable.

Table 5.10: Meta-analysis results for team communication.

	k	N	r	S <sup>2</sup> r	$\rho$	SD <sub><math>\rho</math></sub>	%VE	80% CV	95% CI
<b>Sharing</b>	12	787	0.40	0.02	0.49	0.11	41%	0.34 — 0.63	0.40 — 0.57
<b>Integration</b>	5	330	0.52	0.02	0.58	0.15	23%	0.39 — 0.77	0.43 — 0.73
<b>Density</b>	4	334	0.05	0.09	0.06	0.32	11%	-0.35 — 0.47	-0.28 — 0.39
<b>Centralisation</b>	3	98	-0.15	0.10	-0.16	0.30	25%	-0.55 — 0.22	-0.55 — 0.23

Two characteristics of teams’ communication networks have also been evaluated as antecedents of team creativity, namely the density and the centralisation of the communication network.

The density of a communication network is an indication of the level of interaction between team members (*Kratzer et al., 2004*), thus it is a measure of the “closeness of team member interactions with each other” (*Wu & Cormican, 2016*). It has been proposed to positively impact communication as it facilitates the transfer of informal or tacit knowledge which is not easily transmitted amongst members of a team with weak ties (*Jia et al., 2014*). Dense communication networks also enable more effective interpersonal communication, enabling speed and timeliness which are proposed to be conducive to team creativity (*Jia et al., 2014*). As shown in Table 5.10, a meta-analysis based on data from 334 teams indicates that the correlation between the density of the communication network within a team and team creativity is not significant.

The centralisation of the communication network refers to “the extent to which team members rely on a small concentrated number of people” (*Wu & Cormican, 2016*). Lower levels of network centralisation in a team are proposed to have an indirect impact on team

### 5.3 Meta-analysis of team mediators

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creativity by facilitating higher levels of team co-operation, as a larger number of team members are in a frequent contact, rather than communication flowing mostly through a small number of team members (Wu & Cormican, 2016). Furthermore, central team members are proposed to impede team creativity as they experience information overload, making them unable to effectively gather and disseminate ideas (Leenders *et al.*, 2003). As shown in Table 5.10, a meta-analysis based on data from 98 teams indicates that the correlation between the extent of centralisation of the communication network within a team and team creativity is not significant.

In summary, it is recommended that a framework for supporting team creativity in engineering organisations should incorporate an awareness of the role of information sharing, coupled with information integration, as antecedents of team creativity that do not appear to be subject to boundary conditions.

#### 5.3.6 Team state regulatory focus

According to the regulatory theory, two motivational orientations can be discerned, namely an orientation towards achieving goals and ideals, and one towards ensuring security and minimising losses (Sacramento *et al.*, 2013). Team regulatory focus, also called team goal orientation, refers to “a shared understanding of the extent to which a team emphasizes” particular outcomes (Gong *et al.*, 2013). One explanation for the impact of team regulatory focus on team creativity involves the thinking or processing styles associated with each type of regulatory focus, whilst another explanation proposes that a team’s regulatory focus has an indirect impact on team creativity through its impact on information exchange within the team. A meta-analysis is performed on the relationship between team creativity and two types of team regulatory focus, namely team promotion focus and team prevention focus. For similar reasons as those provided in the two preceding sections, it is deemed inappropriate to perform a meta-analysis on a merged dataset containing measures of both team promotion focus and team prevention focus.

Team promotion focus is also referred to as team performance approach goal and refers to the team’s shared understanding of the emphasis that it places on “gaining favourable evaluations and outperforming other teams” (Gong *et al.*, 2013). Empirical research has demonstrated that “promotion focus is associated with a more holistic... processing style”, this is likely to allow “for a larger number of connections between a larger set of cognitive elements” which in turn is expected to enhance creativity (Sacramento *et al.*, 2013).

### 5.3 Meta-analysis of team mediators

Research has also shown that “a shared team performance approach goal produces outcome interdependence among team members and generates a preference for a positive joint outcome” this “draws team members together and motivates them to share task-related information” (Gong *et al.*, 2013). This increased sharing of information in the team is proposed to promote team creativity. A meta-analysis on the effect of various aspects of communication within a team, including the impact of information sharing, was presented in Section 5.3.5.

Team prevention focus, also referred to as performance avoidance goal, refers to the team’s shared understanding of the emphasis it places on “avoiding negative evaluations and failures” (Gong *et al.*, 2013). Empirical research has demonstrated that prevention focus is associated with “a more focused and localized processing style” which is proposed to be less conducive to creativity (Sacramento *et al.*, 2013). There is a risk associated with information exchange as seeking inputs from team members could be viewed as “a sign of incompetence” and sharing one’s ideas could elicit criticism (Gong *et al.*, 2013). When the overarching goal of the team is therefore oriented towards avoiding risk, the team is proposed to be less likely to exchange information and this in turn is proposed to have a negative impact on team creativity (Gong *et al.*, 2013).

Table 5.11: Meta-analysis results for team state regulatory focus.

	k	N	r	S <sup>2</sup> r	$\rho$	SD <sub><math>\rho</math></sub>	%VE	80% CV	95% CI
<b>Promotion focus</b>	3	239	0.17	0.01	0.20	0.00	100%	0.20 — 0.20	0.09 — 0.32
<b>Prevention focus</b>	3	239	-0.01	0.01	-0.02	0.10	58%	-0.14 — 0.11	-0.19 — 0.15

The results of the meta-analysis on the impact of the two motivational orientations on team creativity is displayed in Table 5.11. As shown, based on data from 239 teams, the meta-analysis indicates that the correlation between team promotion focus and team creativity is positive, significant, and generalisable. Based on data from the same number of teams, the meta-analysis indicates that the relationship between team promotion focus and team creativity is not significant.

In summary, it is recommended that a framework for supporting team creativity in engineering organisations should incorporate team promotion focus as an antecedent of team creativity that does not appear to be subject to boundary conditions.



## 5.3 Meta-analysis of team mediators

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### 5.3.7 Team affective tone

Affective tone within a team refers to affective reactions that are either consistent or homogeneous amongst team members (Shin, 2014; Tsai *et al.*, 2012). Affective tone is characterised as positive when team members experience emotions such as enthusiasm, contentment and joy, and negative when team members experience anxiety, sadness, and anger (Shin, 2014). Two theoretical mechanisms have been proposed to explain the impact of a team's affective tone on team creativity, namely information processing and the creative process (Tsai *et al.*, 2012). For similar reasons as those provided in the three preceding sections, it is deemed inappropriate to perform a meta-analysis on a merged dataset containing measures of both positive and negative affective tone.

In terms of information processing, at the individual level, positive affect has been shown to cause individuals to use their own information more flexibly and to “detect parallels between seemingly unrelated task elements and contexts” (Hoever *et al.*, 2018). Extending this perspective to the team level, Shin (2014) propose that “when team members collectively experience positive affect, their thoughts and actions expand” and they are more likely to “discard automatic behavioural routines and pursue novel and creative ways of thought and action”.

In terms of the impact of affective tone on the creative process, positive team affective tone is proposed to make team members more willing to engage in the creative process and to increase their enjoyment of the creative process. In turn, this is proposed to make them more likely to engage in information sharing and information integration (Tsai *et al.*, 2012). As discussed in Section 5.3.5, a meta-analysis shows that both information sharing and information integration are antecedents of team creativity.

In terms of negative team affective tone, literature contains conflicting perspectives, variously proposing that it has a positive impact, no impact, and a negative impact on team creativity (Tsai *et al.*, 2012). Arguments for a positive impact include that negative affective tone draws team members' attention to shortfalls associated with the status quo, thus making them more likely to propose improvements. Arguments for a negative impact include that team creativity inhibits “positive social interactions and morale building among team members” (Tsai *et al.*, 2012) and that it has a negative impact on information processing by restricting team members' “range of possible reactions” (Shin, 2014).

### 5.3 Meta-analysis of team mediators

Table 5.12: Meta-analysis results for team affective tone.

	k	N	r	S <sup>2</sup> r	$\rho$	SD <sub><math>\rho</math></sub>	%VE	80% CV	95% CI
<b>Positive tone</b>	6	489	0.33	0.02	0.37	0.13	34%	0.20 — 0.54	0.24 — 0.50
<b>Negative tone</b>	3	272	-0.25	0.00	-0.29	0.00	100%	-0.29 — -0.29	-0.36 — -0.23

The result of the meta-analysis on the relationship between team affective tone and team creativity is displayed in Table 5.12. As indicated, based on data from 489 teams, the meta-analysis indicates that the correlation between a positive team affective tone and team creativity is positive, significant, and generalisable. Furthermore, based on data from 272 teams, the meta-analysis indicates that the correlation between a negative team affective tone and team creativity is negative, significant, and generalisable.

In summary, it is recommended that a framework for supporting team creativity in engineering organisations should incorporate an understanding of both positive and negative team affective tone as antecedents of team creativity that, respectively, have a positive and negative impact that does not appear to be subject to boundary conditions.

#### 5.3.8 Team absorptive capacity

Absorptive capacity is an emergent team state that refers to “the ability and motivation of team members to create and deploy new knowledge” (Men *et al.*, 2017) and is defined as “the ability of a team to interrelate with the expertise of their peer team members” (Tiwana & McLean, 2005). Absorptive capacity serves to increase team members’ “awareness of the pool of available expertise in their team” and decreases “interpretive ambiguities” (Tiwana & McLean, 2005).

The two studies that are included in the meta-analysis conceptualise absorptive capacity’s role in team creativity differently. Men *et al.* (2017) position absorptive capacity as one of two parallel mediators (along with information integration) of information sharing, while Tiwana & McLean (2005) position absorptive capacity as an antecedent of team creativity that is fully mediated by information integration. A meta-analysis of information sharing and information integration as antecedents of team creativity was presented in Section 5.3.5. Tiwana & McLean (2005) reason that absorptive capacity provides cognitive resources for team creativity as it allows team members to “connect previously unconnected knowledge and ideas, and thus create new knowledge”.

### 5.3 Meta-analysis of team mediators

Table 5.13: Meta-analysis results for team absorptive capacity.

	k	N	r	S <sup>2</sup> r	$\rho$	SD <sub><math>\rho</math></sub>	%VE	80% CV	95% CI
<b>Absorptive capacity</b>	2	128	0.51	0.00	0.57	0.00	100%	0.57 — 0.57	0.48 — 0.67

The result of the meta-analysis on the correlation between team absorptive capacity and team creativity is displayed in Table 5.13. As indicated, based on data from 128 teams, the meta-analysis indicates that the correlation between team absorptive capacity and team creativity is positive, significant, and generalisable.

In summary, it is recommended that a framework for supporting team creativity in engineering organisations should incorporate team absorptive capacity as an antecedent of team creativity that does not appear to be subject to boundary conditions.

#### 5.3.9 Team task interdependence

Though team task interdependence has been proposed as an antecedent of team creativity by one of the articles included in the qualitative database of 90 articles, all of the articles included in the quantitative database conceptualised it as a control variable. Gilson & Shalley's (2004) reasoning for proposing team task interdependence as an antecedent of team creativity is that interdependence is likely to promote communication, an exchange of resources and a dependence on one another amongst team members. This in turn is reasoned to increase "the motivational aspects of work itself". Finally, "motivation has been described as one of the most critical elements necessary for creativity" (Gilson & Shalley, 2004).

Before presenting the results of the meta-analysis, it is also prudent to note that in three of the seven studies included in the meta-analysis, task interdependence is measured using a scale with only one item, while in another of the seven studies, the number of items in the scale that was used to assess the variable is not reported. This is most likely because it was included as a control variable, rather than a variable of primary interest, in these studies.

Table 5.14: Meta-analysis results for team task interdependence.

	k	N	r	S <sup>2</sup> r	$\rho$	SD <sub><math>\rho</math></sub>	%VE	80% CV	95% CI
<b>Task interdependence</b>	7	462	0.12	0.02	0.16	0.16	37%	-0.04 — 0.36	0.01 — 0.31

## 5.4 Meta-analysis on properties of macro-social system

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As shown in Table 5.14, though the meta-analysis indicates that the positive correlation between team task interdependence and team creativity is significant, it is not generalisable. Consequently, the meta-analysis indicates that the impact of team task interdependence on team creativity is subject to boundary conditions. No potential moderators of the relationship between team task interdependence and team creativity have been proposed in either the quantitative or qualitative databases. This finding differs slightly from that reported in Hülsheger *et al.*'s (2009) meta-analysis, where, based on data from 130 teams, the relationship between task interdependence and team creativity and innovation (operationalised as a single variable) is found to not be statistically significant. This seeming incongruence in the findings of the meta-analyses is not viewed as cause for concern: (i) as discussed, the dependent variable utilised in Hülsheger *et al.*'s meta-analysis differs from that implemented in the study reported in Table 5.14 through the inclusion of team innovation; and (ii) the number of studies included in the meta-analyses differ, with the results reported in Table 5.14 being based on a significantly larger dataset. It is also prudent to note that the confidence interval reported in Table 5.14 very narrowly misses including zero.

For the following reasons it is recommended that a framework for supporting team creativity in engineering organisations should not incorporate team task interdependence as an antecedent of team creativity despite the finding of a significant positive correlation: there is limited theorising proposing team task interdependence as an antecedent; and though the findings of the meta-analysis are not generalisable, no plausible moderator has been proposed in literature. The reasoning for the impact of team task interdependence on team creativity includes its role in encouraging communication and interdependence amongst team members. As discussed in Section 5.3.5, it is recommended that the framework incorporates both team information sharing and team information integration as antecedents of team creativity. Furthermore, as discussed in Section 5.3.6, it is recommended that team promotion focus, which is theorised to promote co-operation by producing outcome interdependence amongst team members, is incorporated as an antecedent of team creativity in the framework.

## 5.4 Meta-analysis on properties of macro-social system

As described in Section 5.1.3, only one property of the macro-social system is included in the meta-analysis, namely leadership.

## 5.4 Meta-analysis on properties of macro-social system

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### 5.4.1 Leadership

Leadership has been proposed to have a pronounced impact on team creativity-relevant processes and on team creativity as an outcome (Cirella *et al.*, 2014; Hon & Chan, 2012; Hu *et al.*, 2018; Shin & Zhou, 2007). Five aspects of leadership, listed in Table 5.15, have been identified in the studies included in the quantitative database and a meta-analysis is performed on each of these aspects separately. Similar to the approach employed for the meta-analyses on conflict and on communication presented earlier in the chapter, it is deemed inappropriate to perform a meta-analysis on a merged dataset consisting of these five aspects of leadership.

Transformational leadership is “one of the most influential leadership theories in contemporary research” (Shin & Zhou, 2007). It is theorised to increase motivation and identification within a team by “increasing the intrinsic valence of team goal accomplishment, communicating vision, and emphasizing collective outcomes” (Shin & Zhou, 2007) and is recognised as “an influential enabler for creativity” (Dong *et al.*, 2017). Furthermore, transformational leadership at the team-level is proposed to benefit team creativity as it facilitates the sharing of information (Dong *et al.*, 2017). Dong *et al.* (2017) address inconsistent findings on the relationship between transformational leadership and creativity, reported in a meta-analysis by Rosing *et al.* (2011), by suggesting that it is important to distinguish the level of analysis when examining this relationship as various authors have proposed that “effective transformational leaders have different emphases when managing individuals and teams”. In line with Dong *et al.*'s suggestion, the meta-analysis presented here incorporates only data that analysed the relationship at the team level. As shown in Table 5.15, a meta-analysis based on data from 252 teams indicates that the correlation between transformational leadership and team creativity is positive, significant, and generalisable.

Sun *et al.* (2016) argue that shared leadership can contribute to team creativity as “the complexity and ambiguity facing innovative teams make it unrealistic for a single external leader to successfully perform all leading functions that are needed in an organization”. Shared leadership is defined as “a dynamic, interactive influence process among individuals in groups for which the objective is to lead one another to the achievement of group or organizational goals or both” (Pearce & Conger, 2003). Shared leadership is proposed to have a positive impact on team creativity by facilitating or encouraging communication and

#### 5.4 Meta-analysis on properties of macro-social system

cooperation amongst team members (Sun *et al.*, 2016). Furthermore, shared leadership is proposed to enable autonomy within teams (Sun *et al.*, 2016), which, according to self-determination theory, is beneficial for creative teams (Hon & Chan, 2012). As shown in Table 5.15, a meta-analysis based on data from 151 teams indicates that the correlation between shared leadership and team creativity is positive, significant, and generalisable.

Leader-member exchange (LMX) differentiation has been positioned as an antecedent of team creativity in two of the studies that are included in the quantitative database. LMX differentiation refers to “the development of differential relationships between a leader and the followers who report directly to the leader in a work group”, the higher the “degree of variability in the quality of exchange relationships”, the higher the LMX differentiation (Li *et al.*, 2016). LMX differentiation is proposed to influence team creativity through its impact on the work context (Li *et al.*, 2016). Li *et al.*'s theorising proposes that there is an inverse u-shaped relationship between LMX differentiation and team creativity. Thus LMX differentiation is proposed to have a positive impact on team creativity by enabling leaders to assign tasks to employees according to their competencies; at a certain point however, the negative impact of LMX differentiation on the affective relationships amongst team members and consequently on team creativity, is proposed to exceed the positive impact of LMX differentiation on team creativity (Li *et al.*, 2016). Zhao (2015) differ from Li *et al.* (2016), and theorize that the relationship is purely negative due to the negative impact of reduced group solidarity, caused by the negative impact of LMX on team affective relationships, on the “team members’ mutual production of ideas”. As shown in Table 5.15, a meta-analysis based on data from 157 teams indicates that the correlation between LMX differentiation and team creativity is negative, significant, and generalisable. This finding therefore aligns with Zhao's theorising of a purely negative relationship, rather than with Li *et al.*'s theorising of an inverted u-shaped relationship.

Table 5.15: Meta-analysis results for team leadership.

	k	N	r	S <sup>2</sup> r	$\rho$	SD <sub><math>\rho</math></sub>	%VE	80% CV	95% CI
<b>Transformational</b>	4	252	0.33	0.00	0.37	0.00	100%	0.37 — 0.37	0.32 — 0.42
<b>Shared</b>	4	151	0.52	0.04	0.63	0.19	21%	0.38 — 0.87	0.41 — 0.84
<b>LMX differentiation</b>	2	157	-0.25	0.02	-0.28	0.11	49%	-0.42 — -0.15	-0.49 — -0.08
<b>Leader humility</b>	2	145	0.44	0.00	0.57	0.03	87%	0.53 — 0.61	0.45 — 0.69
<b>Empowering</b>	2	114	0.39	0.01	0.48	0.08	60%	0.37 — 0.58	0.29 — 0.66

## 5.4 Meta-analysis on properties of macro-social system

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Hu *et al.* (2018) argue that existing theorising on the role of transformational leadership in facilitating team creativity doesn't "explicitly consider how leaders influence the way team members view their own limitations, respond to other's contributions and strengths, and absorb new information and ideas, which are key to team creativity". Hu *et al.* (2018) propose that leader humility has an explicit impact on these aspects. Leader humility describes how accurately a leader views themselves, including their own shortcomings, how much value they attach to others' strengths, and their receptiveness to advice, feedback and new ideas (Gonçalves & Brandão, 2017; Hu *et al.*, 2018). Rather than directly influencing team performance, leader humility is proposed to create contextual conditions in which both individuals and teams are able to perform better (Gonçalves & Brandão, 2017). Leader humility is proposed to encourage followers not to seek to be the centre of attention, which in turn is proposed to facilitate a process of appreciating the contributions of others amongst team members (Gonçalves & Brandão, 2017). Furthermore, humble leaders are proposed to increase both engagement and intrinsic motivation amongst followers. Leader humility is proposed to positively impact both information sharing (discussed in Section 5.3.5) and psychological safety (discussed in Section 5.3.1.1) (Hu *et al.*, 2018). As shown in Table 5.15, a meta-analysis based on data from 145 teams indicates that the correlation between leader humility and team creativity is positive, significant, and generalisable.

The fifth aspect of leadership that has been examined as an antecedent of team creativity in the studies included in the quantitative database is empowering leadership. Dimensions of empowering leadership behaviour include leading by example, a commitment to assisting team members to become more self-reliant, participative decision-making, disseminating information, and supporting subordinates and treating them fairly (Hon & Chan, 2012). This empowering leadership behaviour is proposed to elicit a variety of behaviours in employees that are beneficial for team creativity, including: autonomy, fostering team trust, access to relevant information, and identifying with work goals (Hon & Chan, 2012). As shown in Table 5.15, a meta-analysis based on data from 114 teams indicates that the correlation between empowering leadership and team creativity is positive, significant, and generalisable. This concurs with the finding of a positive, significant, generalisable relationship between empowering leadership and team creativity reported by Lee *et al.* (2018) in their meta-analysis on the outcomes of empowering leadership.

In summary, it is recommended that a framework for supporting team creativity in engineering organisations should incorporate an understanding of the role of transforma-

## 5.5 Summary: Findings recommended for framework inclusion

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tional leadership, shared leadership, empowering leadership, and leader humility as positive antecedents of team creativity that do not appear to be subject to boundary conditions. Furthermore it is recommended that such a framework should incorporate an awareness of the negative impact of LMX differentiation on team creativity, which also does not appear to be subject to boundary conditions.

## 5.5 Summary: Findings recommended for framework inclusion

The summary provided in this section is intended to facilitate future research to develop a framework for supporting team creativity in engineering organisations. Thus only antecedents of team creativity that have been recommended for inclusion in such a framework, based on the interpretation of the meta-analysis presented in the preceding sections, are included in the discussion.

The results of the meta-analysis that are recommended for inclusion in the framework are summarised in Table 5.16. The contents of the table are sorted according to  $\rho$ , the estimated corrected population correlation. The estimated standard deviation of the corrected population is also displayed. All of the findings in the table are both significant (based on the confidence interval), and generalisable (based on the credibility interval). Finally, the sample size, i.e. the number of teams on which the meta-analytic finding is based, is also reported as it is prudent to bear this information in mind when interpreting the summarised findings.

A heat map-type shading approach has been applied to the table containing the correlations and the sample sizes. This is merely intended as a mechanism to reduce the cognitive load associated with interpreting the information in the table. When interpreting the findings, it is recommended that both the size of the correlation coefficient and the sample size are taken into consideration. For example, though the summary indicates that the influence of individual creativity, shared leadership, team reflexivity, information integration, absorptive capacity and leader humility on team creativity are all strong (at  $\rho \approx 0.6$ ), the findings on individual creativity and information integration are based on a significantly larger pool of data than the findings on shared leadership and absorptive capacity, and it would therefore be prudent to attach greater weight to these.

In the preceding discussions, all statistically significant, generalisable findings were recommended for framework inclusion. For practical reasons, the designers of a framework may



## 5.5 Summary: Findings recommended for framework inclusion

Table 5.16: Summarised findings recommended for framework inclusion.

	<b>N</b>	<b><math>\rho</math></b>	<b><math>SD_{\rho}</math></b>
<b>Individual creativity</b>	435	<b>0.64</b>	0.10
<b>Shared leadership</b>	151	<b>0.63</b>	0.19
<b>Team reflexivity<sup>[1]</sup></b>	232	<b>0.59</b>	0.12
<b>Information integration</b>	330	<b>0.58</b>	0.15
<b>Absorptive capacity</b>	128	<b>0.57</b>	0.00
<b>Leader humility</b>	145	<b>0.57</b>	0.03
<b>Trust</b>	253	<b>0.54</b>	0.23
<b>Information sharing</b>	787	<b>0.49</b>	0.11
<b>Empowering leadership</b>	114	<b>0.48</b>	0.08
<b>Team (creative) efficacy</b>	580	<b>0.42</b>	0.11
<b>Psychological safety<sup>[2]</sup></b>	387	<b>0.41</b>	0.13
<b>Positive tone</b>	489	<b>0.37</b>	0.13
<b>Transformational leadership</b>	252	<b>0.37</b>	0.00
<b>Support for innovation<sup>[3]</sup></b>	250	<b>0.30</b>	0.20
<b>Task orientation<sup>[3]</sup></b>	150	<b>0.24</b>	0.05
<b>Team promotion focus</b>	239	<b>0.20</b>	0.00
<b>LMX differentiation</b>	157	<b>-0.28</b>	0.11
<b>Negative tone</b>	272	<b>-0.29</b>	0.00
<b>Relationship conflict</b>	803	<b>-0.33</b>	0.23

### Notes

[1] A component of the task orientation facet of the team climate for innovation.

[2] A component of the participative safety facet of the team climate for innovation.

[3] A facet of the team climate for innovation.

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## 5.6 Conclusion: Meta-analytic review on antecedents

wish to focus on a smaller set of antecedents in order to feasibly design a framework that is not overly onerous for use by managers that are likely to have various demands on their time and attention. The information provided in Table 5.16 is intended to assist framework designers in selecting which antecedents to include in a framework if it is deemed infeasible to include all of the antecedents that have been identified.

The decision to omit statistically significant findings that are not generalisable from Table 5.16 is also motivated by practical considerations. Recommending that only antecedents that are not subject to boundary conditions be included in a framework, is an attempt towards ensuring that organisations do not expend resources on attempting to foster antecedents that end up not having a positive impact on team creativity because the linked boundary conditions have not been effectively fostered. The meta-analysis uncovered only two antecedents that are statistically significant but not generalisable: namely job-relevant diversity which has a weak, positive correlation (at  $\rho \approx 0.1$ ) with team creativity; and team task interdependence which has a weak, positive correlation (at  $\rho \approx 0.2$ ) with team creativity.

Finally, as briefly mentioned earlier in the chapter, the finding on the significant role of individual creativity as a predictor of team creativity (at  $\rho \approx 0.6$ ) raises questions regarding the logic of constructing a framework to support team creativity in isolation. The large body of research on antecedents of individual creativity point to a perception that, similar to team creativity, individual creativity can be promoted and supported by various antecedents, rather than it being a fixed trait. Thus, this stream of research indicates that, similar to team creativity, organisations and managers can employ specific mechanisms to promote individual creativity amongst employees. A key recommendation based on the results of the meta-analysis presented in this chapter is that it would be prudent for the designers of a framework to also consider antecedents of individual creativity. Specifically, it is likely to be particularly effective to include those constructs that have been identified as having strong correlations with both individual creativity and team creativity in a framework.

## 5.6 Conclusion: Meta-analytic review on antecedents

The objective of this chapter (and of Part III of the dissertation) was to obtain estimates of construct-level relationships between various potential antecedents and team creativity in the population as a whole. This was achieved by performing a meta-analysis on a

## **5.6 Conclusion: Meta-analytic review on antecedents**

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wide range of antecedents that have been investigated in literature. A succinct summary of a subset of the findings of the meta-analysis, namely those that are recommended for framework inclusion, was also provided. Part IV of the dissertation is concerned with making a contribution to the body of knowledge on outcomes of team creativity.

## **Part IV**

# **Objective 4: Outcomes of team creativity**

## Chapter 6

# Empirical knowledge on outcomes

Position of Chapter 6 in dissertation structure.		
Chapter	Chapter type	Chapter topic
<b>Part I: Research rationale (RO1)</b>		
<b>Part II: Framework feasibility (RO2)</b>		
<b>Part III: Antecedents of team creativity (RO3)</b>		
<b>Part IV: Outcomes of team creativity (RO4)</b>		
6	Published article	Narrative literature review of outcomes of team creativity and development of a generalised conceptual model to facilitate theorising on outcomes.
7	Unpublished article	Objectives 4.4–4.5: Development of a conceptual model linking team creativity to a specific proposed outcome, non-experimental hypothesis-testing research based on the conceptual model.
<b>Part V: Conclusion</b>		

A key conclusion that was reached in Part II of the dissertation, is that the body of knowledge on the outcomes of team creativity does not appear to be sufficiently mature to support the development of a framework. Consequently, Part IV of the dissertation contains two chapters that are concerned with making a contribution to literature on the outcomes of team creativity. More specifically, the present chapter comprises a narrative review of existing empirical research on outcomes, whilst the following chapter comprises an empirical study on a potential outcome of team creativity.

The chapter consists of an article that has been published in the journal *Management Research Review*, Volume 42, Number 6<sup>1</sup>. An earlier iteration of the research contained in

<sup>1</sup>The supervisors, Professors PJ Vlok and Katleen de Stobbeleir, are the co-authors of the article (Bam *et al.*, 2019). The formal declaration of author contributions, as required for publications included in

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**6.1 RO4.1–4.3: MRR Vol. 42(6), pp. 760–774**

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this article was presented at the British Academy of Management's 2017 Annual Conference held in Coventry, United Kingdom, from 5 to 7 September 2017.

**6.1 RO4.1–4.3: MRR Vol. 42(6), pp. 760–774**

The research contained in this article addresses RO4.1 through a comprehensive review of the body of knowledge on the outcomes of team creativity. RO4.2 is addressed by organising the literature that has been uncovered through the review into an extension of the organising framework for knowledge on the inputs of team creativity constructed by *Cirella et al. (2014)*<sup>1</sup>. Finally, RO4.3 is addressed by incorporating a person-environment fit meta-theory perspective to develop a conceptual model and propose directions for future research on the outcomes of team creativity based on this model.

In line with Emerald Publishing's open access policy, the author accepted manuscript version of the article is included in the dissertation. The branded publisher version of the article can be accessed at: <https://www.emerald.com/insight/content/doi/10.1108/MRR-02-2018-0098/full/html>.

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dissertations by Stellenbosch University, is provided in Appendix A.

<sup>1</sup>The *Cirella et al. (2014)* framework was described in Section 4.2.1.

## OUTCOMES OF TEAM CREATIVITY: A PERSON-ENVIRONMENT FIT

### PERSPECTIVE

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### ABSTRACT

**Purpose** — Limited research where team creativity (TC) is positioned as an independent variable constitutes a weak point in the body of knowledge. This paper offers three contributions to address this research gap: empirical research that has been conducted on the outcomes of TC is summarized; a person-environment fit perspective is applied to develop a conceptual model for TC; and directions for future empirical research are proposed.

**Design / methodology / approach** — A literature review is conducted to identify empirical research on the outcomes of TC, this is summarized into an extension of an existing framework that organizes empirical research on the antecedents of TC. Furthermore, the fit model for TC is developed, based on a person-environment fit perspective.

**Findings** — Research on the outcomes of TC has focused on three themes: performance; affective state; and processes. Gaps in this body of knowledge include limited knowledge on performance outcomes and a lack of research on potential negative outcomes. Recommendations for future research include: potential moderators of the relationship between TC and two outcome, innovation and team performance, are proposed; strain and unethical decision-making are proposed as potential negative outcomes of TC; and it is proposed that incorporating a temporal dimension would improve the understanding of the cyclical manner in which certain variables and TC may interact over time.

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**Value** — The organizing framework extension summarizes existing knowledge on the outcomes of TC, and together with the fit model for TC, this offers a basis for identifying research gaps and directions for future research. Specific directions for future empirical research are proposed.

**Keywords:** Team creativity; Positive outcomes; Negative outcomes; Organizational perspective; Organizational context; Person-environment fit.

## 1 INTRODUCTION

Research has considered the role of a wide variety of antecedents of team creativity (TC), however, an extensive scan of literature, described in more detail in the next section, indicates that the outcomes of TC have received markedly less attention. A large portion of the research on TC appears to be written from the assumption that TC is desirable in an organizational context (Shalley et al., 2004; Peralta et al., 2015). Shalley et al. (2004) questioned this positive bias and called for research to interrogate the potential detrimental effects of creativity. More recently, Peralta et al. (2015) stated that more studies that consider creativity more critically have now been published, yet there are still only a relatively small number of empirical studies where TC is positioned as the independent variable.

Knowledge on the topic of TC would be strengthened by a larger number of empirical studies that position TC as an independent variable. As an example, it is plausible that, under certain boundary conditions (for example, unattainable goals), TC could lead to a negative outcome (for example, unethical behavior). If this were the case, it would be important to be aware of and to understand these boundary conditions so that the risk could be actively managed. As a second example, it is reasonable to assume that many organizations that attempt to foster TC do so with the aim of increasing innovation. Though various perspectives on the relationship between creativity and innovation exist, there is general acknowledgement of the role of creativity as a necessary (though not sufficient) element for innovation in an organization. This highlights the need for knowledge on the role of mediators and moderators in channeling TC towards innovation. Thus, the relatively limited



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knowledge on the relationship between TC and organizationally relevant outcome variables is a weak point in the body of knowledge on the topic.

Cirella et al. (2014) state that knowledge on TC is highly fragmented, and that this fragmentation limits understanding of the topic. This paper commences by mapping the body of knowledge on the outcomes of TC to form an extension to an existing organizing framework for knowledge on the antecedents of TC proposed by Cirella et al. (2014). In line with the aim defined by Cirella et al. (2014) during the development of the original framework, the extension of the framework aims to (i) improve the understanding of the impact of TC, and (ii) assist researchers in uncovering areas where further research would be valuable.

As a second contribution to proposing directions for future empirical research where TC is positioned as the independent variable, the person-environment (P-E) fit metatheory perspective is applied to develop a conceptual model for TC within an organization. The use of the P-E fit metatheory is aligned to the perspective taken by Shalley et al. (2004) in their influential review of empirical research on personal or contextual characteristics that impact employee creativity in organizations. The proposed link between improved fit and improved outcomes from TC relies on a mechanism whereby improved alignment (of the manner in which TC is executed or that which the TC is directed at) ensures that the outputs of TC contribute to outcomes that are significant to the organization. Mechanisms through which TC could potentially impact both positive and negative individual-, team- and organizational-level outcomes are proposed based on this fit model for TC thereby proposing concrete directions for future research. The fit model for TC is also likely to be conceptually useful to other researchers seeking to identify future directions for research on TC as an independent variable.

## **2 REVIEW OF LITERATURE ON OUTCOMES OF TC**

This section comprises a review of literature where TC is positioned as an independent variable. Based on this review, a proposed extension to the organizing framework for knowledge on the antecedents of TC, proposed by Cirella et al. (2014), is developed to map the body of knowledge on the outcomes of TC.

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### *2.1 Literature search protocol*

A search for the term “team creativity” in either the title, abstract or keywords of journal articles, conference papers or book chapters that are indexed in the Scopus database, uncovered 249 items.

The abstracts of these literature pieces were scanned to categorize the items as follows:

- Empirical research where TC is (one of) the dependent variable(s), 135 items;
- Conceptual research where TC is (one of) the dependent variable(s), 38 items;
- Empirical research where TC is (one of) the independent variable(s), 10 items;
- Conceptual research where TC is (one of) the independent variable(s), 1 item; and
- Research that does not fall into one of the aforementioned categories, 65 items.

The results of this literature scan clearly indicate that the vast majority of research on the topic positions TC as a dependent rather than an independent variable.

Several further literature searches were executed<sup>1</sup> before arriving at the set of articles included in this review. The literature scan and additional searches described Footnote 1 uncovered a total of 14 empirical articles where TC is positioned as the independent variable or as a mediator, 13 of these are cited in Table 1.

The studies that position TC as an independent variable differ in terms of the aspects of TC that are measured, this is discussed in Section 2.2. The body of knowledge on the outcomes of TC is

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<sup>1</sup> The following search was performed in Scopus, yielding 297 results: “(team OR teamwork OR group) w/5 creativity AND (outcomes OR productivity OR output OR turnover OR profit OR wellbeing)”. Filtering steps were applied to filter out articles from publications that fall outside of the fields of psychology, organizational behavior or management; this reduced the list to 198 items. The abstracts of these items were scanned to identify empirical studies where TC is positioned as an independent variable or mediator. Two additional Scopus searches were performed (“(team OR teamwork OR group) w/5 creativity w/5 impact”, and “collective w/5 creativity AND (outcomes OR productivity OR output OR turnover OR profit OR wellbeing OR impact)”); and some articles were uncovered serendipitously.

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summarized into a framework extension presented in Section 2.3. This is followed by a discussion of specific research findings within this body of knowledge. Finally, research gaps that can be identified based on the framework extension are discussed in Section 2.7.

### **2.2 *The measurement of TC***

Three aspects of creativity are measured in the articles included in this review, namely: (i) team / group creativity; (ii) team / group innovation; and (iii) product creativity (operationalized as novelty).

In the Cirella et al. (2014) research, the measurement of TC also varies significantly between the various studies included in the review and the authors note that “pooling these studies together into a common framework can thus be questionable”. However, similar to the scoping of the Cirella et al. (2014) research, the purpose of this research is “not to draw any specific inference on the links between cause and effect” but rather to provide an overview of outcomes of TC that have been studied to improve understanding of the research field and to assist researchers in identifying outcomes on which empirical evidence has not yet been gathered. Therefore the variance in the measurement of TC in the studies included in this review is not considered an impediment to the construction of an extension to the Cirella et al. (2014) framework.

### **2.3 *Suggested expansion of existing framework***

The findings of the literature review on the outcomes of TC are summarized and organized in Table 1. It is proposed that this table is viewed as an extension to the framework summarizing and organizing research on the inputs and mediators of TC that has been developed by Cirella et al. (2014).

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**TABLE 1: Outcomes of TC that have been empirically researched.**

Extended framework elements	Central themes	Key variables / constructs	Examples of contributing scholars
Outcomes: Performance	Team performance	Generalized: performance	Yoon et al. (2010); Peralta et al. (2015); Ratzmann et al. (2018)
		Financial performance	Santos et al. (2015); Sung and Choi (2012)
		Budget adherence	Bonner et al. (2002)
		Schedule adherence	Bonner et al. (2002)
		Competitive performance of product	Im et al. (2013); Bonner et al. (2002)
		Service quality	Peralta et al. (2015)
	Innovation	Innovation implementation	Somech and Drach-Zahavy (2013)
		Innovation complexity	Torugsa and Arundel (2016)
Corporate brand	Corporate brand building	Andriopoulos and Gotsi (2000)	
Outcomes: Affective states	Individual affective states	Job satisfaction	Valentine et al. (2011)
		Turnover intention	Valentine et al. (2011)
	Team satisfaction	Team member's satisfaction	Santos et al. (2015)
Outcomes: Processes	Communication	Task discourse (in teams)	Ratzmann et al. (2018)
	Learning and knowledge creation	Individual's project learning	Parboteeah et al. (2015)
		Knowledge creation practices	Yoon et al. (2010); Song et al. (2012)

Cirella et al.'s (2014) framework contains five elements: (i) “individual-level inputs”; (ii) “team-level inputs”; (iii) “team-level mediators: processes”; (iv) “team-level mediators: emergent states”; and (v) “properties of macro-social system”. It is proposed that the Cirella et al. (2014) framework is expanded though three additional framework elements presented in Table 1, namely: (i) “outcomes: performance”; (ii) “outcomes: affective states”; and (iii) “outcomes: processes”. Table 1 follows the basic structure of Cirella et al.'s (2014) framework by incorporating (i) “framework elements” at the

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highest level of organization; (ii) “central themes” that fall under these framework elements at the second level of organization; and (iii) “key variables / constructs” that are included in each of the central themes at the lowest level of organization. The framework also follows Cirella et al. (2014) in providing examples of contributing scholars that have conducted research on each of the key variables or constructs.

#### **2.4 Findings on the impact of TC on performance outcomes**

Research has considered the impact of TC on three types of performance outcomes, namely: team performance; innovation; and the strength of the corporate brand. Various aspects of team performance are the most thoroughly researched outcome variable in studies where TC is positioned as an independent variable.

##### **2.4.1 Findings on the impact of TC on team performance**

In general, research findings indicate a positive relationship between TC and performance. For example: Sung and Choi (2012) found that TC is a significant predictor of team financial performance; Santos et al. (2015) found that creativity was positively and significantly correlated with team effectiveness; and Im et al. (2013) found that the creativity of a new product developed by a team has a strong, positive effect on competitive advantage. Yoon et al. (2010) found that TC had both a direct impact on team performance and an indirect impact on team performance through teams’ collaborative knowledge creation practices.

In contrast to these findings, Ratzmann et al. (2018) found that the direct impact of TC on a generalized measure of team performance is not statistically significant, but that the indirect impact of TC on team performance through task discourse is significantly positive. Ratzmann et al. (2018) propose that task discourse functions as a mediator between TC and team performance by functioning as a mechanism for team members to challenge the innovation potential of ideas and to refine their ideas.

Bonner et al. (2002) took a different approach, positioning TC (operationalized as product innovativeness) as a moderator of project performance. The researchers hypothesized that product

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innovativeness moderates two relationships, namely: the relationship between the degree of formal process control that is imposed and the project performance; and the relationship between the degree of formal output control that is imposed and the project performance. They found no support for product innovativeness playing such a moderating role.

#### *2.4.2 Findings on the impact of TC on innovation*

Somech and Drach-Zahavy (2013) found that TC translates “to innovation implementation only under high levels of climate for innovation”. The Team Climate Inventory scale which was used in the study consists of four subscales: participative safety; support for innovation; vision; and task orientation. Somech and Drach-Zahavy (2013) conclude that the role of these four aspects of the climate for innovation may be particularly critical considering that the implementation of innovations in the contemporary environment are “characterized by a higher degree of interdependence”, specifically when the innovations are delivered in a team context.

Torugsa and Arundel (2016) investigated the impact of both individual creativity and TC on the complexity of innovation that is generated, where the complexity of an innovation is related to the number of dimensions of the innovation. The researchers established that TC is positively and significantly related to the complexity of innovation, and that in turn, the variety of organizationally relevant benefits that result from an innovation increases as the complexity of the innovation increases.

#### *2.4.3 Findings on the impact of TC on corporate brand*

Andriopoulos and Gotsi (2000) report that in three case studies within the creative industry, interviewees indicated that TC impacts corporate brand building. The conceptual framework that was developed based on the data gathered through interviews and observations in organizations indicates a circular effect with the strength of the corporate brand impacting employee management practices which, in turn, impact TC.

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## **2.5 Findings on the impact of TC on affective state**

The impact of TC on affective state has been evaluated at both the individual- and the team-level.

### *2.5.1 Findings on the impact of TC on individual affective state*

In terms of individual affective state, Valentine et al. (2011) considered two outcomes: job satisfaction and turnover intention. They found support for their hypothesis that group creativity is associated with increased job satisfaction, but did not find support for their hypothesis that group creativity is associated with decreased turnover intention.

### *2.5.2 Findings on the impact of TC on team affective state*

In terms of team affective state, Santos et al. (2015) found that creativity mediated the relationship between shared mental models and team satisfaction.

## **2.6 The impact of TC on processes**

Research has investigated the impact of TC on two process outcomes, namely communication and learning or knowledge creation.

### *2.6.1 The impact of TC on communication*

As mentioned previously, Ratzmann et al. (2018) positioned task discourse as a mediator between TC and performance and found that TC had a significant indirect positive impact on performance through task discourse. This finding was discussed more thoroughly in Section 2.4.1.

### *2.6.2 The impact of TC on learning and knowledge creation*

Parboteeah et al. (2015) found marginal support (at  $p < 0.1$ ) for their hypothesis that TC is positively related to individual learning. They propose that “a creative team environment allows individuals to reframe their thinking to be able to integrate other’s perspectives and positions and thus learn in the process”.

Both Yoon et al. (2010) and Song et al. (2012) found that TC impacts knowledge creation practices. Though Song et al. (2012) found that TC explained a significant amount of the variance in knowledge

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creation practices in the school system, they did not find support for their hypothesis that task-related job autonomy moderates the relationship between TC and organizational knowledge creation practices.

### **2.7 *The current gap in empirical research***

It is evident from the extension to the organizing framework for knowledge on TC, presented in Section 2.3, that research on the outcomes of TC has been limited in scope.

Though at least eight studies have investigated the impact of TC on team performance, our search has uncovered only two studies that have empirically investigated the impact of TC on innovation. Given Somech and Drach-Zahavy's (2013) finding that TC results in the implementation of innovation only under specific circumstances, and Ratzmann et al.'s (2018) conclusion that TC does not necessarily result in innovation, it is evident that the very limited knowledge on the mediators and moderators that impact the relationship between TC and innovation represents an important gap in the body of knowledge on TC. Furthermore, with the exception of Ratzmann et al. (2018) and Yoon et al. (2010), none of the studies that investigate the impact of TC on team performance consider the role of potential moderators or mediators of the relationship. This lack of knowledge on the nature of the relationship between TC and team performance represents another important gap in the body of knowledge on TC.

The results of the literature review also support the notion of a positive bias in creativity literature, as alluded to in Section 1. As discussed, it is plausible that under certain boundary conditions TC could lead to negative outcomes, yet our search has not uncovered any research on the impact of TC on potential negative outcomes.

Finally, though there has been some research on the impact of TC on affective states and processes, our search indicates that this has been limited in scope. Cirella et al.'s (2014) framework clearly indicates that a large variety of processes and emergent states have been studied as antecedents of TC. Therefore, before recommendations on further research on processes and affective states can be made,



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it is necessary to consider whether the identification of a variable as an antecedent of TC implies that it cannot also be an outcome of TC.

In the remainder of this paper, a P-E fit perspective is applied in order to develop a model that can be used as conceptual basis for identifying directions for future research to address the gaps in the body of knowledge on TC that have been identified here.

### **3 IDENTIFYING DIRECTIONS FOR FUTURE RESEARCH: A PERSON-ENVIRONMENT FIT PERSPECTIVE**

A P-E fit perspective was employed by Shalley et al. (2004) in their influential review of empirical research on personal or contextual characteristics that impact employee creativity in organizations. In this section, a fit model for TC is developed as an aid for identifying directions for future research on the outcomes of TC.

#### ***3.1 Introduction to the person-environment fit perspective***

P-E fit is broadly defined as “the compatibility between an individual and a work environment that occurs when their characteristics are well matched” (Kristof-Brown et al., 2005). Conceptualizations of fit can be grouped into two categories: (i) supplementary fit, the extent to which “the individual and the environment are similar” (Kristof-Brown et al., 2005); and (ii) complementary fit, the extent to which the “individual’s characteristics fill a gap in the current environment, or vice versa” (Kristof-Brown et al., 2005). Complementary fit can be further sub-divided into (i) demand-abilities fit, the extent to which the individual’s skills meet the environmental needs; and (ii) need-supplies fit, the extent to which the “individual’s needs are met by environmental supplies” (Kristof-Brown et al., 2005).

Different types of fit have been defined with the four types most frequently researched being (Chuang et al., 2016):

- person-organization fit, defined as “the compatibility between people and organizations that occurs when: (a) at least one entity provides what the other needs, or (b) they share fundamental characteristics, or (c) both” (Kristof, 1996);

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- person-group fit, which considers “the interpersonal compatibility between individuals and their work groups” (Kristof-Brown et al., 2005), where the group may be defined in many different ways, including as the immediate co-workers or simply as colleagues within any sub-unit of the organization (Kristof, 1996);
- person-job fit, defined as the fit between either “the demands of a job and the abilities of an individual” (Chuang et al., 2016) or “the needs of a person and the supplied attributes of a job” (Chuang et al., 2016); and
- person-supervisor fit, which considers the match between and employee and a supervisor in terms of value congruence, personality similarity, goal congruence, etc. (Kristof-Brown et al., 2005).

A large body of research considers the outcomes of various types of P-E fit at an individual-, team- and organizational-level. Kristof (1996) proposed that perceived fit would have a more pronounced impact on individual attitudinal outcomes while actual fit would have a more pronounced impact on process and performance outcomes. Cable and DeRue (2002) found that the various types of fit relate uniquely to specific outcomes. When thinking about the impact of fit, it is therefore appropriate to be specific about the type of fit being considered; and to evaluate its impact at various levels in an organization.

Though the vast majority of fit literature considers the person-related type of fit, a team-related type of fit has also been proposed. DeRue and Hollenbeck (2012) propose a model that defines both internal and external fit in teams. The external fit “refers to the alignment between certain team characteristics and the external environment”.

### **3.2 *The person-environment fit perspective on creativity***

In a review of research on employee creativity in general (not TC specifically), Shalley et al. (2004) employ a P-E fit perspective, arguing that “creativity is a function of the employee’s personal characteristics, the characteristics of the context in which he or she works, and also interactions among these characteristics”. Shalley et al. (2004) use Cognitive Evaluation Theory to reason that an

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alignment between contextual factors and individual preferences results in individuals experiencing contextual factors as informational rather than controlling. This experience is theorized to enhance (rather than diminish) intrinsic motivation. Shalley et al. (2004) propose that “each contextual variable affects creativity via its effect on employees’ ‘intrinsic motivation’ to perform a work assignment”. Furthermore, Shalley et al. (2004) argue that the interaction between different contextual variables may play a role in how salient a particular contextual variable is to an employee, which may in turn impact intrinsic motivation and creativity via the same process described earlier.

### 3.3 *A fit model for TC*

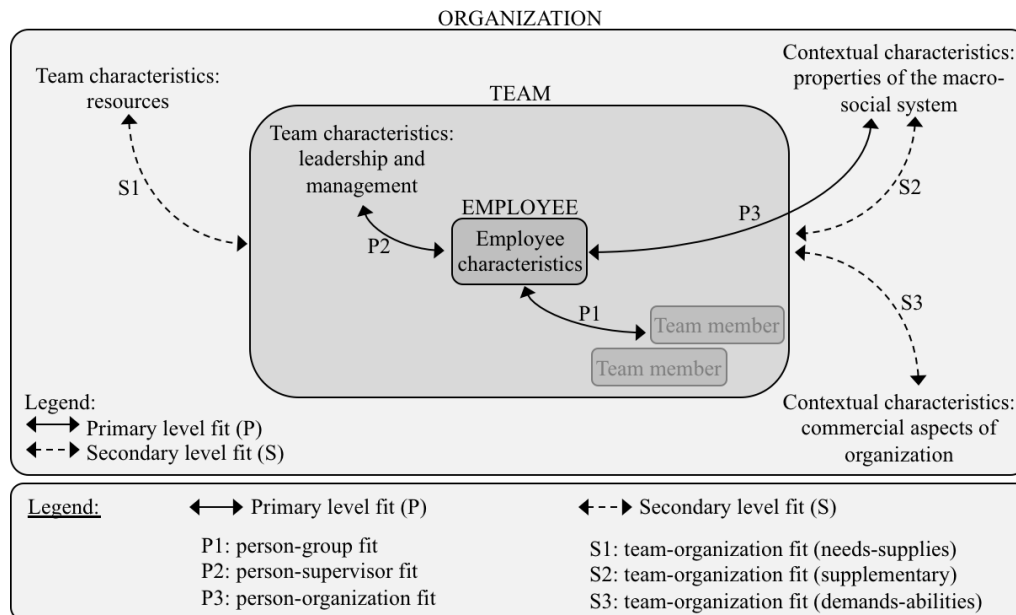
Shalley et al.'s (2004) proposed relationship between individual creativity and an employee’s personal characteristics and the context in which he or she works, can be expanded to propose a fit model for TC, depicted in Figure 1. It is proposed that:

*TC is a function of: the characteristics of each of the employees in the team, the team itself, and the context in which the team operates; the interaction amongst these sets of characteristics; and the team-level mediators.*

The “characteristics of each employee in the team” is equivalent to both the “employee’s personal characteristics” as defined by Shalley et al. (2004) and to the “individual-level inputs” as defined in Cirella et al.'s (2014) framework and includes factors such as basic demographics, personality, motivation and skills. The “characteristics of the team itself” is equivalent to the “team-level inputs” as defined in Cirella et al.'s (2014) framework and includes characteristics of the team’s management and leadership as well as the resources (such as time, budget and physical space) available to the team. Finally, the “characteristics of the context in which the team operates” include both properties of the macro-social system and commercial aspects of the organization. Cirella et al. (2014) include aspects of the work environment, such as the climate for creativity and the organizational culture, as “properties of the macro-social system”. More recent studies on creativity have also included (i) aspects of strategic HR management such as high-commitment work systems (Chang *et al.*, 2014) and high-performance work systems (Zhu and Chen 2014); and (ii) perceptions of organizational justice

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(Janssen, 2004) as contextual variables. Relevant commercial aspects of the organization include the outputs that are required from the team for the organization to accomplish its commercial goals.



**FIGURE 1: Depiction of primary and secondary level fit in the fit model for TC.**

The “team-level mediators” include both the process mediators and the emergent states mediators proposed by Cirella et al. (2014). Process mediators include team learning and development (e.g. cognitive phases and the progression of emotional states such as the socialization process) as well as the interaction between both: team members; and team members and non-team members. Emergent states mediators include the team climate (e.g. the clarity of objectives and participation in decision-making) and affective states (e.g. trust and empathy).

Within this fit model for TC, fit is relevant at two levels. The labels assigned to the various types of fit described here correspond to those used in Figure 1. The primary level remains that of the individual (person) and their person-group (P1), person-supervisor (P2), and person-organization (P3) fit. At the secondary level, it is proposed that there is also: (i) a needs-supplies fit between the team and the organization (S1), specifically related to the provision of resources to the team by the organization; (ii) a supplementary type fit between the team and the organization (S2), specifically related to the

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congruence between the properties of the macro-social system and the team characteristics; and (iii) a demands-abilities type fit between the team and the organization (S3), specifically related to the team's ability to support the organization in achieving its commercial goals. It is proposed that fit at both the primary and the secondary level is moderated by team-level process and emergent state mediators. Examples of this proposed moderation include: the socialization process that improves person-group (P1) fit and team learning that may reduce the team's need for a specific organizational resource, thereby moderating the needs-supplies (S1) fit.

In terms of the impact of fit on TC, it is proposed that Shalley et al.'s (2004) Cognitive Evaluation Theory-based reasoning to explain the impact of fit on intrinsic motivation and thereby on the creativity of the individual remains relevant and is applicable to fit at the primary level in the model. One aspect of a team's creative output is the collective output of its members, and individual intrinsic motivation and creativity therefore plays a role. However, it is proposed that person-group fit at the primary level (P1 in Figure 1) also impacts TC through its influence on group cohesiveness and on co-operation and interaction within the group. Findings on the impact of group cohesiveness on TC differ, with Staw (2009) describing a "cohesion-creativity divide" in literature, however literature does agree that cohesion has an impact on TC. Co-operation and interaction within the group are required to generate the team creative outputs that occur at the collective level, i.e. creative outputs that are not generated by a single group member, but by team-level creative synergy (Hargadon and Bechky 2006).

At the secondary level of fit, improved needs-supplies (S1) and supplementary (S2) fit are proposed to support the functioning of the team, thereby indirectly supporting TC.

In terms of the impact of TC on outcomes, Somech and Drach-Zahavy's (2013) findings on the role of climate for innovation in facilitating the translation of TC into the implementation of innovation appears to support the fit model for TC. Specifically, three of the aspects of the climate for innovation investigated in Somech and Drach-Zahavy's (2013) research, namely participative safety, support for innovation, and vision, are likely to be positively influenced by an improvement in various of the fit relationships identified in Figure 1. Participative safety will likely be influenced by both improved

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person-group fit (P1) and improved person-supervisor fit (P2); the group's perception of the level of support for innovation will likely be positively influenced by improved person-supervisor (P2), person-organization (P3), and supplementary team-organization (S2) fit; and vision (as assessed in the climate for innovation scale) is strongly related to the emergent states mediators category of "team-level mediators".

Finally, in terms of the impact of TC on outcomes in a more general sense, it is proposed that improved supplementary (S2) fit as well as improved demands-abilities (S3) fit will improve the outcomes that result from TC. Improved supplementary (S2) fit is expected to ensure that the team's creative output is more acceptable to the organization and therefore has a greater likelihood of impacting organizational processes and decision-making. Lastly, it is proposed that improved demands-abilities (S3) fit will ensure that the team's creative output is more aligned to the commercial needs of the organization, thereby contributing to organizationally relevant outcomes.

#### **4 DIRECTIONS FOR FUTURE RESEARCH ON OUTCOMES OF TC**

The proposed link between improved fit (S2 and S3) and improved outcomes from TC relies on a mechanism whereby improved alignment (of the manner in which TC is executed or that which the TC is directed at) ensures that TC contributes to outcomes that are significant to the organization. An example from individual creativity literature illustrates this point well: Zhou and George (2001) found that, under certain circumstances, job dissatisfaction leads to increased employee creativity. This is an interesting finding, but it is not clear whether this employee creativity is directed exclusively at the source of the employee's dissatisfaction or whether it is also directed more broadly at challenges in the organization. It is, therefore, unclear to what extent this increased employee creativity would contribute to improving outcomes that are meaningful to the organization.

Three research gaps were evident from the extension to Cirella et al.'s (2014) framework presented in Section 2, namely: limited research on performance outcomes; a lack of research on potential negative outcomes; and limited research on processes and emergent states as outcomes. In this section,

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directions for future research to address these research gaps are proposed by applying a P-E fit perspective, as operationalized in the fit model for TC.

#### **4.1 General considerations for future research**

It is proposed that, commensurate with existing empirical research on P-E fit (Kristof-Brown et al., 2005), it is appropriate to consider the impact of TC on outcomes at different levels in the organization. This recommendation aligns to the existing body of research on the outcomes of TC, summarized in Table 1, which includes organizational-level outcomes (e.g. strength of the corporate brand), team-level outcomes (e.g. team performance), and individual-level outcomes (e.g. job satisfaction).

As discussed in Section 2.7, it is necessary to consider whether the identification of a variable as an antecedent or mediator of TC implies that it cannot also be an outcome of TC. The fit model for TC presented in Figure 1 is aligned with Cirella et al.'s (2014) view of TC as a complex adaptive system and it provides a useful perspective on this question. In a complex adaptive system, the elements of the system interact and are therefore continuously influencing one another in a cyclical manner. When TC is viewed from this perspective, it becomes evident that in certain cases, it is too restricting to label a variable exclusively as an antecedent, a mediator or an outcome of TC. From a complex adaptive systems perspective, certain variables will simultaneously function as either antecedents or mediators, and as outcomes, of TC. It is therefore proposed that certain variables that have been identified as either antecedents or mediators of TC can also be studied as outcomes of TC.

Mathieu et al. (2008) remark on an increased awareness of temporal dynamics in teamwork and propose that, at different stages during a team's life cycle, performance behaviors such as creativity may be viewed as "outcomes of interest, yet at other stages they are antecedents or mediators driving performance outcomes". In line with recommendations by Mathieu et al. (2008), it is recommended that incorporating a temporal dimension into studies would enable an improved understanding of the cyclical manner in which certain variables and TC may interact over time. Various factors, such as the team's intended tenure (or longevity), and the episodic nature of the performance environment within

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which teams work (see Mathieu et al. (2008) for more detail) also determine whether a temporal element should be considered when researching the outcomes of TC.

#### **4.2 Proposed research on performance outcomes**

As discussed in Section 2.7, the limited research on innovation as an outcome of TC as well as the limited research on the nature of the relationship between TC and team performance, represents an important gap in the body of knowledge on TC.

Bearing the proposed role of improved demands-abilities (S3) fit in mind, it is conceivable that team goal clarity and commitment may play a moderating role in ensuring that TC is directed at the commercial needs of the organization, thereby improving the fit between the abilities of the team and the demands of the organization. Furthermore, it is conceivable that creative ideas that are directed at the commercial needs of the organization would be more likely to be implemented, thereby resulting in innovations. Though goal clarity forms part of the vision subscale of the climate for innovation that Somech and Drach-Zahavy (2013) investigated as a moderator of the relationship between TC and innovation implementation, it is proposed that research that more explicitly investigates the potential moderating role of goal clarity and goal commitment on this relationship would be valuable. In light of the limited understanding of the nature of the relationship between TC and team performance, it is proposed that it would be valuable to research goal clarity and goal commitment as a moderator of this relationship as well.

In a study that echoes Somech and Drach-Zahavy's (2013) findings, Ceschi et al. (2014) found that the climate for innovation in teams, encompassing participative safety, support for innovation, and interaction frequency, is positively related to the team's financial performance. The expected impact of various forms of fit depicted in Figure 1 on participative safety and support for innovation was discussed in Section 3.3. De Dreu et al. (2008) add another perspective on the relationship between TC and innovation, arguing that "creativity is turned into innovation especially when group members exchange and process information and ideas in an open-minded yet critical way". This echoes Ratzmann et al.'s (2018) findings on the role of task discourse as a mediator between TC and team



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performance. Interaction frequency, task discourse, and communication between team members in general is likely to be facilitated by improved person-group (P1) fit. In teams where members are not physically co-located, the needs-supply team-organization (S1) fit may also play a role by providing access to technology and other resources that could facilitate ease of communication across a distance. It is proposed that research that investigates the impact of participative safety, communication within the team, and support for innovation within the team, as distinct variables rather than as part of a compound construct, would be valuable in providing deeper insights into the nature of the relationship between TC and innovation and the relationship between TC and team performance.

Lastly, considering Torugsa and Arundel's (2016) findings on the role of “complexity of innovation” as a mediator between workplace creativity and the diversity of outcomes that were impacted, it could be valuable to also consider how innovation can act as a mediator between TC and other organizationally meaningful outcomes.

#### **4.3 Proposed negative outcomes to research**

The third research gap that has been identified from the literature review presented in Section 2, is a lack of research on potential negative outcomes of TC. It is proposed that researching unethical behavior of teams as a potential team-level outcome of TC, and strain experienced by team members as a potential individual-level outcome of TC, would be valuable.

Though findings on a relationship between individual creativity and unethical behavior (Mai et al. 2015; Niepel et al. 2015; Gino and Ariely 2012; Bryant et al. 2011; Mumford et al. 2010; Bierly et al. 2009) have been mixed, the fact that the existence of such a relationship receives research attention should be of interest to organizations that pro-actively attempt to support creativity. It is proposed that it is particularly important to understand whether this individual phenomenon is replicated at the team level. Thus, it is important to understand whether TC can lead to unethical behavior by the team under specific circumstances. Such research would contribute to addressing the positive bias criticism that has been levelled at creativity research. With reference to the fit model for TC, it would be reasonable

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to expect that congruence between the organization's ethical values and both the individual employees' ethical values (P3) and the team's ethical values (S2) could further serve to strengthen the impact of corporate ethical values on any relationship that may exist between TC and unethical behavior at the team level. It is proposed that it would be valuable to explore whether any potential relationship between TC and unethical behavior by the team is moderated by the team members' perception of organizational justice or corporate ethical values

The positive bias criticism could also be addressed by considering potential negative impacts that TC may have on individual team members. For example, the taxing nature of creativity is recognized in literature and the relationship between individual creativity and strain has received research attention. More specifically: Livingstone et al. (1997) incorporated a P-E fit perspective and determined that, at an individual level, both supplies for creativity and a fit between demands for creativity and abilities for creativity has an impact on strain; and Janssen (2004) established that perceptions of fairness in organizations moderate a relationship between individual innovative behavior and stress. It is conceivable that TC could also result in strain on the individual team members. From the perspective of the fit model for TC, the impact of the needs-supplies fit of the team within the organization (S1) could be investigated to determine whether this impacts any strain that members of a creative team may experience. Furthermore, cognizant of Duan et al.'s (2017) proposition that "value congruence between an employee and their organization may enhance an employee's perception of fairness", both the individual- (P3) and the team-level (S2) supplementary fit may influence perceptions of fairness, thereby buffering employees from strain due to TC. It is proposed that it would be valuable to investigate the following research question: does increased TC result in increased strain on individual team members, and does stress that is experienced by individual team members (such as work ambiguity) moderate the relationship between TC and the strain experienced by individual team members.

## 5 CONCLUSION

The current body of knowledge on the outcomes of TC has been summarized into an extension to the Cirella et al. (2014) framework. Three gaps in the body of knowledge that can be identified from this

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framework extension are: limited research on performance outcomes; a lack of research on potential negative outcomes of TC; and limited research on processes and emergent states as outcomes of TC.

The P-E fit perspective that has been applied to explain the impact of individual and contextual variables on individual creativity can be applied to generate the fit model of TC, which is aligned to a view of TC as a complex adaptive system. This conceptual model can be used to explain how TC may impact outcomes at the organizational-, team-, and individual-level.

It is proposed that certain variables that have been examined as antecedents or mediators of TC could also be examined as outcomes of TC. Furthermore, incorporating a temporal dimension into such research could improve the understanding of the cyclical manner in which certain variables and TC may interact over time. Furthermore, it is proposed that the moderating role of goal clarity and goal commitment, participative safety, communication, and support for innovation on the relationship between TC and innovation, and on the relationship between TC and team performance should be investigated. It is also proposed that unethical decision-making and strain should be researched as two potential negative outcomes of TC. Such research would further expand the body of knowledge on the outcomes of TC, which is expected to hold significant value both for practitioners and the academic community.

An important limitation of this study is that, in spite of the extensive literature searches that were performed, it is possible that some publications where TC is positioned as an independent variable in empirical research may not have been uncovered. A second important limitation is that the three gaps in the body of knowledge on the outcomes of TC that have been identified in this research are not exhaustive. Therefore, in addition to the suggestions for future research presented in this paper, several other valuable avenues for future research are also likely to exist.

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## 6.2 Conclusion: Empirical knowledge on outcomes

### **6.2 Conclusion: Empirical knowledge on outcomes**

An article providing a narrative literature review of research that has been conducted on outcomes of team creativity was presented in this chapter. In summary, research has focused on three groups of outcomes, namely performance, affective state, and processes with “limited knowledge on performance outcomes and a lack of research on potential negative outcomes” constituting important gaps in the body of knowledge. The following chapter contains empirical research on one of the potential negative outcome of team creativity that have been conceptualised in the research presented in the present chapter.

## Chapter 7

# Empirical study: When team creativity leads to unethical behaviour

Position of Chapter 7 in dissertation structure.		
Chapter	Chapter type	Chapter topic
<b>Part I: Research rationale (RO1)</b>		
<b>Part II: Framework feasibility (RO2)</b>		
<b>Part III: Antecedents of team creativity (RO3)</b>		
<b>Part IV: Outcomes of team creativity (RO4)</b>		
6	Published article	Narrative literature review of outcomes of team creativity and development of a generalised conceptual model to facilitate theorising on outcomes.
7	Unpublished article	Objectives 4.4–4.5: Development of a conceptual model linking team creativity to a specific proposed outcome, non-experimental hypothesis-testing research based on the conceptual model.
<b>Part V: Conclusion</b>		

As argued in the previous chapter, it is feasible that, under specific circumstance, team creativity may either not result in positive outcomes that are meaningful to an organisation, or it may result in negative outcomes that are undesirable for an organisation. It is therefore prudent to have a more thorough understanding of the outcomes, and of the factors that drive different outcomes, before one can responsibly encourage organisations to expend effort towards increasing team creativity. In this second and final chapter of Part IV of the dissertation, empirical research on a potential negative outcome of team creativity is



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## 7.1 RO4.4 & 4.5: Unpublished article

presented. This is intended to make a contribution to the maturity of the body of knowledge on outcomes of team creativity as a key conclusion presented in Part II of the dissertation, is that the body of knowledge on the outcomes of team creativity does not appear to be sufficiently mature to support the development of a framework.

### 7.1 RO4.4 & 4.5: Unpublished article

An unpublished article that describes empirical research on a potential negative outcome of team creativity, namely unethical behaviour by the team, is presented in this chapter. As discussed in the article contained in Chapter 6, a thorough search of literature has not uncovered any existing empirical research that investigates whether, under certain circumstances, team creativity can lead to unethical behaviour. As such, the research presented in this unpublished article represents a novel contribution to empirical knowledge on the outcomes of team creativity.

The selection of unethical behaviour as the outcome variable of interest is also motivated by the engineering context. Both the Engineering Council of South Africa and the US-based Accreditation Board for Engineering and Technology highlight an awareness and responsibility in terms of ethical conduct as part of the set of graduate attributes that an engineering programme must achieve in order to be accredited.

The formal declaration of author contributions, as required for publications included in dissertations by Stellenbosch University, is provided in Appendix A.

**WHEN TEAM CREATIVITY AND STRESS MEET:**

**FERTILE GROUND FOR TEAM UNETHICAL BEHAVIOUR**

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**ABSTRACT**

The link between individual creativity and unethical behaviour has been established in several empirical studies, but does this association extend to the team level? If it does, under what conditions will team creativity lead to team unethical behaviour, and through which mechanisms? In this research we address these questions by developing and testing a multi-level model that: explores the mechanisms (i.e. moral justification and displacement of responsibility) through which team creativity may produce team unethical behaviour; and suggests that the level of work stress (both challenge and hindrance stressors) within the team is an important boundary condition for the relationship between team creativity and unethical behaviour at the team level. We tested our hypotheses in 34 teams (107 respondents) in one firm. Results support our hypothesis that team creativity has a conditional indirect positive impact on team unethical behaviour at high levels of challenge stressors through one of two mediators, namely: moral justification, and displacement of responsibility. Furthermore, team creativity also has a conditional indirect positive impact on team unethical behaviour at high levels of hindrance stressors through the mediator, displacement of responsibility.

## INTRODUCTION

Unethical behaviour is not an exclusively individual phenomenon, it can also occur at a team level (Pearsall & Ellis, 2011). The 2015 Volkswagen emissions scandal is a prominent example of unethical behaviour that was not perpetrated or concealed by individuals acting alone, but collectively by various stakeholders within the organisation (Hassler, 2016; Jung & Park, 2016; Rhodes, 2016). Ethical failings can cause organisations, employees, and consumers significant harm and the topic has contemporary relevance as such failings on the part of both corporations and governments continue to make headlines in the popular press. Despite the increased use of work teams in organisations, there has been limited research that specifically investigates “the developmental aspects of employee ethical decision-making in a team environment” (White & Lean, 2008). Pearsall & Ellis (2011) concur that there has been limited research on “collective ethical behavior by teams” and state that, as organisations increasingly rely on teams to make decisions, especially at senior levels in the organisation, “it is essential to understand the drivers of unethical behavior from a team level of analysis”.

The existence of a relationship between individual creativity and unethical behaviour has been investigated in several empirical studies with most finding a positive relationship (Gino & Ariely, 2012; Mai, Ellis, & Welsh, 2015; Vincent & Kouychaki, 2016). Baucus, Norton, Baucus, & Human (2008) describe how four categories of behaviour that are commonly prescribed methods for increasing creativity in organisations are ethically problematic. These categories include: breaking rules or not conforming to standard operating procedures; challenging authority; creating conflict; and taking risks. Given the ubiquity of team work, previous findings of a relationship between individual creativity and unethical behaviour by individuals, the ethically problematic nature of a number of prescribed methods for increasing creativity in organisations, and the significant potential harm associated with unethical behaviour, the lack of research on the existence of a relationship between team creativity and unethical behaviour represents an important research gap.

## 7.1 RO4.4 & 4.5: Unpublished article

The research is framed by the theory of moral disengagement, an extension of Bandura's (1991) more general social cognitive theory<sup>1</sup>. The theory of moral disengagement proposes that individuals are able to engage in unethical acts when their cognitive links between "transgressive behaviour and the self-sanctioning that should prevent it" become disabled (Moore, Detert, Treviño, Baker, & Mayer, 2012). According to Bandura's theory, eight cognitive mechanisms exist that facilitate this moral disengagement, including moral justification, displacement of responsibility, and diffusion of responsibility (Moore et al., 2012). Diffusion of responsibility is particularly relevant in explaining how acting collectively within a team environment may influence the likelihood of engaging in unethical behaviour. Moral justification and displacement of responsibility, on the other hand, have been found to act as mediators between various antecedents and unethical behaviour (Barsky, 2011; Gino & Ariely, 2012). We include moral disengagement as a mediator in our conceptual model, depicted in Figure 1.

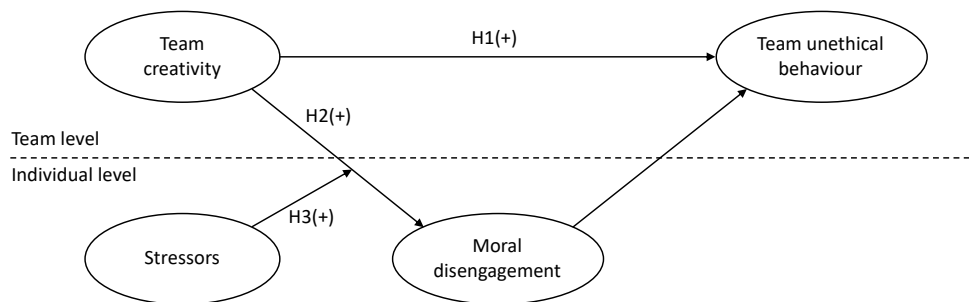
Finally, we include stress as a moderating variable in our research. Stress has been identified as an antecedent of unethical behaviour in a number of previous studies (Liu, Zhao, & Liu, 2018; Parlangeli, Guidi, Marchigiani, Bracci, & Liston, 2019; Ripoll & Breugh, 2019; Schwepker & Good, 2017; van Zyl & Lazenby, 2002). Stress also continues to be topical in the contemporary climate. Though results from the American Psychological Association's (2018) annual Stress in America survey do not display an increasing trend, the range and prevalence of symptoms of stress reported by respondents, are concerning. The inclusion of stress as a moderator aligns with Bandura's (1991) social cognitive theory which proposes that individuals are prevented from engaging in unethical behaviour by self-

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<sup>1</sup> Social cognitive theory proposes that "human behavior is extensively motivated and regulated by the ongoing exercise of self-influence" (Bandura, 1991). Self-regulation is enacted through three sub-functions, namely: "self-monitoring of one's behavior, its determinants, and its effects; judgment of one's behavior in relation to personal standards and environmental circumstances; and affective self-reaction" (Bandura, 1991).

regulation. As self-control is a depletable resource (Muraven & Baumeister, 2000), dealing with stress reduces self-control thereby reducing an individual's ability to self-regulate.

**FIGURE 1: Hypothesised model**



The conceptual model depicted in Figure 1 is developed in the following sections.

## THEORY AND HYPOTHESES

### *Unethical behaviour in teams*

Can unethical behaviour truly occur at a collective level, or is it in fact always an individual activity? Robinson & O'Leary-Kelly (1998) investigated antisocial behaviour (including a broad variety of unethical conduct such as deception, theft, and the withholding of effort) as a group-related activity. The authors propose that, though group-level explanations for antisocial behaviour exist, the decision to engage in the behaviour remains an individual one, and group-level explanations are therefore supplementary to, rather than a replacement of, individual-level explanations. The authors found that "even with many other explanatory variables controlled, the antisocial behavior exhibited by a work group was a significant predictor of an individual's antisocial behavior at work". In this research, we employ a perspective that is aligned to Robinson & O'Leary-Kelly's (1998) findings, namely: though the decision to engage in unethical behaviour undoubtedly remains an individual one, groups of individuals can collectively act unethically, and as the collective unethical behaviour displayed by the team increases, it becomes more likely that individual team members will join in.

## 7.1 RO4.4 & 4.5: Unpublished article

Employing a social cognitive theory perspective, Bandura, Barbaranelli, & Caprara (1996) explain that one of the mechanisms through which “the exercise of moral control is ... weakened” is diffusion of responsibility for unfavourable conduct, which works to obscure personal agency. Such diffusion of responsibility can be achieved through collective decision-making, collective action, or the division of labour (Bandura et al., 1996). Building on the theory of diffusion of responsibility, Conrads, Irlenbusch, Rilke, & Walkowitz (2013) propose that individuals act more unethically in a team-based environment because their unethical actions “cannot unambiguously be attributed to them individually”. Though not directly equivalent, the concept of diffusion of responsibility does relate somewhat to Festinger, Pepitone, & Newcomb's (1952) theory of de-individuation which proposes that “under conditions where the member is not individuated in the group, there is likely to occur for the member a reduction of inner restraints against doing various things”.

Based on the aforementioned, we conclude that it is valid to examine unethical behaviour at the team level.

### ***Individual-level findings on creativity and unethical behaviour***

Several studies have established the existence of a relationship between individual creativity and individual unethical behaviour. For example, Gino and Ariely (2012) conclude that individuals with a creative disposition engage in unethical behaviour more frequently and that the impact of a creative disposition on unethical behaviour is facilitated through an increased ability to justify the unethical behaviour. Gino and Ariely (2012) propose that two aspects of creativity increase individuals' ability to justify unethical behaviour, namely: the divergent thinking aspect of creativity helps individuals to “develop original ways to bypass moral rules”; and the cognitive flexibility aspect of creativity helps individuals to “reinterpret available information regarding their own behavior in a self-serving way”.

Both Gino and Ariely (2012) and Mai, Ellis and Welsh (2015) investigated the impact of the interaction of creative disposition and an activated creative mindset on the likelihood of engaging in unethical behaviour, with differing findings. Gino and Ariely (2012) found that, for individuals with a low level

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## 7.1 RO4.4 & 4.5: Unpublished article

of dispositional creativity, an activated creative mindset significantly increases the likelihood of unethical behaviour, while it slightly decreases the likelihood for individuals with high levels of dispositional creativity. In contrast, Mai, Ellis and Welsh (2015) found that for individuals with a low level of dispositional creativity, an activated creative mindset slightly increases the likelihood of unethical behaviour, whilst for individuals with a high level of dispositional creativity it significantly increases the likelihood of unethical behaviour. Thus, though there is consensus that creative disposition and an activated creative mindset interact to impact unethical behaviour, there have been differing findings on the nature of the impact.

Shifting the focus from a creative disposition to a creative identity, Vincent and Kouychaki (2016) found that individuals with a creative identity are more likely to engage in dishonest behaviour. The authors propose that creative identity impacts dishonest behaviour by facilitating a sense of entitlement, linked to a perception of creativity as a rare trait.

In addition to the role of creative identity, two recent publications have drawn on the theory of moral disengagement to investigate the impact of moral identity on the link between individuals that are creative and unethical behaviour. Zheng, Qin, Liu, & Liao (2017) conclude that creativity predicts moral disengagement and consequently unethical behaviour only when individuals' level of moral identity is low. Thus Zheng et al. (2017) found that moral identity is a boundary condition for individual creativity leading to unethical behaviour. Keem, Shalley, & Kim's (2018) findings concur that employees that are high on both dispositional creativity and moral identity are less likely to disengage morally and therefore to act unethically. Furthermore, Keem et al. (2018) propose that moral imagination and moral disengagement are two parallel mechanisms that serve to either facilitate or inhibit unethical behaviour. Keem et al. (2018) found that individuals that are high on both dispositional creativity and moral identity are more likely to be high on moral imagination and are therefore less likely to act unethically.

## 7.1 RO4.4 & 4.5: Unpublished article

Keem et al.'s (2018) finding on increased moral imagination linked to the intersection of dispositional creativity and moral identity ties in with research by both Wang (2019) and Bierly, Kolodinsky and Charette (2009) that highlights the complexity of the relationship between creativity and ethics. Though both Wang (2019) and Bierly et al. (2009) found that creativity is associated with a pragmatic approach to moral or ethical decision-making, the studies uncovered nuance in the actions of creative individuals. Wang's (2019) findings indicate that creative individuals tend to: "ingeniously use loopholes to circumvent the rules" rather than directly breaking the rules; be more approving of such actions when these are taken on moral grounds; and be more likely to justify "morally debatable issues", but not clearly immoral issues. These findings align with Bierly, Kolodinsky and Charette's (2009) finding that, in terms of Forsyth's (1980, 1992) two ethical ideologies, creative people tend to be high in both ethical idealism and ethical relativism<sup>2</sup>. Bierly et al. (2009) therefore find that, though creative individuals tend to be less likely to adhere to universal moral principles, "relying instead on idiosyncratic decision-making processes for each moral situation", they have an increased social sensitivity and are therefore more likely to have a "desire to avoid harm to others". Bierly et al.'s (2009) study did not empirically uncover an explanation for the relationship between creativity and idealism, but the authors propose that the role of intrinsic motivation in creativity (as proposed in seminal works, such as Shalley, Zhou, & Oldham (2004)) may offer an explanation. Bierly et al. (2009) propose that "creativity and idealism may be associated because the powerful effects of intrinsic motivation require mutual respect and care between an individual and those in his or her social environment".

Finally, there have also been studies that have found a negative association between individual creativity and specific aspects of ethical decision-making. For example: Mumford et al. (2010) found

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<sup>2</sup> The ethical ideology of relativism describes "the degree to which an individual accepts or rejects universal moral principles and rules (e.g., never steal; always tell the truth; killing is always wrong) when making decisions of a moral nature", while the ethical ideology of idealism describes an individual's concern for the welfare of others (Bierly et al., 2009).



## 7.1 RO4.4 & 4.5: Unpublished article

that “creative thinking skills are positively related to ethical decision-making among doctoral students in the sciences”; Bryant, Stone and Wier (2011) found no evidence that accountants that are more creative are less ethical; and Niepel et al. (2015) found “that creativity is not a general predictor of decreases in ethical decision making”. As evidenced in this brief overview of literature on the topic, however, positive findings on the association between individual creativity and various aspects of ethical decision-making significantly outnumber negative findings.

Consequently, we formulate the following hypothesis:

**H1: Team creativity has a direct positive impact on team unethical behaviour.**

### ***Mediating mechanism: Moral disengagement***

In line with Bandura’s theory of moral disengagement, we propose that the impact of team creativity on unethical behaviour is mediated through cognitive mechanisms that enable moral disengagement. As discussed in the introduction, moral disengagement is “a form of moral self-deception that allows individuals to justify unethical behavior and avoid self-censure” (Welsh, Ordóñez, Snyder, & Christian, 2015).

We align with various previous studies in selecting moral justification (Barsky, 2008, 2011; Gino & Ariely, 2012; Mai et al., 2015) and displacement of responsibility (Barsky, 2008, 2011) as the two cognitive mechanisms which enable moral disengagement that we explicitly investigate. Moral justification involves cognitively reframing “unethical acts as being in the service of a greater good” (Moore et al., 2012) whilst displacement of responsibility refers to attributing responsibility for one’s actions to circumstances beyond one’s control, such as management orders, peer pressure, or existing precedent (Barsky, 2011). We align with Barsky’s (2011) reasoning in expecting the two mechanisms to independently influence unethical behaviour as moral justification is concerned with reframing the conduct itself while displacement of responsibility is concerned with ascribing responsibility for the conduct.

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We expect that this justification occurs primarily at the individual, rather than at the team, level. Therefore, though it is certainly plausible that discussions to justify unethical behaviour may take place between individuals within a team, and that these discussions would influence team members' reasoning on the subject, each team member ultimately has to personally decide whether to engage in the unethical behaviour or not and we therefore view justification as primarily an individual action. This aligns with Robinson & O'Leary-Kelly's (1998) perspective that group-level explanations for antisocial behaviour are merely supplementary to individual-level explanations.

We extend Gino & Ariely's (2012) reasoning for why creative individuals find it easier to justify individual unethical behaviour to the team level. Thus we expect that in team-level discourse about ethical issues, teams that are more creative will be more likely to "develop original ways to bypass moral rules" and to "reinterpret available information regarding their own behavior in a self-serving way". As discussed, we expect that this team-level discourse relating to the justification for unethical behaviour will have at least some influence on the rationalisation process of the individual team members. Similarly, we expect that during team-level discourse, creative teams will be more likely to reinterpret information or develop other original ways to ascribe responsibility for unethical behaviour to parties that are external to the team. It is also plausible that role definition and consequently ascription of personal responsibility within a highly creative team, may at times be relatively fluid. This could also make it easier for individual team members to displace the responsibility for their personal role in participating in collective unethical behaviour.

Finally, as the substantive focus of this research is on creativity and unethical behaviour at the team level, we do not measure individual team members' level of moral identity. However, with reference to the previously discussed findings on the role of moral identity as a boundary condition in the relationship between individual creativity and moral disengagement (Keem et al., 2018; Zheng et al., 2017), we expect that the diffusion of responsibility that occurs in a team setting will play a role in reducing the moderating influence of moral identity. Thus, as an individual is justifying unethical

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behaviour that will be perpetrated collectively by a team, we don't expect the individual's moral identity to act as a strong boundary condition in the way that it would if the individual were attempting to justify unethical behaviour that would be perpetrated by themselves.

Based on this reasoning, we propose that:

**H2a: Moral justification, an individual-level variable and one of the cognitive mechanisms of moral disengagement, mediates the positive relationship between team creativity and team unethical behaviour.**

**H2b: Displacement of responsibility, an individual-level variable and one of the cognitive mechanisms of moral disengagement, mediates the positive relationship between team creativity and team unethical behaviour.**

### ***The moderating role of stress***

A number of studies have linked increased levels of stress to unethical behaviour, or with the intent to act unethically. For example, Parlangei, Guidi, Marchigiani, Bracci, & Liston (2019) tested two alternative models. In the first model, the relationship between a generalised measure of perceived stress and unethical behaviour was evaluated, and a statistically significant relationship was uncovered. This finding aligns with that of Schwepker & Good (2017) who also used a generalised measure of perceived stress and found that work stress experienced by salespeople increased the intent to act unethically. In Parlangei et al.'s (2019) second model, the relationship between various potential work stressors and unethical behaviour was evaluated. The findings indicate a statistically significant relationship between unethical behaviour and a number of stressors, including: a measure of demands in the workplace, linked to workload, amongst other factors; the level of support offered by managers; and the quality of the relationship between colleagues. Finally, van Zyl & Lazenby (2002) used a measure for stress that incorporates a generalised measure of perceived stress, work stressors,

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and stressors outside of the work environment, to find that stress experienced by managers increased a variety of unethical behaviours.

Recently, research has also found that stress (including stress linked to financial and job insecurity as well as chronic stress) plays a role in the acceptance of unethical behaviour or unethical attitudes (Liu et al., 2018; Ripoll & Breugh, 2019). Finally, an alternative point of view is presented by Giacalone & Promislo (2010) who argue that stress is in fact an outcome, rather than an antecedent, of engaging in or witnessing unethical behaviour at work. In this study, however, we align with the majority of researchers in conceptualising stress as an antecedent of unethical behaviour.

Based on previous findings, Schwepker & Good (2017) propose that, as stress has been proven to reduce an individual's attention resources, an individual that is experiencing stress may be less likely to pay attention to issues that are not integral to the task at hand. Schwepker & Good (2017) further propose that moral issues may be particularly susceptible to being neglected under such conditions as, in addition to generally being secondary to the task at hand, they also tend to be "unstructured, novel, complex". An alternative explanation offered by Schwepker & Good (2017) aligns with social cognitive theory, and proposes that, as stress is known to reduce an individual's ability to self-regulate, it therefore reduces the likelihood that an individual will abstain from unethical behaviour.

Previous research has established that self-control is a depletable resource, and that coping with stress reduces an individual's self-control (Muraven & Baumeister, 2000). With reference to social cognitive theory, it is therefore reasonable to expect that increased stress would be associated with an increased likelihood of moral disengagement due to the negative impact of stress on an individual's ability to self-regulate. Thus, we align with the alternative explanation for the impact of stress on unethical behaviour offered by Schwepker & Good (2017).

Furthermore, we draw on Schwepker & Good's (2017) theorising that moral issues may be particularly susceptible to the negative impact of stress on individuals' attention resources to offer a possible

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explanation for the role of stress in reducing the impact of ethical idealism on unethical behaviour. As discussed previously, creative individuals tend to be high on ethical idealism, and though they are less likely to adhere to universal moral principles, the high levels of ethical idealism make creative individuals particularly sensitive to the impact of their behaviour on others (Bierly et al., 2009). Though our research does not focus on individual creativity (and we consequently do not measure team members' levels of ethical idealism), it is nonetheless reasonable to assume that at least some of the members of a creative team may also be high on dispositional creativity. Stress has been proven to reduce individuals' available attention resources, and more specifically to reduce the ability to pay attention to task-irrelevant information (Chajut & Algom, 2003). Consequently, we expect that increased levels of stress will reduce the impact of ethical idealism during the moral disengagement process as it will reduce individuals' ability to fully consider the potential impact of unethical behaviour by the team on others.

In a seminal paper, Cavanaugh, Boswell, Roehling, & Boudreau (2000) find that stressors can be partitioned into two categories, with the one category associated with a positive impact and the other with a negative impact on outcomes such as job satisfaction and performance (Ren & Zhang, 2015). We align with this perspective and distinguish between challenge stressors which include "stressful demands viewed by individuals as opportunities for growth, learning, and achievement" and hindrance stressors which comprise "stressful demands viewed by individuals as obstacles to personal growth and goal attainment" (Ren & Zhang, 2015). Examples of challenge stressors include time urgency, levels of responsibility, and high workload, while examples of hindrance stressors include role ambiguity, red tape, and organisational politics. Though we distinguish between the two categories of stressors in our analysis, we expect both categories of stressors to have a similar impact on the relationship between team creativity and moral disengagement as coping with either set of stressors would require self-control and would consume individuals' attention resources.

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The combination of two types of stressors and two forms of moral disengagement, results in four hypotheses. Consequently, we propose that:

**H3a: The level of challenge stressors experienced by an individual moderates the relationship between team creativity and moral justification, such that, the higher the level of challenge stressors experienced by the team member, the higher the level of moral justification that the team member will generate.**

**H3b: The level of challenge stressors experienced by an individual moderates the indirect effect of team creativity on unethical team behaviour through moral justification, such that this indirect effect is more positive when challenge stressors are higher.**

**H4a: The level of challenge stressors experienced by an individual moderates the relationship between team creativity and displacement of responsibility, such that, the higher the level of challenge stressors experienced by the team member, the higher the level of displacement of responsibility that the team member will generate.**

**H4b: The level of challenge stressors experienced by an individual moderates the indirect effect of team creativity on unethical team behaviour through displacement of responsibility, such that this indirect effect is more positive when challenge stressors are higher.**

**H5a: The level of hindrance stressors experienced by an individual moderates the relationship between team creativity and moral justification, such that, the higher the level of hindrance stressors experienced by the team member, the higher the level of moral justification that the team member will generate.**

**H5b: The level of hindrance stressors experienced by an individual moderates the indirect effect of team creativity on unethical team behaviour through moral justification, such that this indirect effect is more positive when hindrance stressors are higher.**

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**H6a: The level of hindrance stressors experienced by an individual moderates the relationship between team creativity and displacement of responsibility, such that, the higher the level of hindrance stressors experienced by the team member, the higher the level of displacement of responsibility that the team member will generate.**

**H6b: The level of hindrance stressors experienced by an individual moderates the indirect effect of team creativity on unethical team behaviour through displacement of responsibility, such that this indirect effect is more positive when hindrance stressors are higher.**

**METHODOLOGY*****Sample and procedures***

Our sample consisted of employees at an engineering consultancy, headquartered in South Africa. The participating teams were distributed over various locations in South Africa. The teams represented different functional units within the organisation, with the majority of teams consisting mainly of engineers that perform outsourced operational management work for the organisation's clients or develop operational management products; less than 10% of the teams consisted of support staff in roles such as finance, HR, and marketing; one managerial team was also included. The teams consisted of an average of 5.6 members, excluding the team managers.

To minimise the risk of common method bias (Podsakoff, Mackenzie, Lee, & Podsakoff, 2003), data was gathered from two sources, namely team members and senior managers (i.e. individuals managing team managers). 228 team members and 17 senior managers were contacted via email and requested to participate in the research. The team member response rate was 54% with a total of 123 team members providing data, while the senior manager response rate was 94% with 16 senior managers providing data. Data was gathered once and responses from both senior managers and team members were received for 34 teams, that included 107 team member respondents. All participants provided informed consent and, due to the sensitive nature of the questions relating to

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unethical behaviour, a coding system was used to enable responses for a team to be matched whilst ensuring anonymity of respondents.

The demographic data indicates a broadly representative sample of respondents. 42% of respondents were female. 23% of respondents reported high school or equivalent as their highest level of education, whilst 14% indicated that they had obtained a Master's degree. The largest number of respondents were 25–34 years old (43%), whilst at the extremes of the scale, the 18–24 years and the 55–64 years categories each contained 6% of respondents. The majority of respondents (30%) had worked for the company for a period of 2–5 years, whilst at the extreme ends of the scale, 10% had worked for the company for less than one year and 19% had worked for the company for at least ten years. The majority of respondents (41%) had been members of their current team for 2–5 years.

### **Measures**

Surveys were administered in English, which is the language in which the organisation conducts their business. A 5-point Likert response scale was used in all questions on both the team member and senior manager questionnaires.

**Team creativity.** Data on team creativity was gathered from senior managers, using the 4-item scale developed by Shin & Zhou (2007). The scale assesses the following three aspects of team creativity: the novelty of ideas; the significance of ideas; and the usefulness of ideas. The use of supervisor measures for team creativity is a widely accepted practice in creativity literature (Shin & Zhou, 2007).

**Moral disengagement.** Data on two cognitive moral disengagement mechanisms, namely moral justification and displacement of responsibility, was gathered from team members. As discussed, the variables were measured at the individual level. A four-item scale was used for moral justification, and a five-item scale for displacement of responsibility. Both scales were originally developed by Bandura et al. (1996) as part of a 32-item scale measuring all eight cognitive mechanisms of moral disengagement amongst schoolchildren. Subsequently, Barsky (2011) adapted the portions of the



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original scale that tapped moral justification and unethical deception to reflect a social context and detrimental activities that are relevant to working adults. The detrimental activities in the scales refer largely to various forms of deception, this aligns with the scale used to assess unethical behaviour.

**Team unethical behaviour.** Data on team unethical behaviour was gathered using a 12-item scale developed by Barsky (2011). Castille, Buckner, & Thoroughgood (2018) state that researchers have recently begun to “acknowledge prosocial behaviours that help maintain an organization’s positive image in ways that violate ethical norms (e.g., misrepresenting or exaggerating the truth, concealing damaging information about the firm)”. Umphress, Bingham, & Mitchell (2010) refer to these as unethical pro-organisational behaviours and Castille et al. (2018) mention the Volkswagen emissions scandal as an example of such unethical pro-organisational behaviours. The Barsky (2011) measure for unethical behaviour that is used in this research focuses on deceptive behaviour, and the scale contains a number of questions that represent unethical pro-organisational behaviours. Whilst deceptive behaviour is only one of the many forms that unethical behaviour can take, Barsky (2011) motivate this focus by highlighting the central role of deception in many high profile instances of corporate corruption. The scale assesses instances of wilful deceit that violates generally-held ethical standards relating to truthfulness.

The introductory question of the scale was phrased as follows: “How often has your team engaged in the following behaviour?”<sup>3</sup>. Furthermore, in the two instances where the word ‘supervisor’ is used in the scale, it was replaced with the words ‘team manager’ in order to adapt the scale for use at the team rather than at the individual level. Following Robinson & O’Leary-Kelly (1998), we aggregated

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<sup>3</sup> Barsky (2011) does not prescribe exact wording for the introductory question in the questionnaire, but states that “participants were asked to indicate ... how often they had performed a list of behaviors since they began their current job”.

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individual team members' responses in order to calculate a team-level variable for unethical behaviour.

**Stressors.** We utilised a 6-item scale for challenge stressors and a 7-item scale for hindrance stressors, both developed by Zhang, Lepine, Buckman, & Wei (2014). The scales tap a broad range of challenge and hindrance stressors and this mechanism of measuring stressors aligns with the approach used in previous empirical research (Cavanaugh et al., 2000; Zhang et al., 2014).

### **Controls**

We gathered data on various variables that have been found to related to unethical behaviour in general and in teams specifically, namely: corporate ethical values (Martin & Cullen, 2006)<sup>4</sup>, perceptions of various dimensions of organisational justice (Jacobs, Belschak, & Den Hartog, 2014); and psychological safety (Pearsall & Ellis, 2011). We also measured two variables that relate to decision-making and discourse within teams, namely leader openness and participation in decision-making. In line with previous research, we only included variables as controls if they were correlated with at least one of our endogenous variables.

We included the following three control variables: leader openness; perception of corporate ethical values; and perception of distributive justice. Leader openness was evaluated at the team level using De Dreu & West's (2001) 3-item scale, which is a shortened version of the scale developed by Ashford, Rothbard, Piderit, & Dutton (1998). We measured team members' perception of corporate ethical values at the individual level, using a 5-item scale developed by Hunt, Wood, & Chonko (1989). Finally, we measured team members' perception of distributive justice at the individual level using a 4-item scale developed by (Colquitt, 2001).

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<sup>4</sup> The meta-analysis conducted by Martin & Cullen (2006) focuses on corporate ethical climate, however, the construct of perceived corporate ethical values, as it is defined in Hunt et al.'s (1989) scale, aligns well with Martin & Cullen's (2006) conceptualization of corporate ethical values.

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Data on variables that were not correlated with any of the endogenous variables in our study and were therefore not included as control variables, were gathered as follows. We used Edmondson's (1999) 7-item scale to measure the level of psychological safety, and, in line with previous research (Koopmann, Lanaj, Wang, Zhou, & Shi, 2016), we aggregated the responses received from team members to create a team-level variable. We measured participation in decision-making at the individual-level using De Dreu & West's (2001) 3-item adaptation of the scale originally developed by Campion, Medsker, & Higgs (1993). We measured team members' perception of procedural, interpersonal, and informational justice at the individual level, using scales developed by Colquitt (2001).

### RESULTS

The descriptive statistics and zero-order correlations for the study- and control variables, are given in Table 1. Each variable displayed an acceptable degree of internal consistency, as evidenced through the Cronbach's  $\alpha$ , displayed on the diagonal. The relationships amongst the variables are broadly consistent with previous research, both in terms of direction and strength.

Our hypotheses imply a two-level, first-stage moderated mediation model of the 2-1-2 form. First stage moderated mediation refers to a model where the relationship between the independent variable and the outcome variable varies due to the impact of a moderator on the relationship between the independent variable and a mediator (Zhang et al., 2014). According to our hypotheses, the impact of the independent variable (team creativity) on the outcome variable (team unethical behaviour) varies as a result of the moderating impact of stress experienced by individuals on the relationship between team creativity and the moderator, moral disengagement.

The model contains two-level data with employees nested in teams. The values of the intraclass correlations for the endogenous individual-level variables in the model are 0.72 for moral justification and 0.38 for displacement of responsibility. The strong intraclass correlation for moral justification

TABLE 1: Means, standard deviations, and intercorrelations among study variables

Variables	M	SD	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Team creativity (SM)	3.35	0.71	.90													
2. Unethical behaviour (T)	1.31	0.68	.37*	.94												
3. Moral justification (T)	1.26	0.55	.31	.91**	.85											
4. Displacement of responsibility (T)	1.75	0.89	.20	.73**	.77**	.85										
5. Challenge stressors (T)	3.84	0.54	.21	.27	.31	.16	.80									
6. Hindrance stressors (T)	2.30	0.76	.27	.68**	.55**	.40*	.48**	.85								
7. Leader openness (T)	4.22	0.76	.11	-.39*	-.26	-.24	.05	-.55**	.95							
8. Psychological safety (T)	3.73	0.52	.12	-.32	-.23	-.23	-.29	-.71**	.76**	.78						
9. Participation in decision making (T)	3.56	0.92	.51**	.25	.31	.03	.11	-.13	.51**	.61**	.91					
10. Corporate ethical values (T)	4.01	0.74	-.09	-.41*	-.45**	-.47**	-.21	-.46**	.43*	.50**	.13	.76				
11. Procedural justice (T)	3.01	0.99	.36*	.23	.23	.10	-.20	-.21	.35*	.55**	.57**	.35*	.93			
12. Distributive justice (T)	2.76	1.08	.27	.45**	.38*	.31	.15	-.12	.15	.37*	.43*	.23	.80**	.97		
13. Interpersonal justice (T)	4.16	0.88	.14	.08	.21	.22	.26	-.23	.69**	.56**	.47**	.34*	.58**	.41*	.93	
14. Informational justice (T)	3.75	0.88	.32	.24	.33	.11	.24	-.08	.41*	.41*	.51**	.23	.52**	.36*	.62**	.91

Note. n = 107 team members and 34 teams. T = rated by team members; SM = rated by senior managers. Variables 1, 2, 7, and 8 are team-level (i.e. Level 2) variables. As variable 2 is the substantive variable of interest, the inter-correlations in the table are calculated at the team-level. For individual-level variables, a team average was calculated and used in the calculation of the intercorrelations. Cronbach's  $\alpha$  is shown in bold on the diagonal. For individual-level variables, the mean and standard deviation are based on the individual-level data, i.e. on 107 observations.

\*  $p < .05$  (two-tailed). \*\*  $p < .01$  (two tailed).

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provides evidence that responses from employees were influenced by their clustering within teams. Therefore a multi-level modelling approach is appropriate.

Multilevel modelling is widely used in the analysis of multi-level moderated mediation, however this method cannot accommodate upper-level dependent variables (Preacher, Zyphur, & Zhang, 2010), such as the Level 2 outcome variable in our conceptual model. Consequently, we use multi-level structural equation modelling (MSEM), proposed by Preacher et al. (2010), to perform our analyses. In comparison to three alternative approaches that can also be utilised to analyse a 2-1-2 model, namely two-step analyses, the aggregation approach, and the disaggregation approach, MSEM holds the advantage that it does not require two-stage analysis (Preacher et al., 2010). The results generated with the MSEM approach are also less biased than those generated with the more conventional multilevel modelling approach, which “does not fully separate between-group and within-group effects without introducing bias” (Preacher et al., 2010).

Variables were centred prior to analysis in line with the approach used in traditional multilevel modelling. As the primary substantive focus of the research is on a Level 2 predictor variable, Level 1 predictor variables were centred at the grand mean (Enders & Tofighi, 2007), this is acceptable when using the MSEM approach (Preacher et al., 2010). When analysing interaction effects of Level 2 variables, we centred these at the grand mean. As is standard practice for multi-level models, random intercepts were used.

The analyses were performed using MPLus 8.1 (L. K. Muthén & Muthén, n.d.). When the two stressors (challenge stressors and hindrance stressors) as well as the two forms of moral disengagement (moral justification and displacement of responsibility) that are referred to in our hypotheses are substituted into the conceptual model displayed in Figure 1, four distinct structural models are generated. We tested each of these models separately.

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Preacher et al. (2010) emphasise the importance of establishing that MSEM models have sufficiently good fit before interpreting indirect effects. The MLR estimator is the default option for two-level analysis in MPlus, however we used the Bayes estimator as it does not rely on large-sample theory and it is consequently proposed as particularly useful when the number of clusters is relatively small (B. Muthén & Asparouhov, 2012), such as in our study. We followed a conservative approach when assessing model fit and, in line with B. Muthén & Asparouhov (2012), only report results for models with a posterior predictive p-value of at least 0.05. In line with B. Muthén's (2010) recommendation, we also verified convergence by checking the value of the Proportional Scale Reduction factor—this was 1.006 or less.

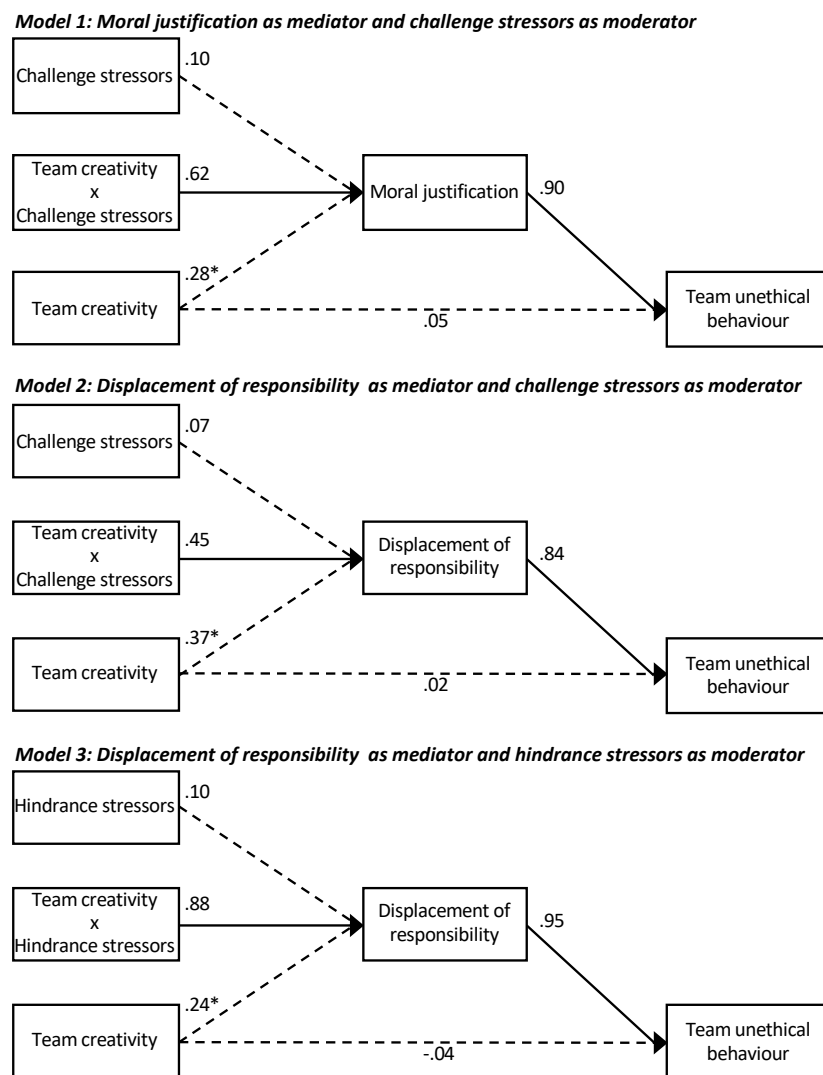
The standardised path coefficients for three of the four structural models are presented in Figure 2. As shown, all three models follow the same pattern in terms of paths that are significant (at  $p < 0.05$ ), paths that are not significant, and paths that narrowly miss being significant (with  $p < 0.1$ ).

The fourth structural model, where moral justification is positioned as mediator and hindrance stressors as moderator, did not have an acceptable model fit and its path coefficients and other model statistics are therefore not reported. Due to the lack of an acceptable fit for this model, we find no support for H5a and H5b.

### ***Linkages between team creativity and team unethical behaviour***

In all three models, the direct effect of team creativity on unethical behaviour is not significant. Thus we find no evidence that team creativity has a direct impact on unethical behaviour and Hypothesis 1 is not supported. However, as we have hypothesised that mediators and moderators play a role in the relationship between team creativity and team unethical behaviour, this lack of a significant direct relationship between team creativity and team unethical behaviour does not imply that team creativity does not have an impact on team unethical behaviour.

FIGURE 2: Structural models with study variables.

**Notes:**

Standardised path coefficients are given;  $\longrightarrow$   $p < 0.05$ ;  $-\text{---}$   $p > 0.05$ ; \*  $p < 0.1$ .

**Linkages between team creativity and moral disengagement**

In all three models, the impact of team creativity on the mechanism of moral disengagement (either moral justification or displacement of responsibility), is not statistically significant but, at  $p < 0.1$ , it narrowly misses being so. Nonetheless, these findings indicate that individuals in teams that are more

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creative are no more or less likely to morally disengage than individuals in team that are less creative. As indicated in our theorising, however, we expect that the stress experienced by individuals plays a role in influencing the relationship between team creativity and mechanisms of moral disengagement, thus the lack of a statistically significant relationship between team creativity and either of the mechanisms of moral disengagement does not necessarily imply that team creativity does not play a role in influencing moral disengagement.

**TABLE 2: Summary of indirect effects and conditional indirect effects.**

	Indirect effect	p value	95% bias-corrected CI	
			lower limit	upper limit
Mediator: Moral justification				
Mediation only (average indirect effect)	0.32 <sup>†</sup>	.025 <sup>†</sup>	-2.99 <sup>†</sup>	3.83 <sup>†</sup>
Moderated mediation:				
Moderator: Challenge stressors				
Low challenge stressors	-0.56	.051	-1.25	0.17
High challenge stressors	1.01	.002	0.31	1.71
Difference	1.57	.006	1.22	1.94
Mediator: Displacement of responsibility				
Mediation only (average indirect effect)	0.31	.048	-7.07	7.90
Moderated mediation:				
Moderator: Challenge stressors				
Low challenge stressors	-0.27	.230	-1.04	0.56
High challenge stressors	0.86	.014	0.03	1.62
Difference	1.21	.043	0.89	1.47
Moderator: Hindrance stressors				
Low hindrance stressors	-0.43	.024	-0.91	0.05
High hindrance stressors	0.84	.000	0.40	1.31
Difference	1.27	.000	0.93	1.68

<sup>†</sup> Model fit is unacceptably poor with posterior predictive p-value < 0.05.

#### ***Mediation through moral disengagement***

In all three models, the relationship between the mechanism of moral disengagement and the dependent variable, team unethical behaviour, is positive and significant.



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In order to evaluate the indirect (mediated) impact of team creativity on team unethical behaviour via either of the two mechanisms of moral disengagement, we omit the moderators from the models and calculate the compound coefficients to determine the average indirect effect. As these compound coefficients are not necessarily normally distributed, we do not use the confidence intervals generated by MPlus as these are generated using the delta method and consequently are not an accurate reflection of the “asymmetric nature of the sampling distribution of an indirect effect” (Preacher et al., 2010). Instead, we generate bias-corrected confidence intervals from an empirical distribution that is constructed using re-sampling methods. We utilise a Monte Carlo method of re-sampling as the conventional bootstrapping method of re-sampling cannot be applied to multilevel models (Preacher & Selig, 2012). Specifically, we utilised R to construct the bias-corrected confidence intervals from 20,000 parametric re-samples, implemented via Selig & Preacher's (2008) online facility. The average indirect effect of team creativity on team unethical behaviour via moral disengagement and via displacement of responsibility respectively, is shown in Table 2.

As indicated, though  $p < 0.05$  for both average indirect effects, the bias-corrected confidence interval for both of these indirect effects contains zero. Furthermore, as indicated in Table 2, when the moderator is omitted from the structural model where moral justification is positioned as the mediator, the posterior predictive p-value decreases to 0.027. According to the conservative approach selected for this analysis, this structural model's fit is therefore unacceptably poor. Consequently, both Hypothesis 2a and Hypothesis 2b are not supported. The insignificance of the average indirect effects may be due to the presence of a moderator, this is examined in the following section.

### ***Moderation of creativity-disengagement linkages with stressors***

As shown in Figure 2, the relationship between the stressor-team creativity interaction term and the mediator, is positive and significant in all three models. More specifically, challenge stressors moderate the team creativity-moral justification relationship ( $\gamma = .62, p < .05$ ), thus H3a is supported. Similarly, challenge stressors moderate the relationship between team creativity and displacement of

responsibility ( $\gamma = .45, p < .05$ ), thus H4a is supported. Finally, hindrance stressors also moderated the team creativity-displacement of responsibility relationship ( $\gamma = .88, p < .05$ ), thus H6a is supported.

#### ***Moderation of the mediated relationships***

Lastly, the impact of the moderators on the indirect relationship between team creativity and unethical behaviour is explored. As before, we generated bias-corrected confidence intervals for estimates of the moderated indirect effect at low (one standard deviation below the mean) and high (one standard deviation above the mean) values of the moderators, as well as the difference between each pair of indirect effects. This is the approach for evaluating moderated mediation recommended by Edwards & Lambert (2007). The moderated indirect effects are summarised in Table 2.

For the model where moral justification is positioned as the mediator, the indirect effect of team creativity on team unethical behaviour differs significantly when the moderator, challenge stressors, is at high versus low levels (difference between conditional indirect effects = 1.57,  $p < 0.05$ ). Hypothesis 3b is thus supported. As shown in Table 2, this conditional indirect effect is statistically significant at high values of the moderator, but not at low values of the moderator. Therefore team creativity has a significant, positive impact on team unethical behaviour through moral justification when the levels of challenge stressors are high, but not when they are low.

For the model where displacement of responsibility is positioned as the mediator, the difference between the indirect effect of team creativity on team unethical behaviour at high versus low levels of challenge stressors is also statistically significant (difference between conditional indirect effects = 1.21,  $p < 0.05$ ). Hypothesis 4b is thus supported. As shown in Table 2, a similar pattern as that observed for the interaction of moral justification and challenge stressors is observed, where the conditional indirect effect is statistically significant at high values of the moderator, but not at low values of the moderator.

Finally, for the model where displacement of responsibility is positioned as the mediator and hindrance stressors is positioned as the moderator, the difference in the indirect effect at high versus low levels of the moderator is statistically significant (difference between conditional indirect effects = 1.27,  $p < 0.05$ ). Hypothesis 6b is thus supported. As shown in Table 2, this conditional indirect effect is once again statistically significant at high values of the moderator, but not at low values of the moderator.

Therefore team creativity has a significant, positive impact on team unethical behaviour through displacement of responsibility when the levels of either challenge or hindrance stressors are high, but not when they are low.

## **DISCUSSION**

### ***Theoretical implications***

We investigate a potential outcome of team creativity that has not been investigated before, namely team unethical behaviour. As our theorising is framed by the Bandura's (1991) social cognitive theory, we position moral disengagement at the individual level as a mediator between team creativity and team unethical behaviour and we incorporate the stress experienced by team members as a moderator of the relationship between team creativity and the mechanism of moral disengagement. Broadly, we find support for our conceptual model with no evidence of a direct link between team creativity and team unethical behaviour, but support for a conditional indirect link mediated by moral disengagement and moderated by stress—both the mediator and moderator are measured at the individual (team member) level. The explanation that we offer for this finding draws on social cognitive theory to suggest that stressors experienced by individuals moderate the relationship between team creativity and team members' moral disengagement by limiting the attention resources that team members have available to devote to moral issues. We align with previous research in suggesting that moral disengagement at the individual level facilitates team unethical behaviour by allowing individuals to engage in the team's collective unethical behaviour without negatively impacting their

## 7.1 RO4.4 & 4.5: Unpublished article

self-image, either by rationalising the conduct (in the case of moral justification) or by absolving themselves of personal responsibility (in the case of displacement of responsibility).

The evidence of an indirect effect of team creativity on team unethical behaviour via moral disengagement at high levels of stressors, is a novel theoretical contribution. This finding adds further weight to calls for more research on the outcomes of team creativity and highlights the importance of developing an understanding of boundary conditions that may cause team creativity to result in negative rather than positive outcomes (Bam, De Stobbeleir, & Vlok, 2019).

### ***Summarised findings***

We find no evidence of a direct link between team creativity and unethical behaviour by teams (H1), neither do we find evidence of an unmoderated indirect link between team creativity and team unethical behaviour via moral disengagement (H2a and H2b). Rather, our positive findings are limited to three conditional indirect effects, thereby indicating that stress experienced by individual team members is an important boundary condition that determines whether team creativity is associated with an increased likelihood of team unethical behaviour.

Our first positive finding relates to the interaction of team creativity and challenge stressors. We find that this interaction has a positive, indirect effect on team unethical behaviour through both moral justification and displacement of responsibility. Our second positive finding relates to the interaction of team creativity and hindrance stressors. We find that this interaction has a positive, indirect effect on team unethical behaviour through displacement of responsibility.

Thus we find that when members of a creative team experience high levels of either challenge or hindrance stressors, that team is more likely to act unethically than a team that is less creative would be, but the mechanism that facilitates this unethical behaviour differs, depending on the type of stressors that the team members experience.

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## 7.1 RO4.4 & 4.5: Unpublished article

### ***Limitations and future research***

Our research has a number of noteworthy limitations. First, as this is a cross-sectional study that investigates relationships, alternative pathways cannot be ruled out. This is a common limitation in Organisational Behaviour research and we have employed a number of approaches to address concerns related to the validity of our findings. Most notably, we have included moderated mediation in our models, used different data sources, and utilised multi-level analysis. Future research could employ longitudinal studies or experimental designs to evaluate our hypotheses using a different approach.

Second, we have used the same data source, namely team members, for the moderators, mediators, and dependent variable, thus we are aware that we cannot discount the possibility that our results have been influenced by common source variance (Podsakoff et al., 2003). The team member data has, however, been aggregated to the team level to create the outcome variable and we used a different data source for the independent variable, namely senior managers who are not members of the team. We find it unlikely that the findings supporting a conditional indirect effect could be attributable to common source variance. Future research could address these concerns, however, by using different data sources to evaluate our hypotheses.

Finally, though many published studies measure moral disengagement as a single, generalised construct, we followed an approach of measuring two distinct mechanisms of moral disengagement instead. In doing so, we investigated the moral disengagement construct at a more granular level, which enabled us to find that the type of moral disengagement that results from the interaction of team creativity and stress differs depending on the type of stress. However, in following this approach we excluded Bandura's six other mechanisms of moral disengagement that could potentially also have mediated the relationship between team creativity and unethical behaviour. As we are investigating the influence of a team-level variable, it seems plausible that diffusion of responsibility could play a role and, in retrospect, we should have included this variable in the empirical analysis. We recommend

## 7.1 RO4.4 & 4.5: Unpublished article

that in future studies where different mechanisms of moral disengagement are positioned as antecedents of team-level unethical behaviour, diffusion of responsibility should be included in the analysis along with moral justification and displacement of responsibility.

Finally, though a sample of this size is not uncommon in team-based research (Han, Han, & Brass, 2014; Sun, Jie, Wang, Xue, & Liu, 2016; Tang & Naumann, 2016; Weingart, Todorova, & Cronin, 2008), our Level 2 sample size of 34 is a salient limitation.

### ***Practical implications***

Our findings indicate that when members of creative teams experience high levels of stress, these creative teams act more unethically than teams that are less creative would do. This is a noteworthy finding for managers, indicating that the stress experienced by members of a creative team acts as a boundary condition for increased unethical behaviour by the team. We recognise that it would not be reasonable to expect managers to eliminate all sources of stress for team members, and this would also not be desirable, given previous findings on the role of stress (especially challenge stressors) in positive outcomes such as performance (Ren & Zhang, 2015). However, we recommend that managers should consider taking steps to reduce sources of hindrance stressors and control levels of challenge stressors for members of creative teams where possible. For example, cognisant that when members of a creative team experience hindrance stressors, they are more likely to displace responsibility for their actions and proceed to collectively act unethically, managers could focus on reducing sources of hindrance stressors that are within their control, such as team members' experience of red tape in the organisation. As a second example, cognisant that when members of creative teams experience high levels of challenge stressors, they are more likely to morally justify their actions and proceed to collectively act unethically, managers could focus on controlling levels of challenge stressors, for example controlling time pressure or high workload through better planning.

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Zheng, X., Qin, X., Liu, X., & Liao, H. (2017). Will creative employees always make trouble? Investigating the roles of moral identity and moral disengagement. *Journal of Business Ethics*.

## **7.2 Conclusion: Empirical study**

An unpublished article comprising an empirical study of a negative outcome of team creativity, namely unethical behaviour by the team, was presented in this second chapter of Part IV of the dissertation. Broadly, support was found for the conceptual model with findings indicating three conditional indirect effects, namely: the interaction of team creativity and high levels of hindrance stressors has a positive, indirect effect on unethical behaviour by the team through displacement of responsibility; and the interaction of team creativity and high levels of challenge stressors has a positive, indirect effect on unethical behaviour by the team through both moral justification and displacement of responsibility. These findings provide an initial indication that a framework should include advice on the role of the stress experienced by individual members of creative teams as a boundary condition for increased unethical behaviour by the team. As discussed in the following chapter, further research to confirm these findings would be valuable. A conclusion to the research is provided in Section V.

## **Part V**

# **Conclusion of the research**

## Chapter 8

# Summary and conclusions

Position of Chapter 8 in dissertation structure.		
Chapter	Chapter type	Chapter topic
		Part I: Research rationale (RO1)
		Part II: Framework feasibility (RO2)
		Part III: Antecedents of team creativity (RO3)
		Part IV: Outcomes of team creativity (RO4)
		<b>Part V: Conclusion</b>
8	Bridging text	Conclusion of research

### 8.1 Research summary

The research presented in this dissertation addressed four research objectives in order to achieve the aim of laying the foundation for the development of a managerial framework to support team creativity in engineering organisations, primarily by organising and expanding the body of knowledge on antecedents and outcomes of team creativity. The research objectives were described in detail in Table 2.1. The dissertation is divided into five parts, roughly aligned to the research objectives. An overview of where in the dissertation document each research objective is addressed was presented in Table 2.2.

The rationale for the research was set out in Chapter 1 which contains a published article exploring the likely role of creativity in the engineering design process, prefaced by introductory text that motivates the focus on the role of creativity in the engineering design process specifically, rather than in engineering organisations in general. Three conclusions that were drawn in the article are that “(i) creativity plays a role throughout the engineering design process, and it is possible to incorporate creativity into the engineering design process in a systematic manner; (ii) doing so, at the very least, holds significant potential for

## 8.1 Research summary

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economic benefit; and (iii) due to the complex interplay between creativity and the wide range of factors that influence it, organisational climates and management practices cannot simply be assumed to support creativity effectively." RO1 (formulating the rationale for the research) was therefore addressed in this chapter,

The research was formally defined in Chapter 2, with the articulation of the aim and objectives. A salient delimitation of the research was defined and motivated, namely to focus on team creativity specifically, rather than on creativity in general. This delimitation was deemed necessary to confine the scope of the research to that which could feasibly be considered in a dissertation. The decision to focus on team creativity was motivated by the crucial role that teamwork is likely to play in addressing the complex and large-scale projects that are often the focus of engineers.

Part II of the dissertation is concerned with RO2, establishing the feasibility of developing a framework. Two elements of feasibility are considered, namely the likely scope of a framework and the feasibility of the body of knowledge that would underpin a framework.

Chapter 3 contains a published article that consists of a narrative review of seven elements of creativity that have been identified in literature, thereby addressing RO2.1 (deductively identifying and defining a recommended set of elements for inclusion in a framework). It is proposed that the seven elements, as they have been defined in this article, form a sufficient basis for the development of a framework. As discussed in the introduction to Chapter 3, the delimitation to focus on team creativity specifically had not yet been defined at the time that this article was written. The article utilises the term "organisational creativity" and contains content that is relevant to both individual creativity and team creativity. As argued in the introductory section of Chapter 3, however, when a complex adaptive systems perspective is employed it is evident that the seven elements that have been identified in the article are equally applicable to team creativity as a stand-alone construct, as to organisational creativity as a more holistic construct. Furthermore, as discussed in the conclusion to Chapter 5, the finding on the significant role of individual creativity as an antecedent of team creativity (at  $\rho \approx 0.6$ ), provides a strong indication that, when seeking to develop a managerial framework to support team creativity in engineering organisations, it would be prudent to also include a consideration of the antecedents of individual creativity. (A review of the antecedents of individual creativity does, however, fall outside the scope of this dissertation.)

## 8.1 Research summary

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Chapter 4 contains bridging text that serves to bind the narrative together and it therefore represents a significantly smaller body of work than the substantive chapter (Chapter 5) or those that contain published or unpublished articles (Chapters 1, 3, 6, and 7). RO2.2 (determine whether there is a sufficiently mature body of empirical knowledge to enable the development of a framework) is addressed in this chapter. A structured literature search is conducted and literature is classified into various categories to obtain a sense of the number of research products that have empirically evaluated: (i) antecedents of team creativity; and (ii) outcomes of team creativity. Though the subjective nature of making a recommendation on the maturity of the bodies of knowledge is recognised in the discussion, the following conclusions are nonetheless drawn: (i) the empirical body of knowledge on the antecedents of team creativity appears sufficiently mature; however (ii) the empirical body of knowledge on the outcomes of team creativity does not. The contents of the more detailed reviews that are subsequently presented in Chapters 5 and 6 appear to support these conclusions.

Part III of the dissertation is concerned with RO3, namely obtaining an estimate of the construct-level relationships between team creativity and its proposed antecedents.

Though Chapter 5 of the dissertation does not contain a published or unpublished article, it represents a significantly more substantive body of work than the bridging text chapters. RO3.1-3.3 are addressed in this chapter through a meta-analytic review. The findings of the review are summarised into a table, indicating the estimated relationship between various antecedents and team creativity in the population as a whole. A number of interesting findings that emerged from this meta-analytic review illustrate the power of a meta-analysis in providing insights based on a large number of empirical studies that may contain seemingly contradictory findings. For example, both background diversity and job-relevant diversity have been proposed and identified as antecedents of team creativity, both in primary empirical studies and in narrative reviews (including in at least one of the narrative reviews cited in the article included in Chapter 3). The meta-analytic review, however, indicates that the relationship between background diversity and team creativity is not statistically significant and that, though the relationship between job-relevant diversity and team creativity is statistically significant, the correlation is weak and the finding is not generalisable. Another noteworthy finding from the meta-analysis, namely the significant role of individual creativity as a predictor of team creativity, was briefly referred to earlier in this section.



## 8.1 Research summary

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Part IV of the dissertation is dedicated to RO4, containing contributions to the maturity of the body of knowledge on outcomes of team creativity.

The published article that is included in Chapter 6 comprises an extension to an existing organising framework for research on antecedents of team creativity, to also contain an indication of outcomes of team creativity that have been empirically investigated. This extension is based on a narrative review of the existing empirical research on outcomes of team creativity. An important argument that is formulated in this article is that team creativity in itself is most likely not a meaningful outcome for organisations to pursue and, consequently, that it is valuable to expand the body of knowledge on boundary conditions that cause team creativity to result in either positive or negative outcomes. A person-environment fit meta-theory perspective is also applied to generate a conceptual model that can be used as a basis for proposing potential positive and negative outcomes of team creativity at and individual-, team-, and organisational-level.

Finally, an unpublished article is presented in Chapter 7. In this article, a conceptual model is developed to propose the relationship between team creativity and a specific potential outcome, namely unethical behaviour by the team. The stress experienced by individual team members is proposed as a boundary condition. A correlational design is followed and data is gathered at an engineering organisation. Multi-level structural equation modelling is utilised to evaluate the hypotheses and the findings generally indicate support for the conceptual model. Specifically the study finds that “when members of a creative team experience high levels of either challenge or hindrance stressors, that team is more likely to act unethically than a team that is less creative would be, but the mechanism that facilitates this unethical behaviour differs, depending on the type of stressors that the team members experience.” Further research to confirm these findings would be valuable, however, at present, these findings suggest that a framework should include an indication of the role of the stress experienced by individual members of creative teams as a boundary condition for increased unethical behaviour by the team. Thus these findings indicate that it would be prudent for a framework that makes recommendations on managerial actions to facilitate team creativity, to also include recommendations on managerial actions to reduce sources of hindrance stressors and control levels of challenge stressors for team members.

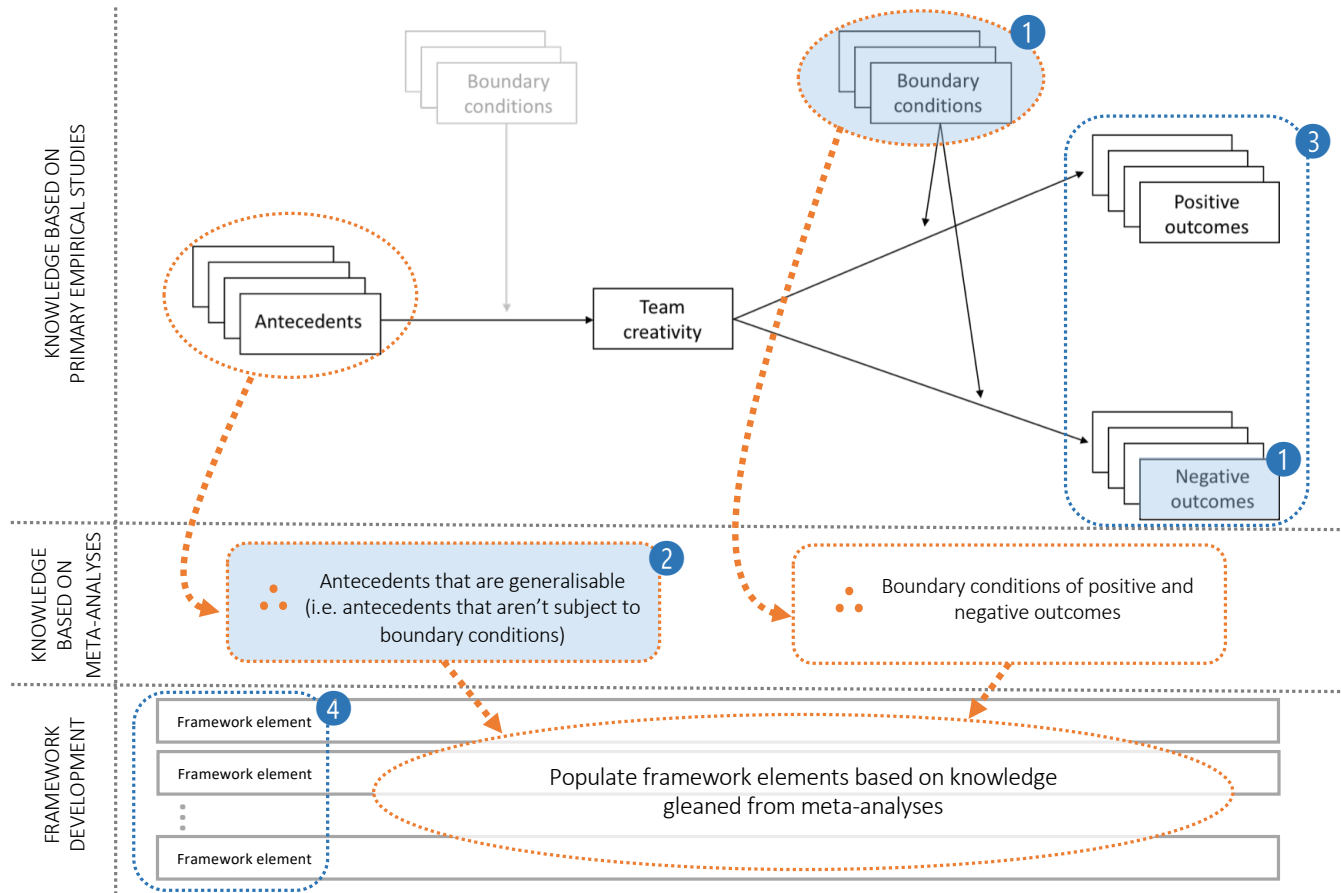


Figure 8.1: Overview of contributions and recommended route for framework development.

## 8.2 Scientific contribution

The work contained in this dissertation comprises a number of diverse scientific contributions, differing in type as well as significance. In the schematic presented in Figure 8.1, these contributions are marked with blue numerals.

The primary scientific contribution of this research (indicated by the two instances of the number “1” in Figure 8.1) is the finding that team creativity can lead to unethical behaviour by the team when team members experience increased levels of either challenge or hindrance stressors. As evidenced by the summary of the existing empirical body of knowledge on the outcomes of team creativity, this is a novel contribution to literature as no prior empirical research has examined unethical behaviour by teams as a potential outcome of team creativity.

A second scientific contribution of this research (indicated by the number “2” in Figure 8.1) is the summarised results of the meta-analysis on existing empirical research on antecedents of team creativity. As mentioned in Chapter 5, at least one other meta-analysis of team-level predictors of team creativity and / or innovation has been published. A number of other published studies also contain a meta-analysis of the relationship between at least one potential antecedent and team creativity, as part of meta-analyses of a range of outcomes of these antecedents. Nonetheless, the meta-analysis presented in Chapter 5 offers a scientific contribution that is unique in: (i) encompassing an analysis of a wide range of potential antecedents, many of which appear not to have been the subject of previous meta-analyses to estimate the construct-level relationship with team creativity; and (ii) focusing on team creativity specifically, rather than on a combination of team creativity and / or innovation, as the dependent variable.

A third scientific contribution of the research (indicated by the number “3” in Figure 8.1) is the extension of the organising framework for research on antecedents of team creativity to also include outcomes of team creativity that have been investigated empirically. This summary of potential outcomes of team creativity that have been examined empirically is a novel contribution to literature and is expected to be useful to researchers that are seeking to identify outcomes that have not yet been investigated. Furthermore, the conceptual model that is developed in Chapter 6 may be a useful tool to researchers that are seeking to identify potential outcomes of team creativity that have not yet been examined.

### 8.3 Opportunities for future work

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The first three scientific contributions go beyond the realm of management within engineering organisations to make a contribution to Organisational Behaviour literature in general.

A final scientific contribution of the research (indicated by the number “4” in Figure 8.1) is to propose a set of seven elements that form a sufficient basis for the development of a managerial framework for team creativity in engineering organisations, based on a narrative review.

### 8.3 Opportunities for future work

The research is positioned as laying a foundation for the future development of a managerial framework to support team creativity in engineering organisations. As such, the most clear opportunity for future research is further work towards the development of such a framework. The recommended route for framework development is indicated in Figure 8.1.

It is recommended that it would be prudent to conduct further primary empirical research on outcomes of team creativity prior to the development of a framework. The motivation for this recommendation is that, besides unethical behaviour by teams, team creativity may also lead to other negative outcomes that have not yet been uncovered, under specific boundary conditions. This research would make a contribution to literature that goes beyond the realm of management in engineering organisations.

An important question that would need to be addressed in future research is at what point the body of research on outcomes of team creativity would be sufficiently mature to enable the development of a framework. As indicated in Figure 8.1, it is recommended that a meta-analysis on the boundary conditions that lead to either positive or negative outcomes be performed at this point as it is better to base a framework on an estimate of the construct-level relationship in the population as a whole than on the relationship determined in a single primary empirical study. However, if it is deemed infeasible to perform a meta-analysis, most likely because the body of empirical evidence is not sufficiently large to enable such an analysis, the information gathered from primary studies could be used instead.

As indicated in Figure 8.1, it is envisaged that the information from the meta-analysis on the antecedents of team creativity, as well as the information from the meta-analysis on the boundary conditions that lead to either positive or negative outcomes (or the data from

### 8.3 Opportunities for future work

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primary empirical studies if such a meta-analysis is judged infeasible) would be combined to formulate recommendations to managers, grouped under the framework elements that have been proposed in this dissertation.

As indicated in the figure, the meta-analysis did not take boundary conditions of antecedents of team creativity into consideration, this is intended to simplify the framework. Thus, in line with the discussion presented in Section 5.5, the summarised findings of the meta-analysis on the antecedents of team creativity that have been presented in Table 5.16 of this dissertation are limited to antecedents that have a statistically significant relationship with team creativity that is not subject to boundary conditions.

A final recommended opportunity for future work is further research on team unethical behaviour as a potential outcome of team creativity in order to determine whether the findings that have been reported in the primary study reported in this dissertation are replicated in other contexts.

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**Note: Sources that have been used exclusively within the articles included in Chapters 1, 3, 6, and 7 have been omitted from this list of references as these have already been given as part of each manuscript.**

## **Appendix A**

# **Declaration of author contributions**

In line with the requirements set out for publications that are included in dissertations by Stellenbosch University, this appendix contains the formal declaration of the scope and nature of the contribution of each author to each publication, in the prescribed format. As per the Stellenbosch University guidelines, these declarations are not signed in order to keep the signatures of the individuals out of the public domain, however a copy of the signed declarations are in the possession of both the candidate and the primary supervisor, Prof. PJ Vlok.

**A.1 Chapter 1 declaration****A.1 Chapter 1 declaration****Declaration by the candidate:**

With regard to the article included in Chapter 1 (page 9 - 22) the nature and scope of my contribution were as follows:

<b>Nature of contribution</b>	<b>Extent of contribution (%)</b>
Conceptualised and executed the research, and wrote the article, incorporating periodic feedback from supervisor. Improved the article in response to feedback received during the journal's peer-review process.	90%

The following co-authors contributed to the article presented in Chapter 1 (page 9 - 22):

<b>Name</b>	<b>e-mail address</b>	<b>Nature of contribution</b>	<b>Extent of contribution (%)</b>
Prof. PJ Vlok	pjvlok@sun.ac.za	As supervisor, Prof. Vlok engaged in discussions to act as a soundboard and offer alternative perspectives during the conceptualisation and development of the article. Prof. Vlok also provided feedback and suggestions on a draft of the article. This contribution is similar in scope and nature to the contribution that a supervisor would typically make to the content of a dissertation.	10%

Date and signature of candidate: *Declaration with signature in possession of candidate and supervisor.*

**Declaration by co-authors:**

The undersigned hereby confirm that

1. the declaration above accurately reflects the nature and extent of the contributions of the candidate and the co-authors to the article included in Chapter 1 (page 9 - 22),
2. no other authors contributed to the article included in Chapter 1 (page 9 - 22) besides those specified above, and
3. potential conflicts of interest have been revealed to all interested parties and that the necessary arrangements have been made to use the material in Chapter 1 (page 9 - 22) of this dissertation.

<b>Name</b>	<b>Signature</b>	<b>Institutional affiliation</b>	<b>Date</b>
Prof. PJ Vlok	<i>Declaration with signature in possession of candidate and supervisor.</i>	Stellenbosch University	



**A.2 Chapter 3 declaration****A.2 Chapter 3 declaration****Declaration by the candidate:**

With regard to the article included in Chapter 3 (page 38 - 51) the nature and scope of my contribution were as follows:

<b>Nature of contribution</b>	<b>Extent of contribution (%)</b>
Conceptualised and executed the research, and wrote the article, incorporating periodic feedback from the supervisor. Improved the article in response to feedback received during the journal's peer-review process.	90%

The following co-authors contributed to the article presented in Chapter 3 (page 38 - 51):

<b>Name</b>	<b>e-mail address</b>	<b>Nature of contribution</b>	<b>Extent of contribution (%)</b>
Prof. PJ Vlok	pjvlok@sun.ac.za	As supervisor, Prof. Vlok engaged in discussions to act as a soundboard and offer alternative perspectives during the conceptualisation and development of the article. Prof. Vlok also provided feedback and suggestions on a draft of the article. This contribution is similar in scope and nature to the contribution that a supervisor would typically make to the content of a dissertation.	10%

Date and signature of candidate: *Declaration with signature in possession of candidate and supervisor.*

**Declaration by co-authors:**

The undersigned hereby confirm that

1. the declaration above accurately reflects the nature and extent of the contributions of the candidate and the co-authors to the article included in Chapter 3 (page 38 - 51),
2. no other authors contributed to the article included in Chapter 3 (page 38 - 51) besides those specified above, and

**A.2 Chapter 3 declaration**

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3. potential conflicts of interest have been revealed to all interested parties and that the necessary arrangements have been made to use the material in Chapter 3 (page 38 - 51) of this dissertation.

<b>Name</b>	<b>Signature</b>	<b>Institutional affiliation</b>	<b>Date</b>
Prof. PJ Vlok	<i>Declaration with signature in possession of candidate and supervisor.</i>	Stellenbosch University	

**A.3 Chapter 6 declaration****A.3 Chapter 6 declaration****Declaration by the candidate:**

With regard to the article included in Chapter 6 (page 101 - 124) the nature and scope of my contribution were as follows:

<b>Nature of contribution</b>	<b>Extent of contribution (%)</b>
Conceptualised the premise of the article in conjunction with Prof. De Stobbeleir. Developed the conceptualisation of the article in more detail, executed the research, and wrote the article, incorporating periodic feedback from the supervisor. Improved the article in response to feedback received during the journal's peer-review process.	85%

The following co-authors contributed to the article presented in Chapter 6 (page 101 - 124):

<b>Name</b>	<b>e-mail address</b>	<b>Nature of contribution</b>	<b>Extent of contribution (%)</b>
Prof. K De Stobbeleir	katleen.destobbeleir@vlerick.com	As supervisor, Prof. De Stobbeleir was engaged in discussions to act as a soundboard and offer alternative perspectives during the conceptualisation and development of the article. Prof. De Stobbeleir also provided feedback and suggestions on a draft of the article. This contribution is similar in scope and nature to the contribution that a supervisor would typically make to the content of a dissertation.	10%
Prof. PJ Vlok	pjvlok@sun.ac.za	As supervisor for the research, Prof. Vlok provided inputs to improve the final draft of the article.	5%

Date and signature of candidate: *Declaration with signature in possession of candidate and supervisor.*

**Declaration by co-authors:**

The undersigned hereby confirm that

1. the declaration above accurately reflects the nature and extent of the contributions of the candidate and the co-authors to the article included in Chapter 6 (page 101 - 124),

### A.3 Chapter 6 declaration

---

2. no other authors contributed to the article included in Chapter 6 (page 101 - 124) besides those specified above, and
3. potential conflicts of interest have been revealed to all interested parties and that the necessary arrangements have been made to use the material in Chapter 6 (page 101 - 124) of this dissertation.

Name	Signature	Institutional affiliation	Date
Prof. K De Stobbeleir	<i>Declaration with signature in possession of candidate and supervisor.</i>	Vlerick Business School & KU Leuven	
Prof. PJ Vlok	<i>Declaration with signature in possession of candidate and supervisor.</i>	Stellenbosch University	

## A.4 Chapter 7 declaration

### Declaration by the candidate:

With regard to the article included in Chapter 7 (page 128 - 161) the nature and scope of my contribution were as follows:

Nature of contribution	Extent of contribution (%)
Conceptualised the premise of the article in conjunction with Prof. De Stobbeleir. Developed the conceptual model and the hypotheses. Secured an industry partner, designed the data gathering instruments with advise from Prof. De Stobbeleir. Gathered the data, identified the most appropriate statistical analysis approach and implemented this. Interpreted the results and wrote the manuscript.	85%

The following co-authors contributed to the article presented in Chapter 7 (page 128 - 161):

Name	e-mail address	Nature of contribution	Extent of contribution (%)
Prof. K De Stobbeleir	katleen.destobbeleir@vlerick.com	As supervisor, Prof. De Stobbeleir was engaged in discussions to act as a soundboard and offer alternative perspectives and technical expertise during the conceptualisation and development of the article. Prof. De Stobbeleir also provided feedback and suggestions on a draft of the article. This contribution is similar in scope and nature to the contribution that a supervisor would typically make to the content of a dissertation.	10%
Prof. PJ Vlok	pjvlok@sun.ac.za	As supervisor for the research, Prof. Vlok provided inputs to improve the final draft of the article.	5%

Date and signature of candidate: *Declaration with signature in possession of candidate and supervisor.*

### Declaration by co-authors:

The undersigned hereby confirm that

1. the declaration above accurately reflects the nature and extent of the contributions of the candidate and the co-authors to the article included in Chapter 7 (page 128 -

#### A.4 Chapter 7 declaration

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161),

2. no other authors contributed to the article included in Chapter 7 (page 128 - 161) besides those specified above, and
3. potential conflicts of interest have been revealed to all interested parties and that the necessary arrangements have been made to use the material in Chapter 7 (page 128 - 161) of this dissertation.

Name	Signature	Institutional affiliation	Date
Prof. K De Stobbeleir	<i>Declaration with signature in possession of candidate and supervisor.</i>	Vlerick Business School & KU Leuven	
Prof. PJ Vlok	<i>Declaration with signature in possession of candidate and supervisor.</i>	Stellenbosch University	