Jesperi Vuorinen

ON THE DUALISTIC NATURE OF KNOWLEDGE AND KNOWLEDGE CREATION
Cognitive Fit and Abstraction Complexity as basic attributes of knowledge

Tampereen yliopisto

ABSTRACT

Knowledge creation is one of the foundational concepts within the knowledge management literature. It has provided the field with a way of contributing to and managing value creation via a connection to innovation and competitive advantage. One of the main paradigms of knowledge creation is that between the interplay of tacit and explicit knowledge, which in themselves are some of the most foundational in all of knowledge management. Despite this, there is a long-standing gap within the way in which the literature uses these concepts, and their philosophical foundations.

The purpose of the work is to establish a new conceptual model for duality of knowledge and knowledge creation, by bridging this existing gap within the foundations of knowledge management literature, between the positivist nature of most knowledge management literature and the non-positivist concepts of tacit and explicit knowledge in its core.

The research is based on a primary literature review covering the entire publications history of the leading journal within the knowledge management field, the Journal of Knowledge Management by Emerald Publishing. This literature review is used to establish a historical development path of the tacit and explicit concepts within the knowledge management literature. From there, a new philosophical foundation based on critical realism and causal tracking reliabilism is introduced to act as the foundation for the new proposed model.

The work proposes a new conceptual model for tacit knowledge, explicit knowledge, and knowledge creation, based on simple premises of two new attributes of knowledge – cognitive fit and abstraction complexity. This model is able to explain knowledge creation, utility of knowledge, explicit and tacit knowledge, conversions between tacit and explicit knowledge and knowledge transfer using two new knowledge attributes and two related mechanism that affect these attributes. Based on the literature review, this concept seems to be the first model that is able to explain all of these concepts without the need for additional mechanics.

Keywords: Tacit knowledge, explicit knowledge, knowledge creation, cognitive fit, abstraction complexity, causal knowledge, philosophy of knowledge

The originality of this thesis has been checked using the Turnitin OriginalityCheck service.

TIIVISTELMÄ

Olli Jesperi Vuorinen: Tiedon ja tiedon luomisen dualistisesta luonteesta: kognitiivinen sopivuus ja abstraktion monipuolisuus tiedon perusominaisuuksina
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Tiedonluonti on yksi tietojohtamiskirjallisuuden perustavimmanlaatuisista konsepteista. Se on tarjonnut alalle tavan edistää ja hallita arvon luomista kytkemällä nämä innovaation ja kilpailuedun luontiin. Yksi tiedon luomisen tärkeimmistä paradigmoista on hiljaisen ja eksplisiittisen tiedon vuorovaikutus, joka itsessään on yksi tärkeimmistä tutkimuskohteista koko kirjallisuudessa. Tästä huolimatta kirjallisuudessa on pitkään ollut olemassa ero käsitteiden käytön ja käsitteiden filosofisten perusteiden välillä.

Tämän työn tarkoituksena on luoda uusi käsitteellinen malli tiedon kaksinaisuudelle ja tiedon luomiselle, korjaamalla tämän olevassa olevan eron tietojohtamiskirjallisuuden perusteissa, alan kirjallisuuden positivisen luonteen ja kirjallisuuden hyödyntämien ei-positivististen hiljaisen ja eksplisiittisen tiedon käsitteiden välillä.

Työn tutkimus perustuu kirjallisuuskatsaukseen joka kattaa alan johtavan lehden, Journal of Knowledge Managementin, koko julkaisuhistorian. Tätä kirjallisuuskatsausta käytetään hiljaisen ja eksplisiittisen tiedon käsitteiden historiallisen kehityspolun määrittämiseen tietojohtamiskirjallisuudessa. Tähän perustuen työssä esitellään kriittiseen realismiin ja kausaali-reliabilistiseen tietoon (causal tracking reliabilism) pohjautuva uusi filosofinen perusta, joka toimii uuden ehdotettavan mallin perustana.

Työssä lopputuloksena ehdotetaan uutta mallia hiljaiselle tiedolle, eksplisiittiselle tiedolle ja tiedon luomiselle, joka perustuu kahden uuden tiedon perusominaisuuteen – kognitiiviseen sopivuuteen (cognitive fit) ja abstraktion monipuolisuuteen (abstraction complexity). Tämä uusi malli pystyy selittämään tiedon luomisen, tiedon hyödyllisyyden, eksplisiittisen ja hiljaisen tiedon, muunnokset hiljaisen ja eksplisiittisen tiedon välillä sekä tiedonsiirron konseptit käyttämällä kahta uutta tiedon perusominaisuutta ja kahta niihin liittyvää mekanismia, jotka vaikuttavat näihin ominaisuuksiin. Työssä esiteltävä malli on kirjallisuuskatsauksen perusteella ensimmäinen, joka pystyy mallintamaan kaikkia näitä käsitteitä ilman mallin ulkopuolisia mekanismeja.

Avainsanat: Hiljainen tieto, eksplisiittinen tieto, tiedon luonti, kognitiivinen sopivuus, abstraktion monipuolisuus, kausaalinen tieto, tiedon filosofia

Tämän julkaisun alkuperäisyys on tarkastettu Turnitin OriginalityCheck –ohjelmalla.

FOREWORD

This thesis has been completed as part of a Degree in Business and Technology Management at Tampere University's Program in Information and Knowledge management. The research and writing process took place between late-2019 and mid-2021, both at Tampere University, Tampere, Finland and during exchange studies at Osaka Institute of Technology, Osaka, Japan.

The author would like to recognise the work's supervisors Pasi Hellsten and Miikka Palvalin for their continuous support and encouragement during this long process. Said support allowed for the thesis to take its unconventional form compared to traditional master's theses at Tampere University, without which the model seen in the thesis would have not been created. The development of herein contained ideas would not have been possible without the time and expertise Mr. Hellsten and Mr. Palvalin selflessly made available.

Great thanks also go out to Professor Kentaro Minagawa, Riki Tanaka and Bernhard zur Lippe for their advice, support, friendship, and sense of humour during the parts of the research and writing process, which took place during the exchange studies at Osaka Institute of Technology.

Finally, I wish to thank the numerous people who have helped with the thesis in a more indirect fashion, including family and friends, both home and abroad. Specific acknowledgement to Van Le Hai and Kris Prulla for allowing me to bounce ideas off them regarding the philosophical foundations of the model, as well as Tarmo and Riitta Vuorinen for their help with the proof-reading.

Tampere, 25.5.2021

Olli Jesperi Vuorinen

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1. INTRODUCTION

This is a master's thesis produced as a part of the author's studies in the Information and Knowledge Management degree program at Tampere University. The thesis is a conceptual work, the originality of which has been checked using the Turnitin-system provided by Tampere University.

1.1 Purpose, background, and motivation

Knowledge creation is one of the fundamental building pillars and mechanisms within knowledge management literature (Newman, 1997; Wiig, 1997; Xu et al., 2010; Gaviria-Marin, Merigo, & Popa, 2018), remaining so even as it has slowly lost momentum to a widening range of research (Serenko & Dumay, 2015b). One of the main paradigms of this mechanism is dualistic view on knowledge, based on the concepts of tacit and explicit knowledge (Nonaka, 1994; Nonaka & Takeuchi, 1995; Bratianu & Orzea, 2010; Xu et al., 2010; Bratianu, 2015).
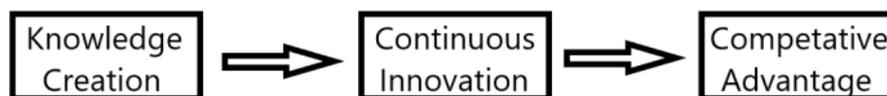
Figure 1. *Relationship between knowledge creation, innovation, and competitive advantage (adapted from Nonaka & Takeuchi, 1995; Schulze, 2001).*

As seen in figure 1, the value and motivation of the literature regarding these subjects often being justified by the insights they provide to value creation and competitive advantage through the medium of innovation, with views that form the core of the knowledge-based theory of the firm (Spender, 1996a; 1996b; Schulze, 2001; Bratianu & Orzea, 2010; Bratianu, 2015).

Yet, there is an underlying problem with the positivist outlook in majority of the literature regarding tacit knowledge, explicit knowledge, and knowledge creation. This has been clearly identified in highly cited works at least as far back as Spender (1996a) in the 90's, with Styhre (2003) advocating for further discussion in the early 00's and as recently

as Crane and Bontis (2014) questioning the use of positivism in knowledge management literature in the 10's; Indeed, it has long been clear that the literature regarding the use of knowledge creation as value creation paradigm requires the use of concepts beyond the purely positivistic approach, and yet the majority of the same literature is by its very nature positivistic (Spender, 1996a; Crane and Bontis, 2014), a view that is mirrored in philosophical literature as the "breakdown down of positivism" (Groff, 2004).

This work is an attempt to address this issue by offering a possible solution to overcome this gap between what is required of the philosophical and conceptual foundations knowledge-based value creation, and what we see in the current knowledge management literature. In this work, I will introduce to you a conceptual model which is based on two new knowledge attributes of cognitive fit and abstraction complexity. These attributes are built upon a novel combination of critical realism and causal tracking reliabilism as their ontological and epistemological foundations (Goldman, 1967; 1979; Groff, 2004; McEvoy, 2014; Saunders et al., 2019), while attempting to maintain the utility and functions of the existing positivist literature where possible.

We[1] will later see that this model can be shown to offer a rethink of the long-standing view that tacitness and explicitness are mutually exclusive attributes (Nonaka, 1994; Mooradian, 2005; Bratianu, 2015), that are either gained or lost when moving between the tacit and explicit knowledge states (Nonaka & Takeuchi, 1995; Mooradian, 2005). This rethink subsequently leads to new possibilities over established literature, including the propositions of the two new knowledge attributes as the basis of underlying mechanisms for other concepts such as knowledge transfer, utility of knowledge as well as the conversion operations between the existing tacit and explicit concepts themselves.

1.2 Formulating the research questions

With the motivation of this work situating the context firmly within the philosophical foundations of knowledge creation, as well as tacit and explicit knowledge, the main research question (MQ) was chosen to be as follows:

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[1] This work will use the *inclusive we* as a literary device in order to better connect the subject matter with the thinking of the potential audience (Wikipedia.org, 2021). This choice will be explained in a further footnote in chapter 5.1.4.

MQ: How can the duality of knowledge be viewed in a way that maintains the utility of the existing literature while overcoming the gap between positivist view of prevalent literature and the need for inclusion of non-positivist concepts of knowledge?

To aid answering this question, the following sub-questions (SQ) were decided upon:

SQ1: What are the foundations behind the historical views on tacit-explicit divide (and related knowledge creation) in the knowledge management literature?

SQ2: What are the philosophical foundations that could be used to replace the ones in established literature in a way which better bridges the gap between positivist nature of the literature and non-positivist foundations of its concepts?

SQ3: What kind of model results from the new foundations?

SQ4: How does the new model compare to existing literature, specifically the prevalent SECI-model?

In the development of these questions Clough & Nutbrown's (2012) work was used. Specifically, the 'Goldilocks test' as seen in relation to Saunders et al (2019) research design was utilized to determine that the questions were not too large in scale (when compared to the available resources), too small (to provide meaningful insights), nor too 'hot' (so as to make the research untenable due to its aggravating nature) (Clough & Nutbrown, 2012).

The main research question's (MQ) scope had to be narrowed down in a way in which would facilitate research by a single author without access to research budget or funding. To this end, the MQ was chosen in away, which would not require empirical research, with a focus on the gap in the philosophical foundations of the duality of knowledge, which can be researched based on existing literature. (Clough & Nutbrown, 2012; Saunders et al., 2019).

The role of the sub-questions (SQ1, SQ2, SQ3, & SQ4) was to make sure that the main research question was approached in a way that would guarantee that the scope of the research and its applicability does not become too small nor narrow to provide significant insights: SQ1 does this by relating the research to the established literature, SQ2 by finding the necessary philosophical foundations that can be used make the findings as

generalizable as possible and SQ3 & SQ4 by making sure that the results and conclusions of the research are related to the SQ1 & SQ2 in a transparent and meaningful way. (Clough & Nutbrown, 2012; Saunders et al., 2019).

The final test of the research questions not being too 'hot' does not pose a major consideration for these questions (Clough & Nutbrown, 2012; Saunders et al., 2019), as while probing the philosophical foundations of an established field of study may be considered aggravating by some fundamentalist, their ability to intervene in the research via angry comments or quiet resentment was considered a risk worth taking.

Finally, in all of these questions were formed with the underlying principle of 'being radical' (Clough & Nutbrown, 2012). This means that the questions were built and more importantly interpreted during the research process in a way which aims to *make the familiar strange*, in order to gain new insights from this new, strange view on the previously familiar subject matter.

These research questions and the above considerations are also used in the construction of the works structure, as will be explained in sub-chapter 1.5. To this end, the abbreviations of MQ, SQ1, SQ2, SQ3, and SQ4 will be used to refer back to these research questions in later parts of the work.

1.3 Expected Findings

The work establishes a historic narrative of the development of the most popular uses of the tacit-explicit paradigm based on analysing this development around the three research questions/directions proposed by Venkitachalam & Busch (2012) for knowledge management research in this context. This development path is used to conceptualize three major iterations of this paradigm, beginning from Polanyi's *Tacit Dimension* (1966) to its usage in Nonaka's (1994) SECI-model, and later development from binary states toward a more nuanced spectrum in which the tacit and explicit states form the extreme ends of said spectrum.

These iterations and the reasons behind them are then used to identify philosophical foundations that could be used to bridge the gap between the positivist nature of the related literature and the non-positivist concepts at its core (Spender, 1996a; Crane & Bontis, 2014). These foundations are used to create two propositions which establish mechanisms for the two new attributes – cognitive fit and abstraction complexity.

Finally, cognitive fit and abstraction complexity are used as the basis for the new conceptual model which answers the MQ and SQs by constructing the previous concepts of

tacit and explicit knowledge from these new concepts, with tacit knowledge being comprised of higher cognitive fit when compared to abstraction complexity and visa-versa for explicit knowledge.

1.4 Implications and value

The main theoretical advantage of the model is its ability to explain a large variety of knowledge managements fundamental concepts using the same two attributes and their mechanisms based on the two propositions. Based on the literature review, this seems to be a first model which utilizes the same mechanisms to explain knowledge creation, knowledge transfer, utility of knowledge and tacit to explicit conversions without the need for additional mechanics, such as combination or socialization from the SECI-model or utility via value creation through innovation process in knowledge-based theory of the firm (Nonaka, 1994; Nonaka & Takeuchi, 1995; Schulze, 2001; Bratianu, 2015).

When compared to the prevalent SECI-model, cognitive fit- and abstraction complexity-based model provides two distinct practical advantages. Firstly, the linear nature of the model provides a different perspective on the knowledge creation process when compared to the prevalent SECI-model and its cyclical nature and offers answers to some missing features within the cyclical models, such as the mechanisms that govern the closure of the process (Nonaka, 1994; Nonaka & Takeuchi, 1995; Spender, 1996a). This linear perspective can be seen as better representing technological and innovation processes which undergo disruptive changes such as those represented by the so-called technology S-curves, or breakthroughs based on paradigm changes (Xu et al., 2010; Netland & Ferdows, 2016; Byun, Sung, & Park, 2017).

Secondly, the SECI-model has been criticised for its inability to model knowledge creation without external input as well as the unequal status of socialization and combination as knowledge transfer when compared to externalization and internalization as conversion processes (Bratianu, 2015). The new cognitive fit and abstraction complexity -based model is not subject to these limitations, as it is able to explain internal knowledge creation processes without the necessity of knowledge transfer, external knowledge sources, or additional mechanisms such as Bas (Nonaka & Konno, 1998; Nonaka, Toyama, & Konno, 2000; Bratianu, 2015).

1.5 Structure and contents

The structure of the work is divided into six chapters: Introduction, Methodology, two chapters covering the theoretical background, a chapter for the construction of the new

conceptual model and its related concepts, as well as discussion and contributions chapter. Taken together, these seven chapters answer the MQ.

This chapter has introduced the purpose and motivation behind the work, as well as the research questions and summary of the findings. From here, chapter two includes the research methodology and conduction of the literature review which acts as the main source of the theory. Additional details and information on the conduction of the research is provided in appendixes A and B.

Theoretical background is covered in chapters three and four, which have the purpose of answering SQ1 and SQ2 respectively. Chapters five and six include the creation on the new model, its properties and discussion related to these topics. SQ3 and SQ4 are mainly answered by these two chapters. After this, the work concludes with evaluation, limitations and future research directions in chapters six.

2. METHODOLOGY

This thesis is written as a theoretical work aimed at introducing a conceptual model. Therefore, the research design has been adapted accordingly, and is inspired by two works: Saunders et al.'s (2019) work *Research methods for business* students, and Snyder's (2019) *Literature review as a research methodology: An overview and guidelines,* published in the *Journal of Business Research*. For the broader top-down view of the necessary research decisions, the common Saunders et al.'s (2019) framework used by most master's theses' is followed, while Snyder's (2019**)** work provides more detailed guidelines for the chosen research strategy, method, and analysis.

2.1 Research Design and Philosophy

The research design and there in contained methodological choices follow the structure seen in the work of Saunders et al. (2019), with a division into research philosophy, theory development approach, methodological choice, research strategy, time horizon, and data collection and analysis. These layers are utilized to express the choices related to the research design. This division is the same as that seen in figure 2, adapted from Saunders et al.'s (2019) 'research onion'.
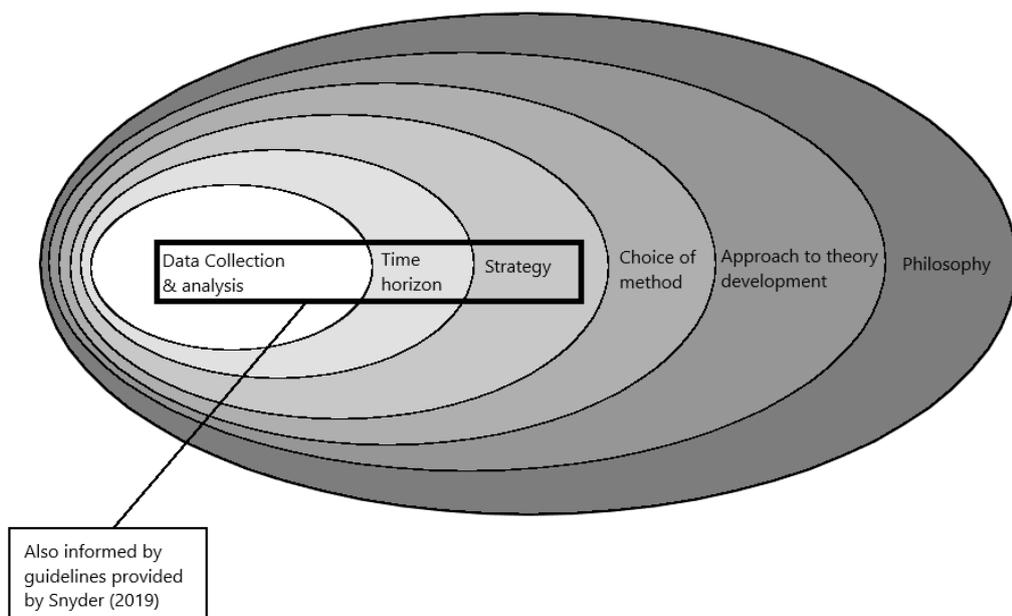
Figure 2. *The 'research onion' (adapted from Saunders et al., 2019), and the choices informed by Snyder's (2019) guidelines.*

The downside of using Saunders et al.'s (2019) model, is that the division into layers seen in figure 2 is best suited for empirical research, and not explicitly meant for use with literature review and theoretical or conceptual models. To address this, the inner layers of figure 2, representing data collection, analysis, time horizon and strategy, were further supplemented with guidelines provided by Snyder (2019).

Finally, due to the subject matter's close connection to philosophical considerations, the choice of research philosophy on the outer most level of figure 2 was not finalized during the research design process. Instead, the philosophical context was decided upon based on the results of the literature review and subsequent analysis. As such, the research philosophy will form a major part the later structure of the work (see chapter 4) and will not be discussed here.

2.2 Approach

The choice of approach, between inductive, deductive, and abductive options (Saunders et al., 2019), was the first choice of this work's research design. Inductive approach was chosen over the deductive alternative, due to its suitability for exploratory research and theory building, with which the purpose of this work is aligned with (Woo et al., 2017; Saunders et al., 2019). The logic of inductive approach allows for the use of known premises (i.e., existing literature) to form untested solutions (i.e., the new conceptual model) (Saunders et al., 2019, p. 145).

This was likewise the major reason for choosing inductive approach over abductive approach, where premises are used to form testable solutions (Saunders et al., 2019, p. 145), as this choice allows the dedication of the limited time and resources to the generation of the solution (proposal), while testability, which is difficult for such a philosophically minded concepts, is given less weight.

It is important to note that while this focus is useful, it is also viewed as a major liability of inductive research by some, due to it sometimes being seen as less scientifically rigorous than deductive approach (Gioia et al., 2013; Woo et al., 2017). While this limitation informs the method, strategy, and process choices, its relevance and negative effects are exceeded by the positives for the purpose of the work and in exploring new ideas by focusing limited resources to inspire new paths for future research.

2.3 Method and Strategy

The methodological choice is best described as a mono-method qualitative choice, which provides a source for the known premises used in the abductive approach. Qualitative

was chosen over quantitative options as this better serves the goals of the work in conceptualization and theory formation, as well as being optimally suited for abductive approach (Saunders et al., 2019; Snyder, 2019).

The single chosen method is a literature review, which forms the main research strategy of the work. Literature review was chosen based on the benefits it provides in the context of the considerations of the available resources as described in relation to the formation of research questions in chapter 1.3 (Clough & Nutbrown, 2012), and based on the prevalence of literature review as a method in knowledge management literature, with more than half of the 'citation classics' in the knowledge management field being using literature review as their research method (Serenko & Dumay, 2015a). This strategy was guided by two works: Snyder's (2019) *Literature review as a research methodology: An overview and guidelines* and Torraco's (2005) *Writing Integrative Literature Reviews: Guidelines and Examples* published in the Human resource development review. These guidelines will be discussed in more in the next chapter when considering data collection and analysis.

The scope of the review, while perhaps more closely connected to time horizon, data collection and analysis choices, is crucial to the method and strategy choices and as such will be discussed here. The object of the review was the full publication history of the leading journal of knowledge management field, the Journal of Knowledge Management (JKM), which was chosen based on the *Global ranking of knowledge management and intellectual capital academic journals* by Serenko & Bontis (2009; 2013; 2017; Bontis & Serenko, 2009). These rankings were utilized for their credibility given by the consistent methodology used by Serenko and Bontis (2009; 2013; 2017), with all three rankings including same methodology consisting of both an expert survey for establishment of subjective opinion and use of citation indexes for a more objective result. (Serenko & Bontis, 2009; 2013; 2017).

JKM has scored highest in all rankings carried out by Serenko & Bontis (2009; 2013; 2017), and has consistently improved on most metrics[2]. From the other top journals, only *Journal of Intellectual Capital* has been categorized in the same A+ category as JKM, and while JKM has consistently scored higher in all categories of the rankings (Bontis & Serenko, 2009), the final decision to use JKM over Journal of Intellectual Capital or other competing publications such as *International Journal of Knowledge Management* or *The Learning Organization* was informed by a separate study by Serenko & Dumay (2015a),

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[2] such as h- and g- indexes.

which concluded that JKM is the journal with the most publications which can be considered as "Citation classics" in the field of knowledge management.

For the review, an integrative strategy was chosen over other options, as it again best fits the goal of the work in producing a conceptual model (Torraco, 2005; Snyder, 2019), as well as enabling the use of a qualitative method (Saunders et al., 2019). The choice also benefits from the integrative reviews usual purpose as a critiquing and synthesizing work and qualitative analysis methods being more suited for the limited resources when compared to a more quantitative option **(**Snyder, 2019), such as a content analysis.

As indicated to above, the search strategy centred around the idea of focusing on a single, peer-reviewed, high quality publishing platform, the JKM (Serenko & Bontis, 2009; 2013; 2017; Bontis & Serenko, 2009). The choice of reviewing all articles published in the history of the publication was made in order to make sure that the largest possible portion of the existing knowledge creation and related models were considered, while also staying within the limitations of the works context.

This initial large and high-quality set of literature provides a level of credibility for the source material (Serenko & Bontis 2009; 2013; 2017; Bontis & Serenko, 2009; Emerald Publishing, 2021), which is used to address the liability of inductive research in scientific rigorousness, as discussed in relation to the choice of approach. With this method and strategy, a well-chosen, high-quality publication also provides a historic filter for the most prominent knowledge creation models via the work already undertaken by the publisher in the form of the peer-review and editorial processes (Emerald Publishing, 2021).

2.4 Time horizon, data collection, and analysis

In addition to the needs of the research method and strategy discussed above, the answer to the question of time horizon can also be derived independently from SQ1. To ensure the best results, (and based on the considerations discussed in both chapters 2.2 and 2.3), the longest possible longitudinal scope was chosen, as it provides a view of the tacit-explicit paradigm's historical and current development.

2.4.1 Scope of the review

The final scope ranges from the publication of JKM volume 1 issue 1 in 1997 to the latest publication at the beginning of this study, volume 23 issue 10 in 2019, with the final data collection covering over 1300 articles from more than 20 years of knowledge manage-

ment literature. The issues which were published during the research and writing process, namely those included in volumes 24 and 25, were excluded. While this scope does not cover the entire history of tacit and explicit concepts, which can be traced back to the 1960s and writings of Michael Polanyi (1966), the majority of the recent development after the major resurgence of the ideas starting from the writings of Ikujiro Nonaka (1991; 1994) is included. Further inclusion of the literature between Polanyi's (1966) writing and initial publication of the JKM in 1997 was considered but decided against due to the already extensive amount of material, and due to the challenges and negative impact any further expansion of the scope outside a single publication could have on the consistency of both source material and subsequent analysis.

Despite this, the amount of material had to be further narrowed down prior to the final analysis process, and the writing of this work. This resulted in a review process consisting of three phases, with two phases aimed at narrowing down a manageable number of articles, and a third phase consisting of the writing and model development process. The first two phases in and of themselves act as the data collection and analysis procedures seen in figure 2, while being constructed based on the guidelines of Snyder (2019) and Torraco (2005).

The guidelines provided by Snyder (2019), consist of four phases (here after called stages, so as to not to be confused with the two phases discussed here). These stages are: Design, conduct, analysis, and structuring/writing, and are largely reflective of the checklist for writing an integrative literature review, provided by Torraco (2005); Torraco's (2005) checklist includes considerations prior to writing a review, the organization of the review and finally the process of writing the review.

Snyder's guidelines begin from the design stage which was covered by the previous chapters and the research design choices from Saunders et al.'s (2019) model in figure 2, answering questions such as search strategy, purpose, and research questions, and was therefore not included in the two phases described here. Likewise, the 4th stage of writing and structuring, which is likewise seen in Torraco's (2005) checklist, is only used in advisory manner as part of the third phase, as the specifics on these areas are contradicted by the nature of the work as a master's thesis (Tampere University, 2019), while the work of Snyder (2019) and Torraco (2005) is concerned mainly with articles. However, some notions, including considerations such as clear communications of ideas and reporting standards, will be utilized as they can be extrapolated easily to the work's context. The two remaining stages, conduct and analysis, form the basis for the first two phases of this works data collection and initial analysis process.
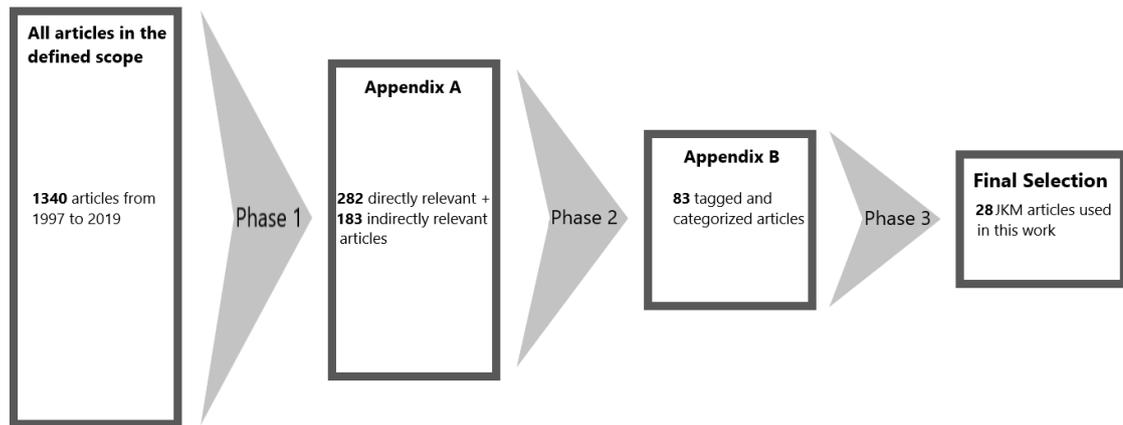
Figure 3. *The review process, its phases, and their results.*

Figure 3 shows the literature review process from the initial full scope to the two phases used to narrow down the most relevant literature. The processes of phases 1 and 2 are explained within the next two sub-chapters. Phase 3 comprised mainly from the writing of this thesis and formulation of the new conceptual model. After the review process, the final selection was articles was used in the work to establish the views from the current literature in Chapter 3, to form the inspiration for the approach in chapter 4, as well as to guide the development of the new model in chapter 5.

2.4.2 Phase 1 – Determining the relevancy of articles

The first phase mirrors the conduct stage in Snyder's (2019) guidelines, including the practical selection of articles, documentation of the search process and quality assurance of the search process. In this phase, the selection of articles took the form of all the articles published within the prior mentioned scope being reviewed based on their abstract and introduction sections (often the first 1 or 2 pages of text). The abstract, while changing slightly over the course of JKM publication history, included the following categories: Purpose, design/methodology/approach, findings, limitations & implications, originality & value, keywords, and paper type). The inclusion of the introduction section within the reviewed portion of each article was done as a part of the quality assurance of phase 1 process; The required quality is achieved by the inclusion of introduction sections as it acts to avoid and alleviate possible biases in the part of the reviewer, that could lead to mistaken interpretation of the articles' contents, if reviewed solely based on the abstract section of each article.

Based on this initial review, the selection of articles was conducted by categorizing them into one of three groups based on a purposefully wide interoperation of the research topic:

1. Those of direct relevance,

2. indirect relevance, and

3. no clear relevance.

These three groups were adapted from the categorization used by Serenko & Dumay (2015b) for their *Citation classics published in Knowledge Management journals* when classifying different types of citations used in the knowledge management literature, with group 1 corresponding to clear support, group 2 corresponding to ambiguous support and group 3 merging the so called 'empty citations' and no support categories. Serenko & Dumay have themselves adapted these categories from the work of Todd et al (2010; Todd et al. cited in Serenko & Dumay, 2015b), but the revised version by Serenko & Dumay (2015b) was used as the basis for the above three groups due to it being more closely related to the knowledge management field compared to the Todd et al.'s (2010) *One in four citations in marine biology papers is inappropriate.*

The results of this phase 1 of the review are detailed in appendix A, including the categorized group of each reviewed article, as well as the total numbers of articles in each category per issue, and total number of articles in each category. Appendix A acts as the documentation of the search and selection in phase 1. As seen in figure 3, the final sample after phase 1 consisting of the directly and indirectly relevant articles, had a total of 465 articles being chose for phase 2, with 282 of those being directly relevant and 183 being indirectly relevant. In overall, the phase one reviewed more than 1300 articles, based on the abstract and introduction portions of these articles.

2.4.3 Phase 2 – Tagging and initial analysis

After the first phase was concluded, the focus of the research was finalized prior to the beginning of the second phase, including the final research questions and focus of the work on the tacit-explicit duality and knowledge creation. Because of this, a major goal of this phase was to further narrow down the material to those articles most relevant to the narrower focus. In addition to this, the second phase formed the more explicit, initial part of the analysis process, mirroring the analysis stage seen in Snyder's (2019) guidelines by answering questions such as: *What information needs to be abstracted? How*

will the reviewers be trained to ensure quality of analysis? and *How the analysis process will be documented?*

The information which needed to be abstracted was two-fold: The results of the phase 1 had to be narrowed down to the new, more focused research, and subsequently, information regarding the MQ and especially SQ1. This abstraction was achieved by taking the results of the first phase and tagging them based on how the articles were considered to be relevant. These tags were initially based on reviewing the articles on a similar depth as in phase 1, with both the abstract and introduction sections being considered. However, this was further supplemented by varying levels of deeper familiarization with the articles in order to determine which types of tags are relevant for each article. Further details on this process are provided in appendix B.

The quality assurance of this second phase benefited both from being conducted by a single reviewer, which removes the need for training of multiple reviewers in order to make the results of the review comparable (Snyder, 2019), and from its documentation in the form of appendix B. As these tags were generated independently for each article, the initial tagging process resulted in more than 250 unique tags, and multiple tags describing same, or similar subject matters. To ease the further analysis and writing process in phase 3, and assure the quality of the analysis, and to make the tags comparable with one-another, these tags were then consolidated by grouping them together into a final selection of tags consisting of around 50 consolidated tags.

From there, the initial analysis process in phase 2 was carried out by using these tags to analyse the chosen articles contents according to the needs of the research questions MQ, SQ1, SQ2, SQ3, & SQ4 in accordance with the inductive approach (Torraco, 2005; Saunders et al., 2019; Snyder, 2019). Appendix B lists the primary way in which these tags were grouped around subject matters identified by the initial analysis on the basis of the tags and research questions, resulting in a list of 83 articles.

2.4.4 Phase 3 – Final selection of articles, forming the new model and writing the thesis

The phase 3 used the 83 articles resulting from phase 2 as the basis of further analysis and writing of the work. As mentioned in relation to phase 2, the main focus for the utilization of these articles and their analysis was to be used in answering the MQ and SQ1. With the initial, explicit part of the analysis process already having taken place in phase 2, phase 3 formed the less structured, implicit part of the analysis which resulted in this thesis. The final outcome of phase 3 are the 28 articles from JKM used as sources in

this work. These 28 articles can be found both in the references and appendixes A and B.

With the methodology and research design completed, the next chapter will move on to the main body of this work. In the next chapter, the work will begin to move towards the new conceptual model by first seeing which types of interpretations have been developed for the concepts of tacit and explicit knowledge within the established literature.

3. EVOLUTION OF TACIT AND EXPLICIT CONCEPTS

In this chapter we will see how the tacit and explicit concepts have developed in the decades following their introduction, with most weight given to the time period from 1997 to 2019 covered by the JKM publication history. Based on the JKM literature review, we could see that the development of these concepts has already been the object of considerable interest of multiple authors over the years, such as Dampney, Busch, & Richards (2002) in *The Meaning of Tacit Knowledge*, Mooradian (2005) in *Tacit knowledge: philosophic roots and role in KM*, Williams (2006) in *Narratives of knowledge and intelligence ... beyond the tacit and explicit*, Venkitachalam & Busch (2012) in *Tacit knowledge: review and possible research directions* and Crane & Bontis (2014) in *Trouble with tacit: developing a new perspective and approach*.

These works consider tacit and explicit concepts from a wide variety of perspectives. For our purposes, the most crucial aspects are the philosophical underpinnings of these concepts. To this end, we will utilize the following questions proposed by Venkitachalam & Busch (2012) for future KM research in this context:

1. Whether or not the articulation of tacit knowledge fundamentally makes that knowledge no longer tacit or not? [3]

2. Do different types of tacit knowledge exist? and,

3. To what extent can tacit knowledge be articulated? (Venkitachalam & Busch, 2012).

For our purposes, the questions 1 and 3 are most relevant[4], as they are fundamentally related to the relationship between explicit and tacit concepts which forms the knowledge creation paradigm (Nonaka, 1991; 1994; Nonaka & Takeuchi, 1995; Xu et al., 2010). Next in this chapter, we will see how previous literature has dealt with similar questions, and after that in chapter 4, we will use the resulting view on the major developmental crossroads to build a new understanding of these concepts.

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[3] Originally stated as: "If tacit knowledge can be articulated, how often can such knowledge still be considered "tacit""?

[4] While the notion of different types of tacit knowledge from the question 2 is not addressed with as much detail, we will return to it in chapter 6, when discussing future possibilities

3.1 Polanyi and the tacit dimension

The ideas of tacit and explicit knowledge have their roots in the work of Michael Polanyi's (1958) work *Personal knowledge*. However, these concepts of tacitness and explicitness were far more concretely and insightfully presented in Polanyi's (1966) book *The Tacit Dimension* and his later works, and as such, we will use them as our starting point *(*Williams, 2006*;* Sudhindra, Ganesh, & Arshinder, 2014*).*

As established literature often views tacit and explicit as opposites, we can start by understanding one and use that understanding to understand the other. While the words tacit and tacitness are frustratingly autological in their ambiguity, especially when compared to explicitness, we have to start somewhere and a true and tested place for this is the Polanyi's (1966) own example.

In order to understand his view, Polanyi (1966) asks us to consider the process of facial recognition[5]. This example has since become to underline the early understanding of tacit knowledge:

"We know a person's face, and can recognize it among a thousand, indeed among a million. Yet we usually cannot tell how we recognize a face we know. So, most of this knowledge cannot be put into words. But the police have recently introduced a method by which we can communicate much of this knowledge. They have made a large collection of pictures showing a variety of noses, mouths, and other features. From these the witness selects the particulars of the face he knows, and the pieces can then be put together to form a reasonably good likeness of the face. This may suggest that we can communicate, after all, our knowledge of a physiognomy, provided we are given adequate means for expressing ourselves. But the application of the police method does not change the fact that previous to it *we did know more than we could tell at the time. Moreover, we can use the police method only by knowing how to match the features we remember with those in the collection, and we cannot tell how we do this*. This very act of communication displays a knowledge that we cannot tell."" – (Polanyi, 1966, as cited in Grandinetti, 2014).

This quote includes the now famous phrase "We know more than we can tell" (Polanyi, 1966), which at the core of tacit and explicit concepts. Polanyi's (1966) above quote shows tacit as that which we can know; that which we can act on but cannot express; "that tacit knowledge consists of search rules, or heuristics, that identify the problem and

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[5] The ability of humans (not AI) to recognize faces.

the elements consisting of the solution" (Kogut & Zander, 1992); or to use Venkitachalam & Busch's (2012) choice of terminology: that which we cannot *articulate*.

In contrast to this, we can understand explicit concept presented by Polanyi (1966) as the partial opposite of tacit, that which we can both know and express how we know, or as per Venkitachalam & Busch's (2012), the knowledge that can be, or rather, *is articulated*.

Li & Gao (2003), Grandinetti (2014) and Sudhindra, Ganesh, & Arshinder (2014) also add to this by pointing out that Polanyi (1966) does not seem to consider any type of tacit knowing to be convertible into explicit knowing. Instead, Polanyi's view is that tacit and explicit knowledge should be considered separate, binary forms of knowledge (Polanyi, 1966; Li & Gao, 2003; Grandinetti, 2014; Sudhindra, Ganesh, & Arshinder, 2014).
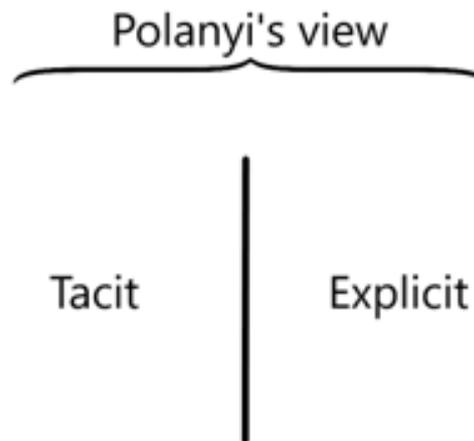
Figure 4. Polanyi's (1966) view of tacit and explicit knowledge as separate, binary types of knowledge that cannot be converted to each other, visualized here with a wall separating the two concepts.

This binary, non-convertible view seen in figure 4 is the first iteration of tacit and explicit concepts that we will consider in the development path of these concepts. It provides us with the 'original' answers to the first question posed by Venkitachalam & Busch (2012).

3.2 Nonaka and the SECI-model

Starting from the 1990s, Nonaka and his co-authors (Nonaka, 1991; 1994; Nonaka & Takeuchi, 1995; Nonaka & Konno, 1998; Nonaka, Toyama & Konno, 2000; 2001; Nonaka & Toyama, 2003; 2005; 2007) started to reinterpret these 'original' concepts posed

by Polanyi's (1966), with what would eventually coalesce into the body of work sometimes referred to as Nonaka's knowledge dynamics (Bratianu & Orzea, 2010; Bratianu 2015).

This body of work is based on the idea of conversions between these two states being possible and is, at least partially, founded on the idea of ontological dimension of organizational levels (Nonaka, 1991; 1994; Nonaka & Toyama, 2003; 2005), which complement the epistemological dimension formed by the tacit and explicit concepts seen in Polanyi's (1966) work, and remained dominant in knowledge management up until the middle of 2000s, and has stayed prevalent even since (Serenko & Dumay, 2015b).

The particular mechanism of conversion and how they derive from the organizational ontology is somewhat debated, with some including separate implicitness and tacitness within the tacit concept (Li & Gao, 2003), which differ from Polanyi's original tacitness while others, such as Mooradian (2005), refer to Nonaka and his co-author's (Nonaka & Takeuchi 1995; cited in Mooradian, 2005) notion of this conversion taking place via the use of language within different organizational levels. However, for the purposes of this work, the notion of ontological dimension acting as a source of these conversions is sufficient, as we will see in chapter 4.

These two dimensions form the basis of the SECI-model, which uses the externalization and internalization operations to move between these two states, with externalization converting tacit knowledge into explicit knowledge and internalization converting explicit knowledge into tacit knowledge (Nonaka, 1994; Nonaka & Takeuchi, 1995). Here, it is good to note that the addition of the ontological dimension can be considered foundational in forming a meaningful utility for these conversions, as it forms the basis achieving the cyclical knowledge creation that is foundational to the derivation of continuous innovation and subsequent competitive advantage (Li & Gao, 2003).

Compared to the concept seen in figure 4, it would seem that while Nonaka (1991; 1994) adjusted the interpretation of tacit and explicit knowledge to allow for these conversion processes, initially Nonaka did consider tacit and explicit knowledge to be binary in nature similar to the view in Polanyi's writing (Polanyi, 1966; Nonaka, 1991; 1994).
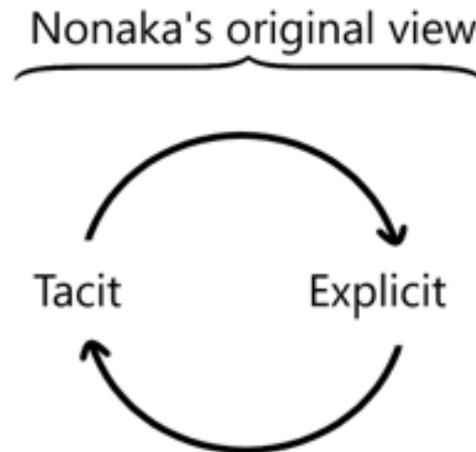
Figure 5. *Nonaka's (1991; 1994) view of conversions between the tacit and explicit states is what differentiates his views from those of Polanyi's (1966) tacit dimension.*

We will consider, this convertible, yet binary view seen in figure 5 as the 2nd iteration of the historical development of tacit and explicit concepts. The addition of conversions between tacit and explicit knowledge fundamentally changes the answers that we give to the questions posed by Venkitachalam & Busch (2012), allowing for *articulation* to take place. Yet, this views answer to the last of Venkitachalam & Busch's (2012) questions is somewhat limited, as the only extents articulation is completely or not at all.

In Trouble with tacit, Crane & Bontis (2014), state that "debates over the tacit question have largely become centered around two questions: what did Polanyi actually mean, and is Nonaka's project of converting tacit to explicit knowledge misguided?". This description of the debate on tacit knowledge and its role in knowledge management literature mirrors the first two of the above iterations of the tacit and explicit concepts, as seen in figures 4 and 5. Crane & Bontis (2014), giving further credence to what we have discussed so far.

However, in addition to these two main conceptual developments and sources of controversy, there is a third iteration of these concepts that we can identify. One that is perhaps not as often discussed and could instead even be considered as overlooked, and yet offers a differing answer to the questions of posed by Venkitachalam & Busch (2012).

3.3 Spectrum of gradual change

In more recent knowledge management literature, such as Li & Gao (2003), Meyer & Sugiyama (2007), Faucher, Everett & Lawson (2008) and also referred to in Ranucci & Sounder (2015), we can see that the binary nature of the tacit and explicit concepts, has

evolved towards a more detailed view. Moving away from the binary view seen in both Polanyi's (1966) original work and Nonaka's (1991, 1994) early writing on the subject, this newer iteration has moved towards understanding the tacit-explicit duality as a more complex series of states.
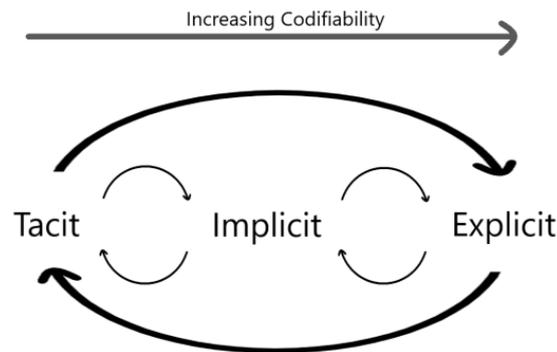
Figure 6. *Implicit knowledge as a form of knowledge between tacit states as presented by Meyer & Sugiyama (2007) based on the level of codifiability.*

Meyer & Sugiyama (2007) portray this as intrinsic knowledge forming a middle state between tacit and explicit knowledge based on its codifiability, as seen in figure 6. This view has also been taken further to form a continuum or spectrum of differing levels of tacitness and explicitness. This spectrum forms between the extremes of purely tacit and explicit knowledge states, with the conversion processes[6] happening within this spectrum (Li & Gao, 2003; Meyer & Sugiyama, 2007; Faucher, Everett & Lawson, 2008; Ranucci & Sounder, 2015). While Ranucci & Sounder (2015) point to this interpretation as resulting from the inability to measure tacitness separately from codifiability, it remains important for our purposes in its ability to recognize that the conversion processes are not binary, and likewise any change in the attributes and capabilities of the knowledge undergoing said conversion can happen gradually (Mooradian, 2005).

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[6] There are many names for these processes, including but not limited to codification (Li & Gao, 2003; Meyer & Sugiyama, 2007), expression (Polanyi, 1966), articulation (Venkitachalam & Busch's (2012) and famously internalization and externalization (Nonaka, 1994; Nonaka & Takeuchi, 1995)
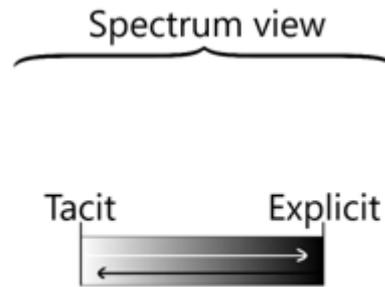
Figure 7. With addition of partial internalization and externalization, the tacit-explicit duality can be seen as a spectrum of states (Li & Gao, 2003; Meyer & Sugiyama, 2007; Faucher, Everett & Lawson, 2008; Ranucci & Sounder, 2015).

This spectrum interpretation is the third and final iteration we will consider and is visualized in figure 7. This interpretation answers the questions of Venkitachalam & Busch's (2012) by allowing for the *articulation* of tacit knowledge with the internalization and externalization operations which are not limited to all or nothing style of articulation in the same way as the binary model in figure 5. This subsequently would lead us to understand, that knowledge is able to include both tacit and explicit properties simultaneously.

3.4 Summary of the main branch in the development of tacit & explicit concepts

From figures 4, 5 and 7, we can construct a simplified path of to visualize the development of tacit and explicit concepts in the knowledge management literature, as based on the JKM literature review.
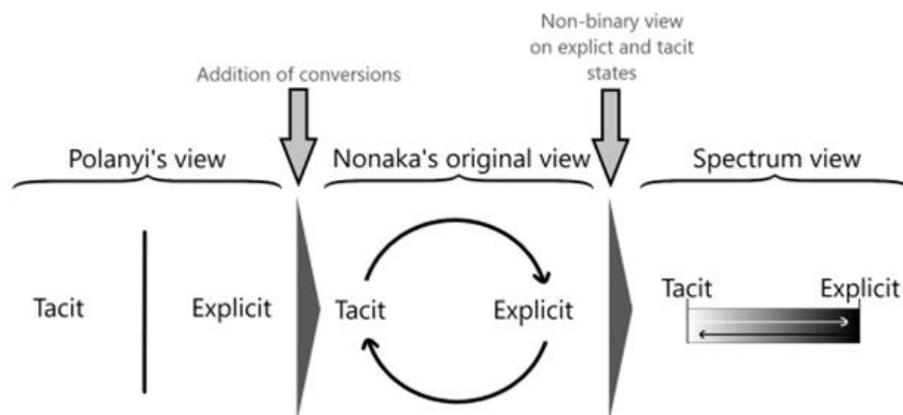
Figure 8. Development of views on tacit and explicit concepts (Polanyi, 1966; Nonaka, 1991; Nonaka, 1994; Faucher, Everett & Lawson, 2008; Ranucci & Souder, 2015).

This path, seen in figure 8, consists of three parts, with the first two based on the ongoing points of debate as identified by Crane & Bontis, 2014, regarding tacit knowledge on the interpretation of Polanyi's (1966) work and whether conversions of tacit and explicit knowledge are possible and the third part focusing on the change from binary tacit and explicit states into a more complex understanding of a continuum between tacit and explicit extremes.

The development from one of these interpretations to the next has been driven by questions similar to those posed by Venkitachalam & Busch's (2012) and have likewise dictated how we answer these questions and the limits on how these concepts can be utilized. These additions and modification, represented in figure 8 as arrows, will be our key to building the new model in the next chapter, as we change the content of these modifications to gain more opportunities, while keeping their overall goals and motivations intact so as to not lose the benefits given to us by the work of previous authors.

As noted in the beginning of the chapter, this development path seen in figure 8 was created based on the literature review carried out for this work. While this view is not the only one within the literature, it can be seen as a successful summary of the most commons views, based on the prevalence of the works of works of Polanyi (1966) as well as Nonaka and his co-authors (Nonaka, 1991; Nonaka & Takeuchi, 1995; Nonaka & Toyama, 2003) as seen in a bibliometric analysis by Gaviria-Marin, Merigo, & Popa (2018) in *Twenty years of the Journal of Knowledge Management: a bibliometric analysis* and Serenko & Dumay's (2015a, 2015b, 2017) three-part publication *Citation classics published in knowledge management journals.* However, before moving forwards to chapter 4, we will briefly discuss some of the alternative views.

3.5 Alternative interpretations

With foundational concepts, such as the duality of knowledge, there is often a wide variety of differing interpretations, which means that forming an exhaustive list of every alternative interpretation is unfeasible within the scope of this work. Instead, this chapter is only meant to recognize some views worth consideration, with the following ideas being considered:

- Full or partial dismissal of the usefulness of traditional tacit and explicit concepts in KM (Williams, 2005; Grandinetti 2014), Or alternative views without this separation (Jakubik, 2007).

- Conversions between tacit and explicit knowledge as untenable (Crane & Bontis, 2014).

- Tacitness and implicitness as separate types of knowledge (Kogut & Zander, 1992; Li & Gao, 2003; Grandinetti, 2014).

- Tacit and explicit -paradigm as lacking basis for a knowledge creation paradigm (Jakubik, 2011).

These four ideas act as representations of how each part of the development path seen in figure 8 could be countered. Williams' (2005), Jakubik's (2007) and Grandinetti's (2014) notions challenge the initial framework of tacitness and explicitness which originated from Polanyi's (1958; 1966) work, affecting the first iteration of the development path. Then the idea of conversions gained from Nonaka's (1994; Nonaka & Takeuchi, 1995) addition of the organizational ontology can be challenged along the ideas presented by Crane & Bontis (2014), affecting the critical aspect of the second iteration. Next, the integration of different levels of tacitness and explicitness into a spectrum like form can be indirectly challenged with views such as those proposed by Li & Gao (2003), which split tacit and implicit knowledge into separate dimensions, which is untenable with the view seen in figure 6 (Meyer & Sugiyama, 2007). Finally, the modern utility of the entire development path, as a basis of knowledge creation and subsequently innovation and competitive advantage as seen in figure 1 can be challenged (Jakubik, 2011).

Still, despite all of this, we will retain the idea that the development path seen in figure 8 and its related concepts remain useful in modern knowledge management literature, based on this work's literature review and the earlier works by Gaviria-Marin, Merigo, & Popa (2018) and Serenko & Dumay (2015a, 2015b, 2017).

In many ways, this is in line with the earlier discussed conclusion by from Crane & Bontis (2014) that "debates - - become centered around two questions: what did Polanyi actually mean and is Nonaka's project of converting tacit to explicit knowledge misguided?", with the natural addition that the entire tacit and explicit concepts might refuted. Instead of discarding contents of figure 8, we should think that taken together, these alternative views reflect more strongly on the notion those authors who have advocated before; that the knowledge management field is still in the process of maturing and formation of any single view on the matter is still unavoidably subject to interpretation.

4. PHILOSOPHICAL FOUNDATIONS

In this chapter we will go over some of the notions we came across in the previous chapter in order to grasp the philosophical foundations that underpin the new model, and also defines the philosophy of the work itself. We start by substituting a stratified ontological context to replace the organizational one used by Nonaka (1991; 1994) (Groff, 2004), in order to overcome the gap between the philosophical foundations of the positivist knowledge management literature and the concept of tacit knowledge (Spender, 1996a; Groff, 2004; Crane & Bontis, 2014). From there, we will connect an epistemological foundation to this ontological context by delving into the work of Alvin Goldman (1967; 1979), with the aim of defining what we should think of as knowledge, tacitness and explicitness, in the context of the new model.

4.1 Critical realism as ontology

Crane & Bontis (2014) found that the philosophical foundation in the majority of knowledge management literature is an objectivistic view gained from a positivist outlook. Simultaneously, both Spender (1996a) and Crane & Bontis (2014) themselves criticize the use of such philosophy when used together with the post-modernist philosophy of Polanyi (1966), which Crane & Bontis (2014) accurately describe as integration of objectivist and subjectivist viewpoints.

While Nonaka (1991,1994; Nonaka & Takeuchi, 1995) uses the organizational levels as the ontological context in order to facilitate conversions between tacit and explicit knowledge, I propose we can gain a better, more powerful version of the same utility by substituting this with a stratified ontological context, similar to that seen in the work of Groff (2004), Echajari & Thomas (2015), and Saunders et al. (2019) when discussing critical realism, an ontological context which is situated between the objectivist and subjectivist viewpoints (Huttunen, 2005, cited in Tuomi & Sarajärvi, 2017), somewhat similarly to the view of Polanyi (1966).

The Empirical:
Events as are observed or experienced

The Actual:
All that is generated by the *Real*. Can be, but are not nessecarily observed.

The Real:
Enduring causal structures, rules and
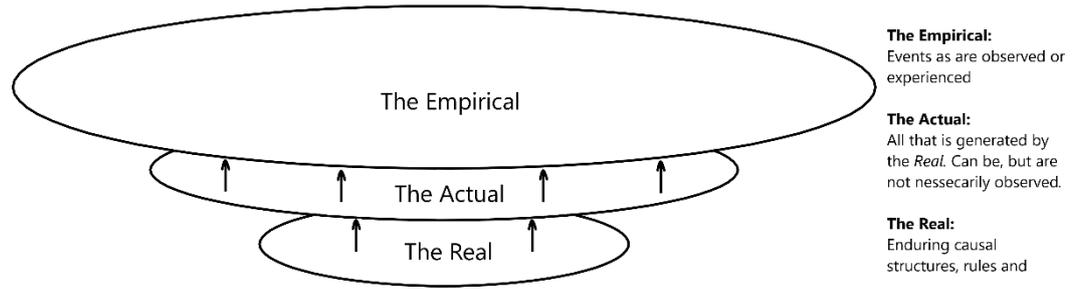
Figure 9. Stratified ontology of critical realism (adapted from Saunders et al., 2019). The flow of causality is represented by arrows connecting the Real, the Actual and the Empirical.

The essence of this stratified ontology seen in figure 9, is that the observations and experiences at the level of the Empirical are fundamentally connected to causal rules, and thus to nature of truth that is purely objective on the level of the Real. In fact, we can think of the realism in critical realism as a way of countering the notion of true relativism; that there is no notion or knowledge which can be seen as more valid than another (Groff, 2004). This necessary causal link between the Real and the events in the empirical establishes that all claims are not equal, and that there is a point of reference that we may use (Groff, 2004; Saunders et al., 2019).

However, I propose that we can view this stratified ontology in a way that allows for one case where critical realism does allow for a level of relativism to take place, that case being knowledge itself. While the causality and the environment described by the ontology in figure 9 is purely causal, when the causal flow moves through to the Actual, becoming observable, the objective natures of the causal mechanisms, rules and structures, becomes so complex that it is blurred by the limits of knowledge and knowing (Groff, 2004); As seen in Echajari & Thomas (2015), knowledge requires the ability to draw distinctions, representing what is known via coding and symbols. In this way, we can think of knowledge as starting to lose its singular basis as a purely objective notion related to truth, as the symbols, coding and other methods of representation blur the objective causal structure being represented by that knowledge. As a result, the knowledge becomes separated from the positivist viewpoint. This leads us to think, that complexity and essence of everything on the level of the Actual and the Real is such, that any observation introduces a necessary level of subjectivity as the causal flow finally reaches the level of the Empirical, as a result of said observation and therein contained biases.

In addition to these insights gained from the relationships between the different levels of the Real, the Actual and the Empirical, an important part of the stratified ontology in figure 9 is the representation of the levels as consisting of differing sizes. The reason we use this style of representation is based on a line of thinking presented concisely by Groff (2004): "*Reality, from this perspective, is regarded as being of (as yet) indeterminate depth: any given causal mechanism itself is assumed to itself be the product of an underlying causal process.*" This is our basis for modelling the levels of figure 9 as expanding from the Real towards the Empirical, which is in contrast to the visualization of Saunders et al. (2019) who instead show the layers as expanding towards the level of the Real. From this line of thinking, we can see that as we go down from the level of the Empirical towards the Actual and the Real, multitude of empirical events which we perceive in everyday life as seemingly separate, merge into a smaller number of shared causal rules and structures; the causal flows merge together as we travel upstream towards the Real. (Groff, 2014; Saunders et al., 2019).
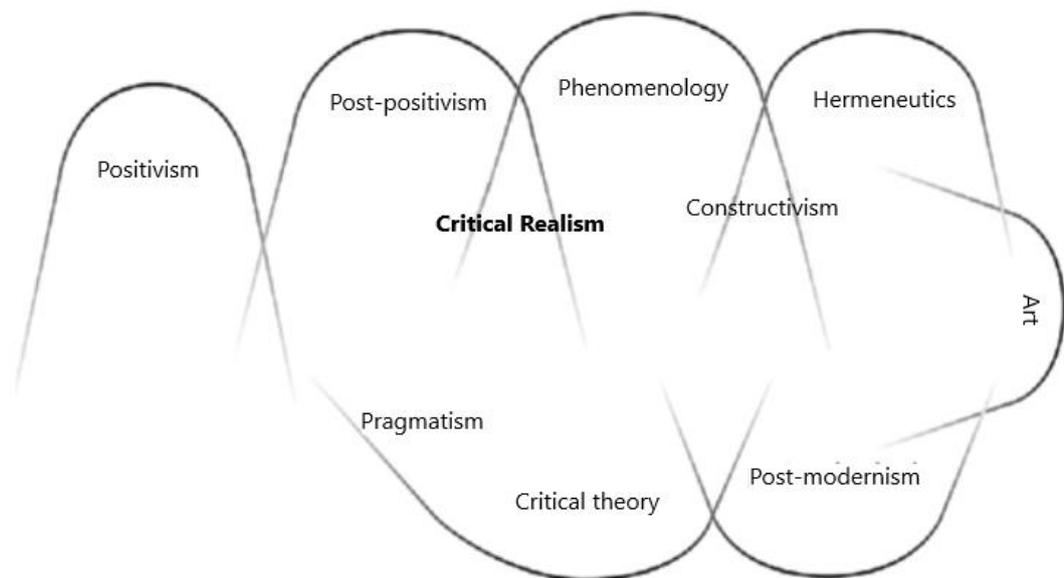
Figure 10. *The position of Critical Realism in the philosophical landscape[7] (Huttunen 2005, cited in Tuomi & Sarajärvi, 2017).*

Figure 10 shows how this stratified ontology, seen in figure 9, resides in between positivism and post-modernism in the philosophical landscape, while still being more closely related to an objectivist views (Groff, 2004; Huttunen, 2005, cited in Tuomi & Sarajärvi,

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[7]Used by the authors originally in the context or research philosophy.

2017; Saunders et al., 2019). This position of critical realism between positivist and post-modernist viewpoints brings further support for use critical realism to bridge the gap separating much of knowledge management research from the work of Michael Polanyi as presented by Crane & Bontis (2014).

A way of further understanding the role of this ontology plays is to combine it with one very simplified[8] interpretation of Plato's theory of ideal Forms. Plato (cited in Fine, 1995; Plato, cited in Allen, 2012) uses Forms as a type of ideal state of a concept, one that in its idealized state can be used to guide the imperfect creations and thought seen in everyday life.

Let us consider a comparison of stone carving to help explain his ideas on forms, as presented by School of Life (2016): A stone carver is unlikely to ever reach a perfection in his craft, especially as an apprentice. However the idea of perfection, of an ideal, helps guide the work towards betterment, by having a clear vision of the perfection; In this case that perfection is a wooden form made by a master craftsman to be used by their apprentices to guide their work (School of Life, 2016). For us the causal structures within the Real act as our Forms; Just as an apprentice stone carver uses a wooden form to guide his work toward beauty, we can use causal structures to guide our beliefs towards knowledge, to help differentiate beliefs from knowledge.

We can think of these forms, these causal structures, similarly to the idea of 'vision of knowledge' seen in relation to Nonaka's knowledge dynamics (Nonaka, Toyama & Byosiére, 2003, cited in Aramburu, Sáenz, & Rivera, 2006). In the context of organizational ontology, these visions act "to create value by means of knowledge generation activities, the organization needs a vision which gears it all towards the type of knowledge it has to acquire and which may generate spontaneous bonding on the part of individuals and groups involved in knowledge creation. By acting as a type of bridge between the visionary ideals of top level management and the chaotic reality of those members of the organization who are on the front line, middle managers must take the values and the vision generated by top level management and articulate it using concepts and images which may effectively guide the knowledge creation process. Middle managers work as producers of knowledge in the interests of recreating reality or generating new knowledge according to the particular vision of the company." (Aramburu,

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[8]Plato never explicitly presented a detailed theory of the Forms and as a result, his ideas and writings on the matter have multiple interpretations. The example given here is a simplified and in fact somewhat inaccurate representation of the ideas of Plato that have received criticism. However, it serves us well in explaining the role of causality and the stratified ontology for this work.

Sáenz, & Rivera, 2006). In the context of stratified ontology seen in figure 9, these same principles and roles of visions are transferred to the causal structures, while also becoming independent from the contexts of management and organizational ontology, with the role of middle management being comparable to that of an individual knowledge creating entity, who seeks to act as the bridge between the idealized Form of the causal structure and the chaotic realities of subjective knowledge.

The most important idea we gain from this ontology is therefore the nature of causality that we can use as our Form to help bridge the gap found in the literature by incorporating both subjective and objectivist notions of knowledge. This Form, this causality, flows from the Real, through the Actual, and manifests as observed datapoints in the Empirical, and allows us to guide our beliefs towards knowledge. These data points follow the nature of the causality that is based on the level of the Real and are subsequently based on objectivity, but cannot be accessed, observed, nor utilized without an introduction of subjectivity due to the limitations of knowledge itself. This acts as the foundation for a rethink[9] of the epistemological foundations, by introducing us to the work of Alvin Goldman (1967; 1979) and the causal and reliabilist theories of knowing which utilize a similar concept of causality as the basis for considerations on knowledge.

4.2 Justified true belief, the Gettier problem and defining knowledge

The epistemology of causal theory of knowing and reliabilism have their roots in what is known as the Gettier problem (Gettier, 1963; Goldman, 1967; 1979), which was introduced in Edmund Gettier's (1963) essay *Is justified true belief knowledge?*

Gettier (1963) starts his short four-page work by giving three the examples of how the traditional notion of knowledge as justified true belief has been articulated as a definition of knowledge, all of which he shows to be substitutable with the common version as follows:

"S knows that P[10] IFF   (i) P is true,

                          (ii) S believes that P, and

                          (iii) S is justified in believing that P." (Gettier, 1963).

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[9] It should be noted that critical realism is described by Groff (2004) as "not including satisfactory account of the concept of truth" and therefore is contrast to epistemological approaches such as the work of Goldman (1967; 1979) utilized in this piece.

[10] here P stands for *Proposition* or singular truth.

From this, Gettier (1963) continues with two counter examples to show that the above definition, and the traditional notion of justified true belief as knowledge, to be insufficient as definitions of knowledge.

The essence of these examples can be summarized as the possibility that someone has a belief in a proposition P, and that P is justifiable, and true, without that someone actually having knowledge that P. (Gettier, 1963). Gettier himself clearly did not believe that justified true belief was sufficient for knowledge. However, for those that did find justified true belief a compelling argument, the counter examples provided by Gettier (1963) instead formed a problem concerning the nature of justification; A problem in which we can ask the question of what needs to be added to true belief (or altered in justified true belief) to get knowledge?

In his earlier answer to the Gettier problem, Goldman (1967) bases this difference between knowledge and true belief on a *causal chain* [11] *(compare with the causal flow in figure 9)*. This is a concept meant to connect the source of true believing to the concept of knowledge; In other words, someone has knowledge if they believe that P, and that belief in P was gained in a way that was caused by P. In this sense, as stated by Goldman (1979) in his later work, causal theory of knowledge does not require other justification for true belief, as long as the belief was gained in a way caused by the causal chain.

When we combine this thinking with the stratified ontology from critical realism, it gives us a basic understanding that belief formation happens as a subjective result of an observation on the level of the Empirical and is based on the causal flow (-chain) originating from an objective and enduring causal structures, rules and mechanisms on the level of the Real. We can see similar concepts in established knowledge management literature, with work Faucher, Everett & Lawson (2008) and Gackowski (2012) collecting multiple authors notions on the subject, universally recognizing, and to varying degrees supporting, the notion of knowledge (or at least its truth component) as being formed from direct observations of the environment.[12] This causal chain is what connects Goldman's (1967; 1979) work on the previously established hierarchical ontology and is our reason for choosing it over the many other proposed answers to the Gettier problem such as Virtue

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[11] The terms *causal chain* and *causal flow* describe very similar concepts. However, the term causal chain is often used in the literature related to Alvin Goldman's (1967; McEvoy, 2014) work. We have used the term causal flow in relation to the critical realism context in order to separate the two origins of these similar terms, as the two are not historically related. Later in the work, we will use these terms interchangeably.

[12] often via the knowledge-hierarchy of data, information, knowledge, and wisdom

epistemology or No-False-Lemma & No-Defeater analysis (Lehrer & Paxson, 1969; Napier, 2012; Blackburn, 2016).

Yet, to understand how this belief formation connects to the concepts of tacitness and explicitness, we need to be able to explain and understand not just the basics, but also the nuances of belief formation based on the environment we have now described with the stratified ontology. For this, we need a more advanced version of Goldman's (1967) work.

4.3 Causal tracking reliabilism

The causal theory of knowing, while solving the original cases presented by Gettier (1963), has seen its share of counter examples and rebuttals (McEvoy, 2014). From these, another approach, reliabilism, has emerged, one also advocated for by Goldman (1979). In short, reliabilism considers true belief to be knowledge, if it is produced by a process that results in true beliefs reliably (Goldman, 1979; McEvoy, 2014). In other words, the process can also result in false beliefs, but the ratio of false to true beliefs needs to be sufficiently high.

To understand how these two notions finally relate to tacit and explicit concepts, we must combine the two. As suggested by Mark McEvoy (2014) in his work *Causal tracking reliabilism and the Gettier problem*, by combining causal theory of knowledge and reliabilism approaches, we can gain a more comprehensive and accurate depiction of empirical knowledge and knowing than from using justified true belief, causal theory of knowing or reliabilism approaches individually. McEvoy (2014) argues for the following:

"S[13] knows empirically that P IFF S's belief that P was produced or sustained by a reliable process that,

> (i) causally tracks P, or
>
> (ii) took as input a report that p from a reliable chain of testimony, or
>
> (iii) infers P by valid inference from premises that satisfy (i) or (ii)." (McEvoy, 2014).

Importance of this notion of knowledge, as opposed to choosing the justified true belief notion utilized by likes of Nonaka (1994; Nonaka & Takeuchi, 1995; Faucher, Everett & Lawson, 2008; Bratianu & Orzea, 2010; Xu et al., 2010), is in the propositions we can

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[13] here S stands for *Someone* or anyone

make based analysis of these two[14] belief formation methods of causal tracking and input of reliable report.

We will base the conceptual model on these ideas, as when used together with the notions of the environment as a stratified ontology, they allow us to utilise non-positivist interpretation of knowledge that still has a reference point for reality and empirical knowing in a form similarly to above. In the next chapter we will use these philosophical notions as the foundations for our interpretation of tacitness, explicitness and knowledge creation.

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[14] We will consider the inference of P as per iii from above to be a form of utilizing causal tracking and reports, instead of treating inference as a separate mechanism.

5. NEW CONCEPTUAL MODEL FOR TACIT AND EXPLICIT KNOWLEDGE

In this chapter, we will explore how the new philosophical foundations established in chapter 4 can be utilized at different iterations within the historical development path seen in figure 8. By the end of this chapter, we will have formed the new conceptual model and answered all of the research questions. We will do this by first establishing the model's foundational propositions and two corollary new attributes for knowledge. These propositions and attributes are then used to show explicit and tacit knowledge as constructs based on these two attributes, with knowledge creation and transfer also likewise being based on these same attributes. We will also build a visual representation of the model in order to help with its application.

5.1 Sources of knowledge and types of knowing: Cognitive fit and Abstraction

We begin from Polanyi's (1966) position of separate, non-convertible tacit and explicit knowledge. From there, instead of utilizing organizational ontology to allow for conversions as Nonaka (1994) did, we instead add the stratified ontology that is the environment (our Form for knowledge) and modify our epistemological viewpoint to resemble that which we derived from causal tracking reliabilism in the previous chapter.
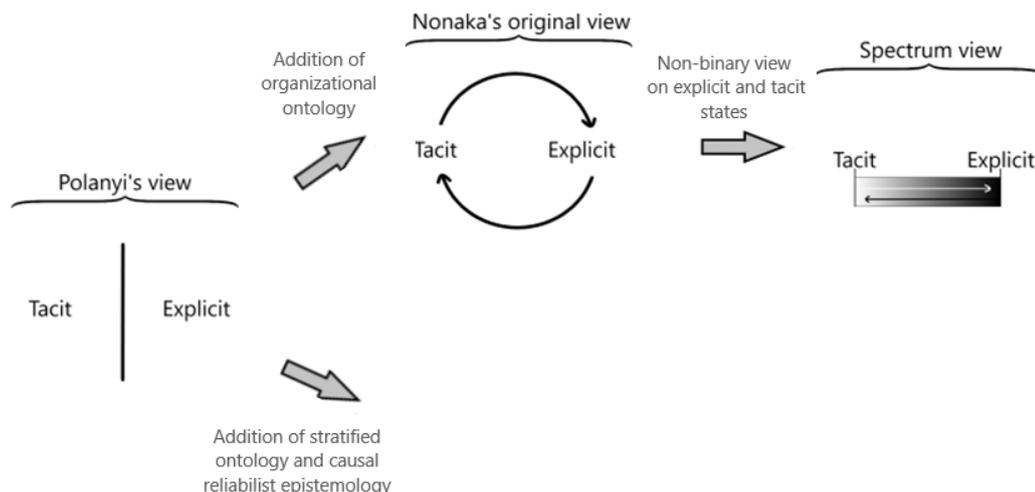
Figure 11. The historical development path and the development path of the new conceptual model. The shared starting point in the foundations of Polanyi's (1958; 1966) work allows for easy comparison of the development paths.

Figure 11 shows this the first divergence from the previous knowledge management literature. By using the stratified ontology based on critical realism and causal reliabilist approach to replace the organizational ontology used by Nonaka (1994), we link knowledge creation to empirical observation of the causal chain. This gives the new conceptual model a way of differentiating between different subjective beliefs and knowledge by comparing the subjective beliefs to the objective environment in the form of causality.

This bridges the gap identified by Crane & Bontis (2014) between the objectivist discourse in literature and the subjectivist approach seen in the work of Polanyi (1966); with the empirical observation resulting in the belief formation and constituting the gaining of knowledge when the formation takes place as a result of the previously discussed constraints of causal tracking reliabilism: (i) causally tracking P[15] from the ontology, or (ii) a reliable chain of testimony (McEvoy, 2014).

5.1.1 Cognitive fit – Causal tracking as internal source of knowledge

Let us consider the following: What is the formation of beliefs from causal tracking dependant on? For the purposes of this work, we will interpret it as dependant on a single factor; the extent in which the belief that P fits into the cognitive tendencies of the believer. Here, cognitive tendencies refer to the ways of solving problems; the ways in which we make deductions and inductions; in other words, cognitive tendencies are how we reach conclusions.

This would follow that if there were a theoretically possible belief that P which can be causally tracked, I will only be able to causally track that P, if and only if that way of tracking fits my cognitive tendencies; again meaning the ways in which I solve problems, or in other words, the way in which I causally track. When seen this way, causal tracking is a cognitive process, one which is only possible if that process is able to be supported by the cognition undertaking that process. We will call the ability of the cognition to support the causal tracking as a *cognitive fit* between the causal chain and the cognitive tendencies.

This cognitive fit is a measure of how far down the causal flow from the level of the Empirical the knowledge is tracked. A perfect cognitive fit will explain the level of the

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[15] where P stands for Proposition

Real, while partial cognitive fit can perhaps only explain the Actual, and low to minimal fit means the knowledge explains the Empirical. In this way, cognitive fit is a way of understanding how independent, individual knowledge creation is achieved via belief formation based on the causal tracking of the environment.

This way of thinking of cognitive fit as a measure of how far down the causal flow is tracked, is somewhat reminiscent of an inverse of the notion of 'causal ambiguity' strategic management and organization theory literatures (Barney, cited in Wang & Han, 2011). Where Wang & Han (2011) note that Causal ambiguity "encapsulates a similar lack of understanding of the logical linkages between actions and outcomes", high cognitive fit is representative of the ability to clarify this ambiguity.

5.1.2 Abstraction – Reports as external sources of knowledge

The other option for gaining beliefs that constitutes knowledge in causal tracking reliabilism is the ability to take a report (McEvoy, 2014). Once more, we will need to choose how to interpret this concept for this work.

I propose that we consider this as follows: The possibility of report-based belief formation can be thought of as being based on the way in which the believer abstracts their experience of the environment (level of the Empirical within the ontology), compared to the way in which that environment is abstracted within the report. Here, abstraction refers to the ways in which we summarize, visualize, and conceptualize working of the stratified ontology, the separation between objects, wholes and parts, groups and individuals, causes and effects within the environment.

The complexity of this abstraction is to belief formation, what words, grammar, and cultural norms are to languages. We can only understand something in a given language, if we share in the words, grammar, and cultural intricacies of that language[16]. Similarly, we can only form beliefs based on a report of P, if we have abstraction of sufficient complexity to convey and internalize the report of the causal flow within the environment. This abstraction complexity is a way of understanding shared, communal knowledge

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[16] The notion that there may be different ways of abstraction, different abstraction languages, for any given knowledge is interesting, in that we may be able to model absorptive capacity, barriers, paradoxical frames and other knowledge creation & transfer related concepts as differences in these ways of abstraction (Echajari & Thomas, 2015; Calic et al., 2019).

creation (knowledge created by outside cognition and shared via transfer) via the process of belief formation based on reports of the causal tracking that others have performed.

This notion of abstraction is very much in line with the view of codification seen in Echajari & Thomas' (2015) work *Learning from complex and heterogeneous experiences: the role of knowledge codification,* with the exception that there is no necessity for the assertion of some tacit knowledge being non-abstractable, which Echajari & Thomas (2015) associate with the view of Polanyi (1962 cited in Echajari & Thomas, 2015).

5.1.3 Proposition 1 – The nature of knowledge and its creation

These concepts of Cognitive fit and Abstraction Complexity are my view on the two underlying attributes of knowledge which underpin this new philosophical context; Concepts which can be used as the basis for the discourse on knowledge, tacitness, and explicitness in knowledge management literature.

To summarize, when we combine the stratified ontology as the source of knowledge with the interpretation of knowledge gaining via causal tracking reliabilism, we can understand knowledge as a representation of the environment, gained either via the use of our cognition to track the causal flow within the environment or by achieving a level of abstraction complex enough so that it allows us to take a report of someone else's tracking of the causal flow. We can formalize this as the following proposition seen below.

Proposition 1:

Based on the stratified ontology as the source and reference point for truth for empirical knowledge, the concept of knowledge can be understood as a representation of that ontology and its causal chains. This representation is in turn built by and consisting of two components: cognitive fit and abstraction, which enable knowledge creation via the mechanisms of causal tracking and report formation.

5.1.4 Proposition 2 – Utilization of knowledge

From this proposition, we can use go further and explain how knowledge is utilized via the same type of thinking. We will use this to form the second proposition, that while knowledge is gained by formation of beliefs via cognitive fit and abstraction, knowledge

utilization is similarly based on the mechanisms of these concepts but worked in the opposite direction. We can think of this as follows:

If I were to have knowledge that P, which I gained by using my cognition to causally track the belief that P, then, as that knowledge fits my cognition, I can use that knowledge to make decisions or take actions. As my belief that P is knowledge, making taking these actions will cause the environment to react to P according to the causal rules, due to my knowledge being causally tracked from the environment, and causality governing the way in which the environment reacts. In other words, because I know that P based on the causal chain and in a way which fits my cognition, I have a capability to use my cognition to act on the causal chain within the limits of the knowledge; *Cognitive fit of knowledge determines the ability to use knowledge for actions*.

We can use a similar line of thinking to understand the utility of abstraction complexity: if I were to have the knowledge that P, which I gained via taking of a reliable report using abstraction of the environment, then that knowledge is in an abstraction which is sufficient to convey the knowledge that P. Subsequently, I can use the abstraction, to once more form a report that P, meaning that *the abstraction complexity of knowledge determines the ability to share and transfer knowledge*.

In a vacuum this could be interpreted as meaning that knowledge transfer only requires sufficient shared abstraction complexity to take place. However, when we account for the role of cognitive fit, the recipient also needs to be able to support the level of cognitive fit within the abstracted report, as without sufficient ability support the tracked causal chain in their cognition, the recipient is unable to utilize the knowledge in actions and decisions even if he possess a report of the tracked causal chain[17].

To summarize, knowledge can be utilized based cognitive fit to take actions in the environment, in the traditional sense of utilizing knowledge as 'capacity to take effective action' (Argyris, 1999; Faucher, Everett & Lawson, 2008) or based on abstraction of the environment to perform knowledge transfer, giving us our second proposition:

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[17] This is the reason for the use of inclusive we in this work as noted in chapter 1 (Wikipedia.org, 2021); While the causally tracked report could have been created with other grammatical structures, the inclusion of the report recipient as a close participant in the work's structure can be thought of as literary device aimed to incentivise the recipient to utilize the ideas and concepts within this work as part of their own way of abstracting the their knowledge, and subsequently reaching sufficient abstraction complexity to transfer the knowledge from this work.

Proposition 2:

Knowledge utilization, similar to knowledge gaining, can be understood via causal tracking reliabilism and stratified ontology. This takes the form of reversing the same methods used to gain knowledge; with cognitive fit enabling decision making and actions based on the knowledge, while abstraction of the environment allows for knowledge transfer via formation of the report regarding the knowledge.

5.2 The tacit and explicit constructed from cognitive fit and abstraction

We now have two propositions: cognitive fit and abstraction as basis of belief formation and constituent parts of knowledge based on causal tracking reliabilism (proposition 1) and two types of knowledge utilization in the form of actions and knowledge transfer both related to and reliant upon the cognitive fit and abstraction, respectively (proposition 2).

To begin, we should note the similarities between our earlier notion of causal tracking, of cognition, and Kogut & Zander's (1992) summary of Polanyi's writing "that tacit knowledge consists of search rules, or heuristics, that identify the problem and the elements consisting of the solution". This similarity has also been noted by Grandinetti (2014) in his *The explicit dimension: what we could not learn from Polanyi*, which lead him to "considering the terms "unconscious" and "tacit" non-interchangeable and redefining the epistemological profile of knowledge management theory, starting by acknowledging the existence of two planes of analysis. On the first, we have the unconscious–conscious dichotomy, indicating the process by means of which people know (what cognitive psychologists often call "cognition" and Polanyi almost always called "knowing"). On the second, we have the tacit– explicit dichotomy, indicating states of knowledge that have been consciously developed."

In many ways, Grandinetti's (2014) conclusions are eerily similar to our concepts of cognitive fit and abstraction complexity, with causal tracking via cognitive fit relating to unconscious and reporting via abstraction relating to conscious cognition. But this raises the question: If we are to come to a similar conclusion as Grandinetti (2014), or at least use his conclusions as inspiration for the new model, how should we think of this tacit and explicit knowledge?

The answer to this is surprisingly simple, one which we can understand with the description given by Faucher, Everett & Lawson (2008) for explicit and tacit knowledge:

"Explicit knowledge can be expressed in formal and systemic language, and can easily be shared by codifying it through many sorts of data, which can be stored. Tacit knowledge is less easy to handle, because it is highly personal and subjective; it resides in individuals' minds and is transparent. Tacit knowledge is rooted into actions, procedures, routines, commitments, ideals, values, and emotions" (Faucher, Everett & Lawson, 2008).

From here, the new concepts for tacit and explicit knowledge can be construct directly from the proposition 2 almost corollary; With tacit knowledge being described as rooted in actions (Polanyi, 1966; Argyris, 1999; Nonaka, 1994; Nonaka & Takeuchi, 1995; Crane & Bontis, 2014; Grandinetti 2014), cognitive fit is a natural attribute and source to associate with tacitness. This in combination with the causal tracking as the source of cognitive fit, would mean that tacit knowledge is that which is created by increasing cognitive fit via causal tracking.

Likewise, the explicit counterpart for this can be seen from Polanyi's (1966) own example; Regarding "*we know more than we can tell*", action based knowing (recognition of faces) is the basis of tacitness. When we consider the other aspect of the same examples, the ability to form a report of the featured of the face, to express it, to use explicit knowledge, it becomes likewise easy to associate the utilization of the abstraction of the environment in the creation of a report to this explicitness, leading us to the conclusion that explicit knowledge is that which is created by increasing abstraction complexity via report formation.

In this way tacit and explicit concepts, when separated from the act of cognition, are more akin to adjectives describing the dominant attribute of knowledge.
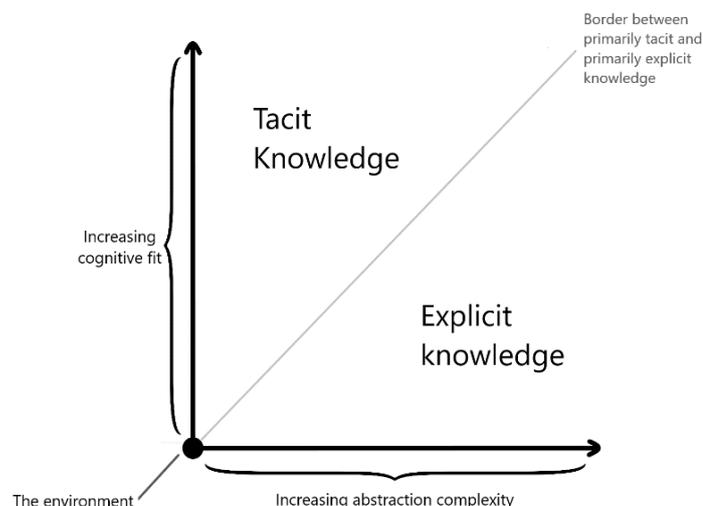
Figure 12. We can conceptualize tacit and explicit knowledge as being expressed as constructs of cognitive fit and abstraction complexity.

Figure 12 shows explicit knowledge consisting the possible states of knowledge where abstraction complexity is dominant over cognitive fit. This explicit knowledge is subsequently that state of knowledge, in which the abstraction is sufficient to form a report of the cognitive process represented by cognitive fit. Likewise, tacit knowledge consisting of the states of knowledge where abstraction complexity is not sufficient for the formation of this report, meaning the state to knowledge where cognitive fit is dominant. The line in between tacit and explicit knowledge seen in figure 12, represents the boundary where cognitive fit and abstraction complexity are balanced.

This view is in many ways in line with the idea of cognitive fit as a measure of how far the causal flow is tracked, which acts as an inverse of causal ambiguity, where the increase of cognitive fit lessens the associated ambiguity (Wang & Han, 2011). As the causal flow is tracked further, and the cognitive fit is subsequently higher, there is a need for more complex abstraction of the ideas in order for those ideas to be transferred.

In figure 12, we can also model the environment by representing it as a 0 cognitive fit, 0 abstraction the source of knowledge, a literal 'origin' from which knowledge is gained. In this way, the stratified ontology and connects the explicit and tacit concepts to a comparison point with reality. This same view in figure 12 is also the way in which we can think of Nonaka's (1994) notion of convertible tacit and explicit knowledge within the context of propositions 1 and 2: by utilizing causal tracking or report creation to increase the cognitive fit or abstraction complexity, we can change the dominant attribute of knowledge. This ultimately means that we are able to convert tacit knowledge into explicit knowledge simply by increasing the complexity of the abstraction, and explicit knowledge to tacit knowledge by increasing the cognitive fit via causal tracking.
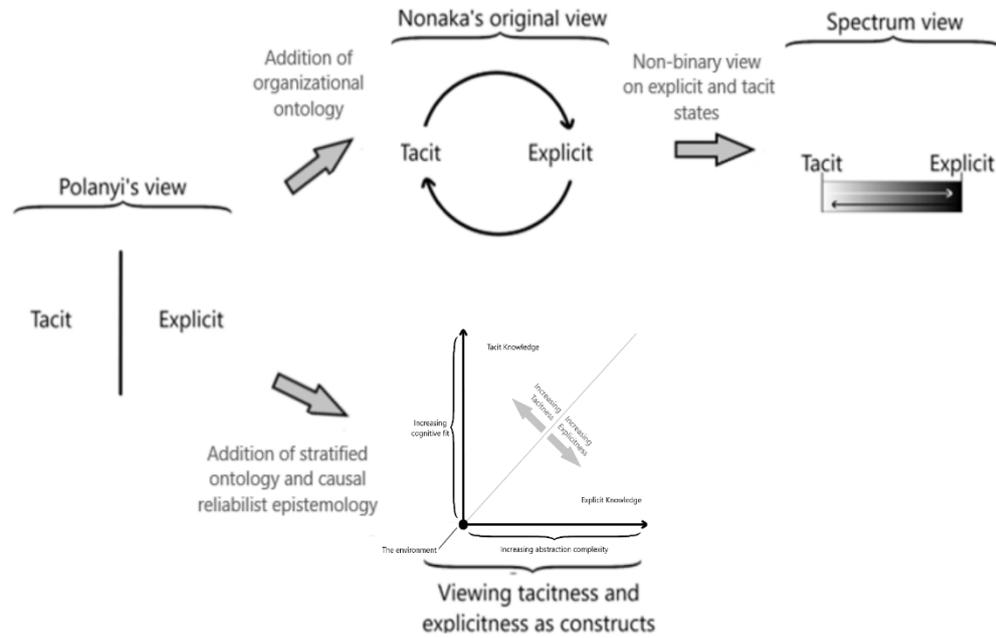
Figure 13. *Relation of different development paths of explicit and tacit concepts.*

In figure 13, we can see how this new view of explicit and tacit knowledge fits to the development paths of these concepts seen previously in figures 8 and 11. From here, we can continue similarly as was done in the historical development path by integrating the non-binary perspective from the 3rd iteration of figure 7 into this view (Li & Gao, 2003; Meyer & Sugiyama, 2007; Faucher, Everett & Lawson, 2008; Ranucci & Sounder, 2015).
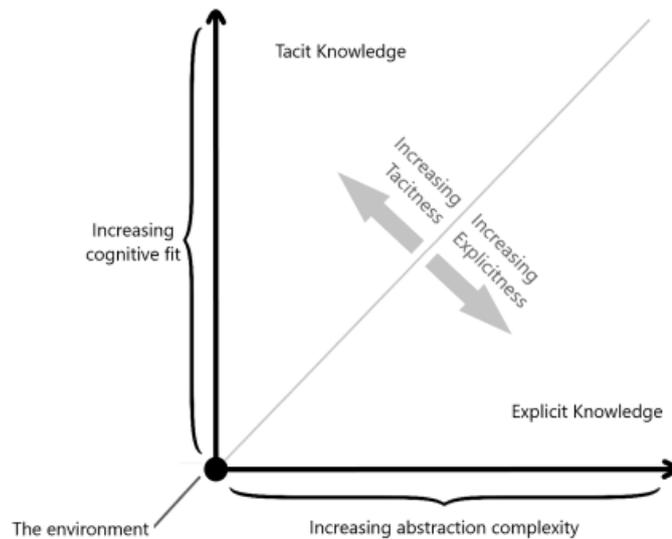
Figure 14. *Tacitness and explicitness increase when moving in orthogonal directions from the division line towards the axis.*

In figure 14, the division line from figure 12 is shown as not only indicating the boundary between two binary states, but as a line from which the tacitness and explicitness is increased in orthogonal direction. In this way, it becomes natural to think of tacitness and explicitness as the ratio of cognitive fit over abstraction complexity, with the division line forming a ratio of '1 to 1'.

Here it is important to note we are not attempting to numerically measure these attributes, but instead we can think of the axis as being adjusted so that the division line between tacit and explicit knowledge forms evenly between the two axis. This even '1 to 1' ratio characterises the point at which abstraction complexity is able to convey the entirety of the cognitive fit, with a ratio between 1 and ∞ representing knowledge that is tacit to an increasing degree, and ratio between 1 and 0 representing knowledge that is increasingly explicit. Following this thinking, we can conceptualize purely tacit and explicit knowledge as the knowledge which consists completely of either cognitive fit or abstraction complexity respectively.
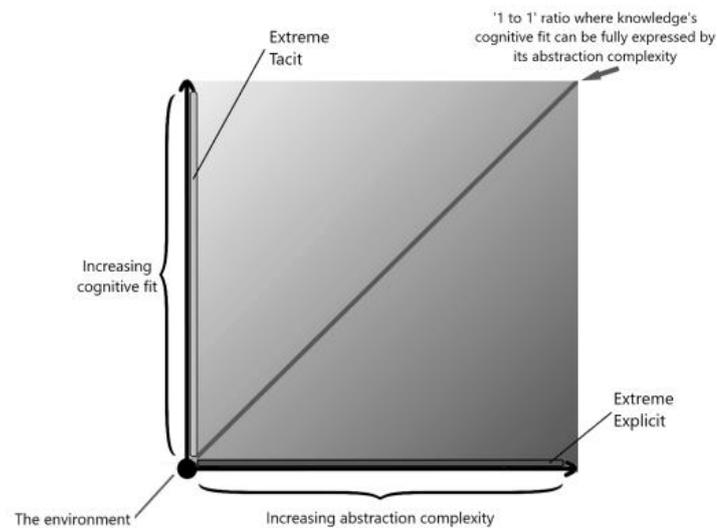
Figure 15. *Purely tacit and explicit knowledge[18] reside along the two axis, being formed purely from cognitive fit or abstraction complexity.*

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[18] Purely tacit and explicit states, or more accurately pure cognitive fit and abstraction complexity, are likely theoretical concepts, as creating a report via abstraction is not possible if there is nothing to be abstracted and likewise causally tracking something without abstracting it in anyway will prove difficult.

In figure 15, this view is adjusted to account for purely tacit and explicit knowledge as consisting only of cognitive fit and only of abstraction complexity, while the spectrum of similar tacitness and explicitness levels form parallel along the division line.

5.3 The interplay of tacit and explicit knowledge in the new model

Now that we have finally established tacit and explicit knowledge, we can move to explaining knowledge creation. Fortunately, we have already established all the tools which we will need.

In the propositions 1 and 2 and the subsequent chapters we have established that cognitive fit forms actionable attribute of knowledge via causal tracking from the stratified ontology, while abstraction complexity makes it possible to share that tracked knowledge via the act of forming a report (Goldman, 1967; 1979; Groff, 2004; McEvoy, 2014). Likewise, any additional causal tracking or report formation will lead to conversion operation similar to internalization and externalization seen in the SECI-model (Nonaka, 1994; Nonaka & Takeuchi, 1995), as a result of the nature of explicitness and tacitness as dominance of one attribute over the other.

However, unlike the SECI-model, the inclusion of cognitive fit and abstraction complexity means that we do repeat these conversion operations without undoing the previous operations, as we will be continuously gaining either cognitive fit or abstraction complexity. This means that we gain the final concept within the new conceptual model by continuously converting between tacit and explicit states of the knowledge. We can visualize this by moving from the bottom left to the top right in the previous visualizations.
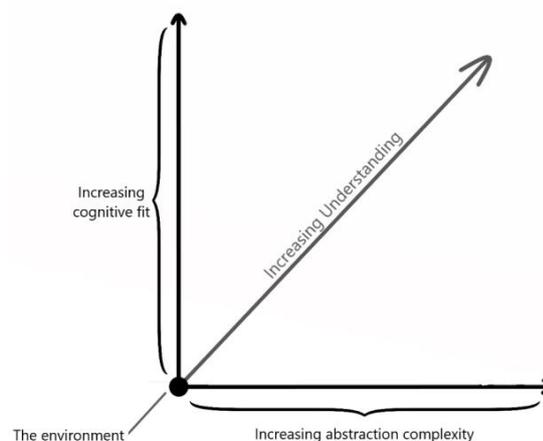
Figure 16. The full process of knowledge creation can be seen through cognitive fit and abstraction complexity, which can be generated with continuous causal tracking and

report formation. This results in increased understanding provided by the knowledge as a result of being more able to both utilize and to share said knowledge.

The combination of these two attributes, and actions and transfer which they enable, forms the basis for understanding; Understanding in turn can be associated with the total utility and performance that can be obtained from the knowledge.

In figure 16, we can see that the limitations lifted by using cognitive fit and abstraction complexity as continuously cumulative attributes mean that we can visualize the knowledge creation process as the increase of understanding[19], beginning stratified on-tology and building via causal tracking and report creation to move along the line sepa-rating tacit and explicit states. This knowledge creation and increase in understanding is the result of either processes affecting existing knowledge, or knowledge creation that is not reliant on any prior knowledge. In addition to this, we can link this increase of under-standing to an increase in another knowledge attribute: Knowledge complexity (Wang & Han, 2011). Knowledge complexity can be defined "as the number of interdependent technologies, routines, individuals, and resources linked to a particular knowledge or asset" (Simonin, 1999, cited in Wang & Han, 2011).

In the case of existing knowledge, the nature of cognitive fit and abstraction complexity as utility providing attributes, leads to their mutual increase constituting an increase in the utility and total complexity of the knowledge itself, in the form of the enablement of new action and transfer opportunities for that knowledge. These new opportunities which were not present prior to the process of increasing the two attributes, means that the process that increases these attributes creates new knowledge. In the case of knowledge creation without any prior knowledge, the process can in turn be thought of as the original tracking of a causal chain (which has not previously been tracked) from the environment.

5.4 The characteristics of the new conceptual model

By substituting new philosophical foundations from chapter 4, we were able to develop two propositions and gain two new attributes for knowledge, cognitive fit and abstraction complexity, to act as the basis of knowledge creation, conversions, utility of knowledge and knowledge transfer. The model introduced in this chapter was then constructed by

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[19] This gives us an interesting correlation with knowledge hierarchies, with data seeming very similar to low cognitive fit and abstraction complexity, and increasing these two attributes moving us towards higher levels of the hierarchy. However, while we will touch on this later on as a future research direction, these considerations are outside the main scope of this work.

substituting these propositions and onto the development path of previous iterations of the tacit and explicit concepts established in chapter 3.
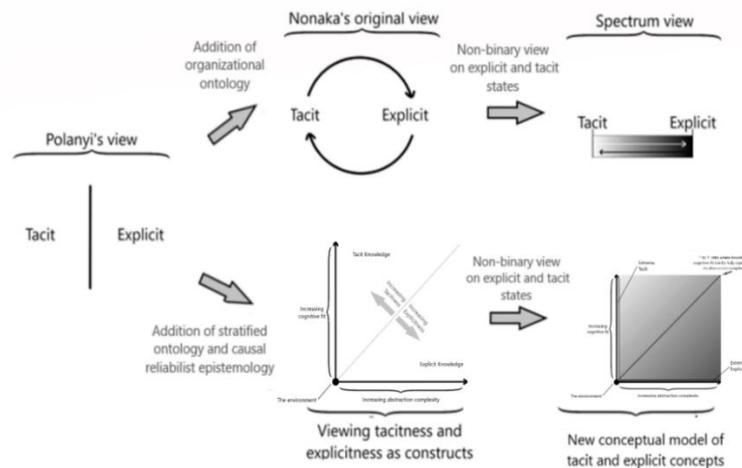
Figure 17. *The historical development path of explicit and tacit concepts compared to that of the new conceptual model based on cognitive fit and abstraction complexity.*

Figure 17 shows how the new conceptual model's development path when compared to the development path of the previous iterations of tacit and explicit knowledge concepts. With the use of the causal tracking reliabilism (Goldman, 1967; 1979; McEvoy, 2014), we were able to gain the utility of both the 2nd and 3rd iterations of the historical development path (Nonaka, 1994; Nonaka & Takeuchi, 1995; Li & Gao, 2003; Meyer & Sugiyama, 2007; Faucher, Everett & Lawson, 2008; Ranucci & Sounder, 2015), while the use of the stratified ontology allowed us to bridge the gap between Polanyi's (1966) concepts with the positivist nature of the majority of knowledge management literature where said concepts are often used (Spender, 1996a; Crane & Bontis, 2014).

The new model is based on two propositions, which are used together with two new knowledge attributes, cognitive fit and abstraction complexity, a stratified ontology and causal reliabilist notion on knowledge. These premises form a new, unified model that can explain many knowledge management concepts, which previously required separate frameworks and concepts, such as knowledge creation, knowledge transfer, knowledge utilization, knowledge complexity, causal ambiguity, and duality of knowledge. (Polanyi, 1966; Nonaka, 1994; Nonaka & Takeuchi, 1995; Bratianu & Orzea, 2010; Wang & Han, 2011; Bratianu, 2015; Echajari & Thomas, 2015).

Using cognitive fit and abstraction complexity and combining them with the inspiration from the conclusions of Grandinetti (2014), we are able to answer the main research

question (MQ) by constructing the tacit and explicit knowledge as subjective representations of an underlying causal structure, where explicitness and tacitness are not viewed as different types of knowledge in themselves, but instead as types of knowledge where one of the new attributes, either cognitive fit or abstraction complexity, is dominant over the other. In this way, the model provides new answers to both points of debate identified by Crane & Bontis (2014), in regard to the nature of tacit and explicit knowledge within the knowledge management literature.

The construction of these concepts and the resulting answer to the main research question is possible even without the use of the explanations given by Polanyi (1966), Nonaka (1991, 1994) and others (Faucher, Everett & Lawson, 2008; Ranucci & Sounder, 2015), and majorly deviates from the traditional understanding of tacit and explicit knowledge, as seen in figure 17. Likewise, the conversions between tacitness and explicitness of knowledge can be explained with the new model via increases and reductions in cognitive fit and abstraction complexity, which happen as a result of causal tracking and report creation and change the relative levels of these two attributes.

The model likewise views knowledge creation as a linear, instead of a cyclical[20], process resulting from the acquisition of understanding. Understanding in the model is created via the cumulative increase of cognitive fit and abstraction complexity using the mechanisms of causal tracking and report creation; A view that is the result of the increase in utility of the knowledge associates with the increase of these two attributes, as per proposition 2. This allows for the model to be used to describe knowledge creation both as a result of processes affecting existing knowledge or the initial tracking of a new causal chain. Proposition 2 likewise gives us a connection between the knowledge attributes and the mechanisms of knowledge transfer.

Overall, the new model uses very simple premises, of two knowledge attributes and two mechanisms to create changes in these two attributes, to achieve a previously impossible level of integration between different aspects of knowledge management literature. With cognitive fit- and abstraction-based view, it can be said that Polanyi's (1966) notion of "we do not know more than we can tell" is no longer an appropriate summary of how knowledge operates within our new model. Instead, in the light of this new model, it is more accurate to conclude that we are able to know by using or by transferring knowledge, but to understand, means to be able to do both.

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[20] such as in the SECI-model (Nonaka & Takeuchi, 1995)

6. DISCUSSION & CONCLUSIONS

The goal and motivation for this work was to bridge the gap between positivist stance seen in knowledge management literature (Spender, 1996a; Crane & Bontis, 2014), while providing a new model for the concepts of tacit-explicit based knowledge creation paradigm that is in line with the bridging of said gap.

The result of this was the new conceptual model, which offers us a perspective on a multitude of concepts within the knowledge management literature that have previously had their own disconnected models. The new model provides simple, shared foundations for all of these concepts, based on cognitive fit and abstraction complexity as basic attributes of knowledge and two associated mechanisms to change said attributes in the form of causal tracking and report creation.

This chapter will discuss the implications of the work, its evaluation, and limitations on the research design and execution. After this, the chapter will briefly go over some of the possibilities opened up for future research, as well as giving suggestions for further reading in relation to these future research directions.

6.1 Implications on theory

We will first approach the implications on theory by focusing on three sections similarly to the internal structure of the work: Review of the conceptual development path of the tacit-explicit duality in previous literature (chapter 3 & SQ1), introduction of the philosophical foundations for the new model (chapter 4 & SQ2), and the process of building the new model and its components (chapter 5, SQ3 & SQ4). This trisection helps allows us to consider the implications each chapter while separating them from each other, so as to make it possible for these implications to be utilized independently. At the end of the chapter, the overall implications of the new conceptual model are contrasted to the alternative theories seen in chapter 3.5.

6.1.1 Contributions of Chapter 3 – The usage of the historical development path in wider context

As previously noted in chapter 3, the development path seen in figure 8 is a simplified representation of a complex and diverse set of literature. Yet, the three iterations from

Polanyi (1966) to Nonaka (1991; 1994; Nonaka & Takeuchi 1995) and finally the spectrum view, offer an easy to approach core of the main narrative in the development of tacit and explicit knowledge that can be seen in the literature (Polanyi, 1966; Nonaka, 1991; 1994; Nonaka & Takeuchi, 1995; Nonaka & Konno, 1998; Nonaka, Toyama & Konno, 2000; 2001; Li & Gao, 2003; Nonaka & Toyama, 2003; 2005; 2007; Williams, 2006; Meyer & Sugiyama, 2007; Faucher, Everett & Lawson, 2008; Crane & Bontis, 2014; Ranucci & Sounder, 2015).

This depiction, as seen in figure 8, also offers a view of the changes and motivations which lead the literature to move from one iteration to the next, in the form of the addition of conversions between the different knowledge states to model knowledge creation, and a more detailed view on these states as non-binary to allow for deeper analysis of the related processes. While this development path has not been the main focus of the work, future research could be conducted on the topic based on source and publication platforms outside of the current Journal of Knowledge Management context.

This would allow for the expansion of this development path outside the scope seen here by including more of the alternative interpretations for these concepts within the literature as independent development paths. The resulting representation of the multiple historical interpretations of these concepts and their interconnected relationships could then be used extensively both as an educational tool to provide a comprehensive understanding of the existing view of these subjects, and as a tool to aid research design by comparing existing and future models on these topics, much in the same way as was done here in a more limited manner with figure 17. In this way, the theoretical implications of the chapter 3 are mainly in providing a solid foundation for further research on this area.

6.1.2 Contributions of Chapter 4 – The effects of the philosophical foundations

Chapter 4 introduced the stratified ontology and causal tracking reliabilism as a basis for the new model (Goldman, 1969; 1979; Groff, 2004; McEvoy, 2014; Echajari & Thomas, 2015; Saunders et al., 2019). The main theoretical contribution of this was to provide a basis to overcome the gap between the positivist nature of the knowledge management literature and the non-positivist concept of tacit knowledge (Polanyi, 1966; Spender, 1996a; Groff, 2004; Crane & Bontis, 2014). The essential foundations of the work are based on these changes, and while the contents of chapter 5 are more closely related to the knowledge management practice, the fundamental nature of these changes is likely

to mean that they have the highest potential when it comes to contributing to the literature at large.

Additional credibility for the utility of these philosophical foundations is given by the prior utilization of critical realist views within the knowledge management literature on a more limited scale, as seen in Echajari & Thomas' (2015) often cited work *Learning from complex and heterogeneous experiences: the role of knowledge codification.* Furthermore, prior notions of the close relationship between the concepts introduced in the work and traditional knowledge management literature can be seen in Gulick's (2016) notion that: "Polanyi would see himself as fitting comfortably within Alvin Goldman's characterization of the aim of classical social epistemologists".

The use of a stratified ontology similar to that of critical realism and causal reliabilist view on knowledge allowed for the later parts of the work to integrate existing knowledge management concepts into a framework to a far greater extent than previously possible. As noted in chapter 3.5, knowledge management is a field of study which is still to reach maturity and the bridging of the gaps within the established literature, such as the one undertaken in chapter 4, is a necessary step on the fields journey towards full maturity.

6.1.3 Contributions of Chapter 5 – Effects of the new model

Chapter 5 introduced the two propositions based the findings of chapter 4, which together with cognitive fit and abstraction complexity form the basis for the new conceptual model. These two attributes and their use in the explaining tacit and explicit knowledge are a major deviation from previous knowledge management literature offering a completely new perspective into explicitness and tacitness that does not treat them as inherent attributes of knowledge in themselves, but instead as manifestations of more underlying properties of knowledge. The major theoretical implications of chapter 5 arise as a result of the ideas behind this perspective, and how the new model is able to subsequently explain knowledge creation, understanding, tacit-explicit conversions, knowledge transfer, the utility of knowledge and other concepts based on a shared set of mechanisms (see chapter 5.4).

This new model simplifies the existing literature significantly, bringing many previously separate concepts under a unified framework. This simplicity works to advocate for the model's further development, as per the principles of Occam's razor. The connections between these concepts these mechanisms establish also provide new answers to open questions in the knowledge management literature, such as those regarding the nature

of tacit knowledge as posed by Venkitachalam & Busch (2012), as well as to the two points of debate identified by Crane & Bontis (2014):

- Whether or not the articulation of tacit knowledge fundamentally makes that knowledge no longer tacit or not (Venkitachalam & Busch, 2012)?

    ➤ Articulation, or in the model's terms reaching the necessary level of abstraction complexity for the report creation, of tacit knowledge does make said knowledge less tacit. This is due to the abstraction complexity becoming the dominant attribute, instead of any change in the properties that form tacitness; As this abstraction does not take away from the cognitive fit, the change from tacit toward explicit knowledge does not unavoidably lead to loss of any utility the previously tacit knowledge had.

- To what extent can tacit knowledge be articulated (Venkitachalam & Busch, 2012)?

    ➤ According to the new model, tacit knowledge can be articulated to the extent that its abstraction complexity allows. There is no reason to think that there is any level of cognitive fit, for which a necessary level of abstraction complexity cannot be reached, given sufficient resources. Yet, as cognitive fit is based on, and gained in the process of actions, the establishment of required abstraction complexity for articulation to take place is not an essential part of gaining every type of knowledge, but one undertaken in order to enable the transfer of knowledge.

- What did Polanyi actually mean (Crane & Bontis, 2014)?

    ➤ The model's view is fundamentally different from that of Polanyi (1966), in that tacit knowledge is considered fully explainable, given enough abstraction complexity. However, the concept of tacit knowledge remains inherently tied to actions while explicit knowledge remains similarly tied to the ability to express knowledge. Polanyi's (1966) non-positivist notions on knowledge, that knowledge is necessarily subjective to some degree, are also considered to be a necessary aspect for the full understanding of the nature of knowledge, and ones that contribute to our ability to connect many previously separate concepts.

- Is Nonaka's project of converting tacit to explicit knowledge misguided (Crane & Bontis, 2014)?

> ➢ The conversion of tacit to explicit knowledge is at the core of the new model's operation. In some ways the correlation between the increasing understanding and the border region between tacit and explicit knowledge seen in figures 14 and 16 means that Nonaka's view is in fact an organizational perspective to the same model, but with lesser detail and explanatory power. However, Nonaka's usage of organizational ontology-imposed also imposed limitations on the conversion operations, which the philosophical foundations utilized by the new model are able to avoid.

While the SECI-model is no longer dominant in knowledge management literature (Serenko & Dumay, 2015b), it remains a foundational piece that underlines many critical portions of the literature (Nonaka & Takeuchi, 1995; Spender, 1996a; Bratianu & Orzea, 2010; Xu et al., 2010; Bratianu, 2015). As such, it is worth to discuss the last answer in regard to Nonaka's project in more detail. The new model disconnects us from major limitations and criticisms received by the SECI-model (Bratianu & Orzea, 2010; Bratianu, 2015), which we are summarized well by the three areas of criticism in Bratianu's (2015) work *A Critical Analysis of Nonaka's Model of Knowledge Dynamics*:

- Within the SECI-model, socialization and combination do not change the state of the knowledge undergoing these processes. Socialization and combination are therefore knowledge transfer, i.e., tacit knowledge to tacit knowledge, and explicit knowledge to explicit knowledge, and as such unequal with the conversion processes of internalization and externalization.

- The evolving spiral of socialization, externalization, combination, and internalization is not possible with knowledge generation from within but requires inputs from the Ba platforms for knowledge creation to take place.

- The same evolving spiral of knowledge creation passes sequentially through individual processes and organizational processes in a deterministic way, although knowledge dynamics is not a physical process based on deterministic laws.

The new model's utilization of a stratified ontology instead of an organizational one means that concerns of the first criticism from above regarding knowledge transfer in the form of socialization and combination is void, as knowledge transfer is not inherently necessary for knowledge creation within the model. Instead, the conversions between tacitness and explicitness can be utilized continuously for internal knowledge creation via mechanisms affecting cognitive fit and abstraction complexity. This is due to the possibility of their cumulative increase, whereas the traditional notion of conversion between

tacit and explicit knowledge would, when undertaken continuously, results in no cumulative change without external inputs.

This also means that the limitation related to the second criticism from above is averted, as external input, which would take the form of a report, is not necessary (but remains an option). This means that concepts similar to Ba platforms and their extensions, act as extensions of the model, instead of essential parts of it (Nonaka & Konno, 1998; Aramburu, Sáenz, & Rivera, 2006; Kaiser & Fordinal, 2010; Bratianu, 2015).

Additional corollary from the use of causal tracking and report creation based on causal tracking reliabilism is that the cognitive fit and abstraction complexity are not bounded in a similar way to tacit and explicit concepts; Cognitive fit can, at least in theory, be continuously increased until the entirety of the causal chain is tracked. Likewise, abstraction complexity can be increased until the entirety of the causal chain is able to be reported on. These increases (and reductions) can then be mixed to model knowledge creation process that do not follow deterministic repeating-step patterns such as the SECI-model, thus circumventing the third criticism from above.

6.1.4 The work in contrast to alternative interpretations

In chapter 3.5, we introduced the following contrasting viewpoints to the development path seen in figure 8:

- Full or partial dismissal of the usefulness of traditional tacit and explicit concepts in KM (Williams, 2005; Grandinetti 2014), Or alternative views without this separation (Jakubik, 2007).

- Conversions between tacit and explicit knowledge as untenable (Crane & Bontis, 2014).

- Tacitness and implicitness as separate types of knowledge (Kogut & Zander, 1992; Li & Gao, 2003; Grandinetti, 2014).

- Tacit and explicit -paradigm as lacking basis for a knowledge creation paradigm (Jakubik, 2011).

Let us address these in order. The model introduced in the work maintains the notion that tacit and explicit knowledge exist but gives their previous foundational status as basic attributes of knowledge to the new concepts of cognitive fit and abstraction complexity. Tacitness and explicitness remain as important notions, but ones that are not fundamentally connected to the nature of knowledge, instead arising as a result of our

perception of the dominance of either cognitive fit or abstraction complexity. Similarly, conversions between tacit and explicit knowledge are foundational to the operation of the new model, but once more result from changes in cognitive fit and abstraction complexity attributes.

In regard to codifiability, implicitness is treated in a very similar manner to that seen in figure 6 as presented by Meyer & Sugiyama (2007). However, there remain open question as to how we should think of implicitness in the context of the chapter 5.2, where the differentiation proposed by Grandinetti (2015) between unconscious and tacit knowledge is endorsed. The notion of implicitness in this context will require additional research.

Jakubik's notion of tacit and explicit -paradigm as a lacking foundation to all knowledge creation is based on a view of knowledge in the "becoming to know" framework. This notion of knowledge combines aspects of learning and knowledge into a paradigm, where knowledge creation is based on the interaction between people based on an ontological and epistemological chain. This chain is, in some ways similar to this works notion of causal chain and stratified ontology.

As such, the model proposed in this work does agree with Jakubik's (2011) notion that the traditional view of explicit and tacit knowledge (as per figure 8) is not a sufficient paradigm to fully explain knowledge creation. However, the differences between the view proposed by this work and the work of Jakubik (2011) is in the ways in which this is addressed. Jakubik's 'becoming to know' -framework is established via the introduction of additional components and mechanisms. while the model proposed in this work works to unify the multitude of concepts into a more cohesive whole by reimagining the notions of tacitness and explicitness and finding more foundational mechanisms behind these concepts.

Overall, this unifying and concise view provided by the new model remains its most insightful contribution to the knowledge management theory. The use of a stratified ontology similar to that of critical realism and causal reliabilist view on knowledge allowed for the later parts of the work to integrate existing knowledge management concepts into a shared foundation to a far greater extent than previously possible. As noted in chapter 3.5, knowledge management is a field of study which is still to reach maturity. However, the consolidation axiomatization of its foundational concepts, such as knowledge creation, transfer, utilization, understanding, complexity, among others, either within the mechanisms and attributes provided here or by similar future research, is likely to prove crucial in the fields journey toward maturity.

6.2 Practical implications

As a result of the conceptual nature of the work and exacerbated by the wide variety of theoretical implications, it is unfeasible to exhaustively cover all practical implications of the model. As such, let us instead focus on one central idea at the core of knowledge management practice which we covered previously in chapter 1: The use of knowledge creation models as ways of managing innovation and subsequently value creation (Nonaka & Takeuchi, 1995; Spender, 1996a; Schulze, 2001; Xu et al., 2010). We will use Nonaka's (1994; Nonaka & Takeuchi, 1995) SECI-model as our point of comparison, due to both its prevalence in the field.

Xu et al. (2010) have compiled different descriptions of innovation processes from knowledge management literature. There in Xu et al. (2010) presented SECI-model in innovation via the work of Schulze (2001) as comprising of four phases, impulse, ideas, innovation, & invention.

Impulse begins the process as the initial awareness of a problem or need for innovation is established. Impulse can be seen as beginning in the socialization phase of the SECI-model (Nonaka 1994; Nonaka & Takeuchi 1995). Impulses develop into ideas which are then evaluated, and this evaluation leads to the third phase, invention. Inventions are then further developed into innovations as their viability compared to other possibilities, such as other technologies, is tested during implementation. In the case of successful innovation, the activities around and based on the innovation can then lead to the circumstances of further impulses, restarting the cycle. (Schulze, 2001).

The cyclical nature of this four-stage innovation process within the SECI-model is one of the major differences between it and the model introduced in this work (Nonaka, 1994; Nonaka & Takeuchi, 1995; Schulze, 2001; Bratianu, 2015). While the cyclicality and following dynamic nature of the SECI-model based innovation is useful for fostering management practices which create competitive advantage on a continuous basis, we can see that it can be a hindrance in other aspects. For example, Spender (1996a) notes the need for a form of closure that is lacking in Nonaka's (1994; Nonaka & Takeuchi, 1995) work and Bratianu (2015) criticises the deterministic nature of the cycle, as we saw in chapter 5.4 in one of his three criticisms. Drucker (2017) in his work *the age of discontinuity* likewise notes that the world in general has become disruptive, and is developing according to discontinuities which challenge continuous, cyclical structures.

One important context in which we can be see a linear process with clearly defined beginning and closure stages is technology innovation that drives growth in modern firms (Sood & Tellis, 2005). This style of discontinuous development would be difficult to model

with a cyclical model, and accordingly the technological innovation and its evolution often represented with so called S-curves[21], which rely on linear development processes (Sood, & Tellis 2005; Xu et al., 2010; Netland & Ferdows, 2016; Byun, Sung, & Park, 2017).
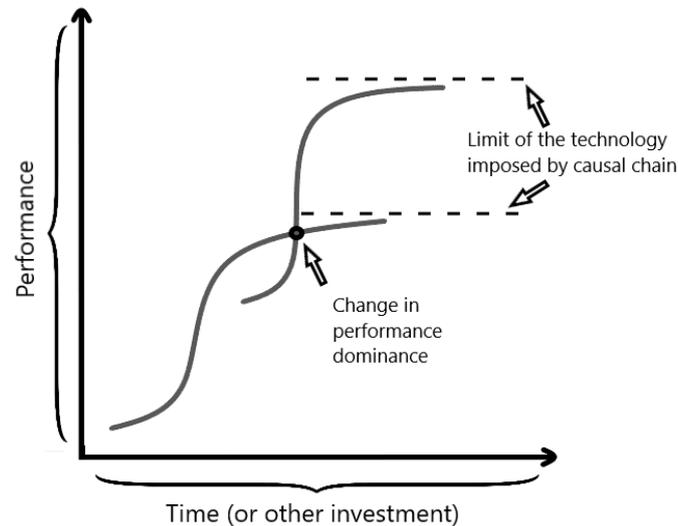
Figure 18. *Example of technology S-curves, which correspond to the linear nature for the new conceptual model (adapted from Adner & Kapoor, 2016; Byun, Sung, & Park, 2017). Note the possibility of correlating the performance axis with cognitive fit and abstraction complexity based on proposition 2's notion of utility of knowledge.*

These S-curves, such as those seen in figure 18, form from the visualization of the development of a technology's performance over time and maturity in three stages. Starting from the initial discovery and slow development of the technology, moving on to a faster paced performance growth phase, and finally a slowing of the performance growth as the limits of the technology and the end of the lifecycle are reached (Xu et al., 2010; Netland & Ferdows, 2016; Byun, Sung, & Park, 2017). S-curves also allow for the comparison of multiple technologies, each with their own S-curves, the dissection points of which represent the change in (performance wise) dominant technology (Adner; 2002; Adner & Kapoor, 2016).

As discussed in chapter 5 of this work, the new conceptual model is linear, and we can associate this linearity and its resulting increase in understanding seen in figure 16, with

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[21] Note that Xu et al. (2010) present S-curves as an alternative to the SECI-model. Yet, the better fit of the new model should be considered a major advantage, as it ties the tacit and explicit concepts to the S-curve model and is able to explain the start and closure points of technologies with the limits of the causal chains which the knowledge at the basis of these technologies track.

the performance dimension in figure 18; In other words, via the proposition 2, we can model the utility of the knowledge, cognitive fit and abstraction complexity as performance of the technology that is based on said knowledge. With cognitive fit and abstraction complexity, we can further analyse this performance increase in more detail; For example, in the case that the technology was developed internally within an organization, the main driver of the performance would likely initially be cognitive fit, with the R&D-department tracking a causal chain that can be utilized for the technology. In the case of technology transfer, the main driver of the performance increase would likely initially be increasing abstraction complexity, in order to facilitate transfer of the cognitive fit at a later stage.

This is already a more complex analysis than the one presented by the impulse, ideas, innovation, & invention -process based on the SECI-model (Schulze, 2001). However, we can then use the role of causal chains as the source of knowledge (Forms), to model different technologies as different causal chains within the stratified ontology. With each technology being based on the tracking of a causal chain and the development of its performance resulting from further tracking of the chain and abstraction of the resulting cognitive fit, we can view the limits, speed of development and other attributes relevant to the technology development and innovation processes as manifestations of the causal chains.

This means that the maximal performance of the technology is formed by a natural closure point similar to that advocated for by Spender (1996a); Here, the closure point is the maximum level of understanding that results from the usage of cognitive fit and abstraction complexity as per proposition 1, where cognitive fit should theoretically have a maximum, where the knowledge is able to fully track the causal chain, while abstraction complexity likewise has a maximum, where this fully tracked causal chain can be fully conveyed and transferred, after which additional abstraction is unable to provide utility.

The new conceptual model introduced in this work is able to accurately model technological development seen in modern markets in a way which a cyclical model is unable to (Spender, 1996a; Adner; 2002; Sood & Tellis, 2005; Xu et al., 2010; Adner & Kapoor, 2016; Drucker, 2017). Simultaneously, this model is also able to explain the existence of different technologies and the differences in their relevant potentials, while only utilizing a set of two mechanics: causal tracking and report formation and two attributes, cognitive fit and abstraction complexity. With further empirical studies and wider practical extensions, the model will have potential to be applicable to a wide variety of practical contexts in knowledge and innovation management.

6.3 Evaluation and limitations

This work has been created and written as a theoretical work aimed at introducing a conceptual model without the use of empirical research. As such, it is especially important to the credibility of the work, that the sources used as the basis of the work be of high quality and representative of as wide a view of the relevant literature as possible. The long timescale and substantial amount of material included in the initial scope of the literature review has been chosen purposefully as a way of addressing this theoretical and conceptual nature, and challenges posed by said nature in producing a credible work, particularly when compared to more empirical thesis designs. In addition to noting the theoretical nature of the work in its evaluation, it is likewise important to address the work's qualitative nature. There are five criteria according to which qualitative research can be evaluated: Relevance, methodological suitability & research practice, analytical accuracy, theoretical coherency, and clarity (Tuomi & Sarajärvi, 2017).

The relevance of the work was established in chapter 1, with long standing gaps within the knowledge management literatures philosophical foundations (Spender, 1996a; Crane & Bontis, 2014). Additional credibility for the value and necessity of the work was gained from the model's final capabilities and the simplicity[22] of its premises discussed chapter 5, and the wide variety of resulting theoretical and practical implications of chapter 6. The work can therefore be considered successful in establishing its relevancy to the knowledge management field (Tuomi & Sarajärvi, 2017).

This work has been structured largely in accordance with the direction available for the writing of theses at Tampere University (Tampere University, 2019), with the work behind divided into chapters, each with their own purpose, contents and goals based on the research questions and the structure of the research itself. Minor freedoms have been taken in order to account for the works theoretical and qualitive nature, such as the further division of introduction and methodology sections and the inclusion of some new material in the discussion section. These deviations were made based on consultation of the faculty staff and were deemed suitable in order to better convey the purpose of the work and its practical implications, respectively. Based on this, the work can be considered successful in regard to its clarity, despite the challenges presented by the complexity of the subject matter (Tuomi & Sarajärvi, 2017).

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[22] In regard to the use of shared mechanism the model uses for multitude of previously separate concepts. The model itself remains complex, mainly due to the difficulty of distancing our thinking from the established status quo.

Due to the focus on philosophical foundations of the research topic, the available number of high-quality sources is comparatively limited as seen from the narrowing of the original 1300 publications within the scope of the review into less than one hundred articles. Similar trend can be fitness in the sources themselves, with the theoretical works of similar integrative and conceptualizing nature often relying on only a few sources of purely philosophical nature, especially from knowledge management literature (Faucher, Everett & Lawson, 2008; Crane & Bontis 2014; Venkitachalam & Busch, 2012). The methodology used was based on high-quality sources and instructions which are used extensively in the field (Torraco, 2005; Saunders et al., 2019; Snyder, 2019), and the research design and execution was successful. Based on these considerations, the methodological suitability and research practice of the work is deemed to have been carried out successfully (Tuomi & Sarajärvi, 2017).

The theoretical coherency of the work is challenging to evaluate. On one hand the philosophical and theoretical foundations have been established in a clear, meticulous manner, with major part of the work dedicated towards this goal. On the other, the work borrows heavily from multiple different philosophical schools of thought and knowledge management models, such as critical realism, causal theory of knowing, reliabilism, Polanyi's (1966) work, Nonaka's knowledge dynamics and Platonic philosophy, that are often either oblivious towards each other or traditionally seen as somewhat contradictory (Plato in Fine, 1995; Plato in Allen, 2012; Gettier, 1963; Polanyi, 1966; Goldman, 1967; 1979; Nonaka, 1991, 1994; Nonaka & Takeuchi, 1995; Nonaka & Konno, 1998; Nonaka, Toyama & Konno, 2000; Groff, 2004; McEvoy, 2014). However, the work has been clear that the ideas within these sources are not used in their entirety, but instead their most useful features have been borrowed and moulded together in order to form the new model, which can stand independently from the previous frameworks. As such, the theoretical coherence of this work is considered to have been established successfully, especially when we consider the works success in addressing the long-standing gap in the foundation of the knowledge management field which acted as the works inspiration (Spender, 1996a; Crane & Bontis, 2014; Tuomi & Sarajärvi, 2017).

The final criterion of analytical accuracy is even more difficult to establish for a conceptual, inductive work. As noted by Gioia et al. (2013) and seen in Woo et al. (2017), inductive research is often seen as less scientifically rigorous than its deductive or abductive counterparts. Saunders et al (2019) also supports this view, yet it is also clear from the guidelines of Snyder (2019) that this type of inductive research is often necessary as a first step for the formation radically new viewpoints. All of this was noted prior to the

initiation of the research, and subsequently the research design was constructed to compensate for these limitations. The viewpoints which differ from those used as the foundations of the conceptual model were recognized in chapter 3.5 and 4.2, with additional assurance for the quality of the analysis and its accuracy provided by the step-by-step documentation of the review process seen in appendixes A and B. Despite all of these precautions, the analytical accuracy of the work is unprovable without future research and review by third parties. Yet, within the limitations set by the biases of the author, the accuracy of the analysis can be considered to be in line with the best practices seen in the field of research.

Based on all of the above considerations and the purpose and motivation of work, the thesis is considered to have successfully reached its goals. There remain limitations in the applicability of the results, especially due to the inductive research approach and the theoretical nature of the work in general, as well as the fact that the entire work has been carried out by a single author, which means there remains a possibility of subjective bias in the analysis process. However, because these limitations were recognized at an early stage and compensated for, further research, especially of empirical nature, can be carried out to lift these limitations and establish the practical utility of the conceptual model. Additionally, while the review by third parties will be the ultimate judge for the theoretical value of here in contained ideas, the works subject matter of knowledge creation, transfer, dualistic nature of knowledge, and the philosophical foundations of these concepts remains at the very core of knowledge management literature.

6.4 Future research directions & further reading

The wide-ranging implications of the work open many new research directions. This chapter will cover five of them. Each of these research directions is also provided with material as further reading, based mainly on the phases 1 and 2 of the literature review.

The first research direction is in expanding the development path established in chapter 3 via additional literature reviews of varied sources (outside of JKM) to provide a tool for comparing future models of the subject matter with previous literature. A result of such research would provide both as a tool for educational purposes and a useful framework for future research design on related topics. For further reading on the matter of where these literature reviews could be aimed, the following articles are recommended:

- The *Global ranking of knowledge management and intellectual capital aca-demic journals* -series (Bontis & Serenko, 2009; Serenko & Bontis, 2009; 2013; 2017)

- Parts I to III of the *Citation classics published in knowledge management journals* by Serenko & Dumay (2015a; 2015b; 2017)

The second research direction is in the correlation of understanding with knowledge hierarchies. As mentioned in a footnote in relation to understanding, the concept of data within knowledge hierarchy context is very similar to low cognitive fit and abstraction complexity. Likewise, the increase of these two attributes to form understanding can be seen as moving us towards higher levels of the hierarchy, from data towards wisdom. For further reading:

- The E2E-model seen in the *Reconstituting knowledge management* by Faucher, Everett & Lawson (2008), which provides a great summary followed by an interesting original perspective on the knowledge-hierarchy.

- *The Problem with the Data-Information-Knowledge-Wisdom Hierarchy* by Weinberger (2010) for a concise piece on why the concept of the knowledge-hierarchy should not be viewed as simply as it often is, and what more complex models, (such as those provided by cognitive fit and abstraction complexity), could provide in this context.

- *The Data-Information-Knowledge-Wisdom Hierarchy and its Antithesis* by Bernstein (2011) for an extension of the hierarchy into the opposite direction.

The third research direction is gained from notion that there may be different ways of abstraction. As noted in a footnote in relation to abstraction complexity, the different types of abstracting something can be thought of as similar to languages, with each type of abstraction conveying the same message, the same causally tracked knowledge, but in a different way. In relation to knowledge transfer, the similarities and differences between these ways of abstraction may be able to be used in modelling concepts such as absorptive capacity, barriers and other knowledge transfer related concepts. For further reading on these topics, see:

- *Linking properties of knowledge with innovation performance: the moderate role of absorptive capacity* by Wang & Han (2011).

- *Facilitating tacit knowledge transfer: routine compatibility, trustworthiness, and integration in M & As* by Rannucci & Souder (2015).

- Calic et al. (2019). *Creativity from paradoxical experience: a theory of how individuals achieve creativity while adopting paradoxical frames* for the results of using different ways of abstraction on creativity.

- A bibliometric analysis of Journal of Knowledge Management by Gaviria-Marin, Merigo & Popa (2018) for most cited documents in the journal, many of which deal directly with these concepts.

Fourth research direction deals with the footnote in relation to Venkatachalam & Busch's (2012) research possibilities on tacit knowledge. This thesis was able to establish a model which provides a perspective regarding the 1st and 3rd questions, but the 2nd question () was considered outside the scope of the work. However, the concepts of cognitive fit and abstraction complexity may provide new insights into the question of different types of tacit knowledge. All of the relevant sources used by this thesis, especially in chapter 3, will be topical for further reading, but a good starting point is provided by:

- Venkitachalam & Busch (2012) in *Tacit knowledge: review and possible research directions*

- Dampney, Busch, & Richards (2002) in *The Meaning of Tacit Knowledge*

- Mooradian (2005) in *Tacit knowledge: philosophic roots and role in KM*

- Williams (2006) in *Narratives of knowledge and intelligence ... beyond the tacit and explicit*,

- Crane & Bontis (2014) in *Trouble with tacit: developing a new perspective and approach*.

- Grandinetti (2014) in *The explicit dimension: what we could not learn from Polanyi*.

Finally, the last research direction is in the extension of this new conceptual model into the field of Bas utilized by Nonaka's knowledge dynamics; While the new model is stronger for not requiring these Bas, as this allows the model to better model knowledge outside of management context, the extension of the model by integrating it with Bas would likely prove useful for practical applications, by allowing for established management related literature to be utilized together with the new model. For further reading on this topic:

- Nonaka & Konno (1998) and Nonaka, Toyama, & Konno (2000; 2001) an introduction to these concepts.

- Kaiser & Fordinal (2010) and Bratianu (2015) for the further extensions and critical analysis of the concept of Ba.

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APPENDIX A: PHASE 1 CATEGORIZATION OF ARTICLES PUBLISHED IN JOURNAL OF KNOWLEDGE MANAGEMENT

The following table presents a color-coded heat map of Articles 1–16 for each Volume/Issue (green = Direct, yellow = Indirect, red = Low/none) with summary counts in the Low/none, Indirect, and Direct columns.

Volume	Issue	Low/none	Indirect	Direct
1	1	5	3	1
	2	5	1	2
	3	6	2	0
	4	5	2	1
2	1	3	3	3
	2	2	5	2
3	1	6	0	2
	2	3	0	3
	3	3	2	0
	4	3	2	2
4	1	4	1	2
	2	6	0	2
	3	6	1	1
	4	4	1	4
5	1	4	2	4
	2	2	3	2
	3	5	1	1
	4	8	0	1
6	1	3	1	4
	2	4	1	3
	3	6	0	2
	4	7	0	0
	5	7	1	1
7	1	8	0	1
	2	6	0	3
	3	4	2	4
	4	7	2	2
	5	7	1	3

Volume	Issue	Article 1	Article 2	Article 3	Article 4	Article 5	Article 6	Article 7	Article 8	Article 9	Article 10	Article 11	Article 12	Article 13	Article 14	Article 15	Article 16	Low/none	Indirect	Direct
8	1																	7	0	3
	2																	8	1	1
	3																	7	1	2
	4																	6	1	1
	5																	8	1	0
	6																	5	0	5
9	1																	7	1	2
	2																	4	2	4
	3																	8	1	1
	4																	6	2	2
	5																	7	1	1
	6																	5	0	5
10	1																	8	2	1
	2																	9	0	0
	3																	5	1	6
	4																	6	2	4
	5																	13	1	0
	6																	6	2	1
11	1																	7	2	3
	2																	7	2	2
	3																	11	0	1
	4																	7	1	5
	5																	12	0	1
	6																	6	3	2
12	1																	7	2	3
	2																	7	1	4
	3																	7	2	3
	4																	10	2	0
	5																	14	0	0
	6																	9	1	2
13	1																	9	4	0
	2																	9	0	1
	3																	9	1	2
	4																	9	1	4
	5																	13	1	0

Volume	Issue	Low/none	Indirect	Direct
	6	11	1	0
14	1	10	1	1
	2	8	1	2
	3	8	1	1
	4	5	0	2
	5	8	0	1
	6	6	1	3
15	1	9	1	1
	2	6	1	3
	3	6	1	3
	4	6	1	1
	5	6	0	3
	6	9	1	1
16	1	8	2	1
	2	5	0	5
	3	6	3	0
	4	7	0	4
	5	6	1	3
	6	4	0	4
17	1	3	4	2
	2	5	3	2
	3	6	2	1
	4	8	0	1
	5	7	1	1
	6	7	1	2
18	1	7	5	2
	2	8	2	2
	3	4	2	2
	4	7	2	1
	5	8	4	1
	6	3	2	4
19	1	4	1	5
	2	5	1	7
	3	7	3	2
	4	10	0	0

Volume	Issue	Low/none	Indirect	Direct
	5	10	0	3
	6	9	0	3
20	1	8	1	1
	2	9	1	1
	3	11	0	0
	4	5	3	4
	5	10	1	4
	6	7	1	4
21	1	3	5	6
	2	5	3	6
	3	7	3	0
	4	9	5	2
	5	7	5	2
	6	7	4	5
22	1	10	1	1
	2	5	2	5
	3	8	1	1
	4	6	3	1
	5	5	3	2
	6	7	1	2
	7	6	1	3
	8	7	0	3
23	1	7	1	1
	2	8	0	1
	3	5	2	2
	4	6	0	3
	5	5	1	3
	6	5	1	3
	7	7	1	1
	8	4	2	3
	9	10	2	0
	10	8	1	3
Total:		875	183	282

Article columns: Article 1 – Article 16

APPENDIX B: PHASE 2 TAGGING OF THE PHASE 1 ARTICLE RESULTS AND SUBSEQUENT CATEGORIZATION AND ANALYSIS

This appendix summarizes the process and results of the phase 2 of the literature review. The phase 1 of the research was performed as a full review of all the articles published in the Journal of Knowledge Management from its first publication in 1997 to the beginning of the research at the end of 2019. The articles published after the beginning of 2020 have not been considered. The results of phase 1, act as the starting point of phase 2.

Phase 2 process: Tagging and initial analysis

Original research was carried out as a qualitative research for the purposes of exploring the possibility of integrating the knowledge-hierarchy to the SECI-model. The Journal of Knowledge Management (JKM) published by Emerald Publishing. The choice was based on the consistent position of JKM as the leading publishing platform for articles in the field of knowledge management (Bontis & Serenko, 2009; Serenko & Bontis, 2009; 2013a; 2013b).

Over the course of the research multiple areas of interest in the literature were categorized, including but not limited to: Knowledge creation, knowledge sharing, sense making, purpose/value of knowledge, dualistic view on knowledge, innovation and organizational culture. In total, phase 1 reviewed over 1300 articles, with more than 450 considered as having direct or indirect relevancy for the purposes of the research.

Phase 2 began with each of the directly or indirectly relevant articles having their full text pulled to a reference management system RefWorks. In this system, each article was given multiple tags to indicate their contents in order facilitate the analysis process and to ease the management the relatively large number of articles. Total number of unique tags after the tagging process was greater than 250.

Next, the tag-management functions of RefWorks were utilized to manage the articles by merging tags into larger groups based on their purpose, with the final consolidated number of tags used for the analysis process being circa. 50. This final grouping of tags was then utilized for the initial analysis process in conjunction with the finalized research question and sub-questions. Via the initial analysis, the following topics of interest were identified:

Knowledge creation:

Primary tags including: SECI, exploration (of knowledge*), Ba (SECI-model*), exploitation (of knowledge*), absorptive capacity, Tacit (knowledge*), sense making, and dynamic capabilities.

Knowledge Transfer:

Primary tags including: SECI, sense making, Combination (SECI-operation*), Ba (SECI-model*), Open Innovation, knowledge transfer; barriers, (knowledge*) boundaries, communities of practice, and explicit (knowledge*)

Identity (sense making / knowledge utilization):

Primary tags including: Sense making, Identity (purpose of knowledge*), capabilities and application.

Theoretical/summarizing papers:

Primary tags including: Theory of knowledge, overview, literature review, and theory integration.

Case studies / Tools / context specific papers:

Primary tags including: Case, tool, context and findings.

Criticisms of existing theory:

Primary tags including: criticism, research gap, alternative theories, and problems.

Asterisks (*) denote explanatory terms which were added in this document for explanatory purposes and were not present in the tags during the analysis process.

List of articles resulting from phase 2

Based on previously established topics, 83 preliminary choices were made from the 465 articles which the original research considered to have either direct or indirect. These were categorized alphabetically under the topics identified by the initial analysis as follows:

Knowledge creation

1. ARAMBURU, N., SÁENZ, J. and RIVERA, O., 2006. Fostering innovation and knowledge creation: the role of management context. *Journal of Knowledge Management,* **10**(3), pp. 157-168.

2. ARLING, P.A. and CHUN, M.W.S., 2011. Facilitating new knowledge creation and obtaining KM maturity. *Journal of Knowledge Management,* **15**(2), pp. 231-250.

3. BALESTRIN, A., VARGAS, L.M. and FAYARD, P., 2008. Knowledge creation in small-firm network. *Journal of Knowledge Management,* **12**(2), pp. 94-106.

4. BATARSEH, F.S., USHER, J.M. and DASPIT, J.J., 2017. Absorptive capacity in virtual teams: examining the influence on diversity and innovation. *Journal of Knowledge Management,* **21**(6), pp. 1342-1361.

5. BHATT, G., 2000. Organizing knowledge in the knowledge development cycle. *Journal of Knowledge Management,* **4**(1), pp. 15-26.

6. ECHAJARI, L. and THOMAS, C., 2015. Learning from complex and heterogeneous experiences: the role of knowledge codification. *Journal of Knowledge Management,* **19**(5), pp. 968-986.

7. FAUCHER, J.P.L., EVERETT, A.M. and LAWSON, R., 2008. Reconstituting knowledge management. *Journal of Knowledge Management*, 12(3), pp. 3-16.

8. FAYARD, P., 2003. Strategic communities for knowledge creation: a Western proposal for the Japanese concept of Ba. *Journal of Knowledge Management,* **7**(5), pp. 25-31.

9. GONZALEZ, R.V.D. and MELO, T.M., 2019. Analyzing dynamic capability in teamwork. *Journal of Knowledge Management,* **23**(6), pp. 1196-1217.

10. JIAO, H., YANG, J., ZHOU, J. and LI, J., 2019. Commercial partnerships and collaborative innovation in China: the moderating effect of technological uncertainty and dynamic capabilities. *Journal of Knowledge Management,* **23**(7), pp. 1429-1454.

11. LI, D., LIN, J., CUI, W. and QIAN, Y., 2018. The trade-off between knowledge exploration and exploitation in technological innovation. *Journal of Knowledge Management,* **22**(4), pp. 781-801.

12. LI, J., LI, Y., YU, Y. and YUAN, L., 2019. Search broadly or search narrowly? Role of knowledge search strategy in innovation performance. *Journal of Knowledge Management,* **23**(5), pp. 809-835.

13. MEYER, B. and SUGIYAMA, K., 2007. The concept of knowledge in KM: a dimensional model. Journal of Knowledge Management, 11(1), pp. 17-35.

14. OLUIKPE, P.I., 2015. Knowledge creation and utilization in project teams. *Journal of Knowledge Management,* **19**(2), pp. 351-371.

15. PERUFFO, E., MARCHEGIANI, L. and VICENTINI, F., 2018. Experience as a source of knowledge in divestiture decisions: emerging issues and knowledge management implications. *Journal of Knowledge Management,* **22**(2), pp. 344-361.

16. SEGARRA-CIPRÉS, M. and BOU-LLUSAR, J.C., 2018. External knowledge search for innovation: the role of firms' innovation strategy and industry context. *Journal of Knowledge Management,* **22**(2), pp. 280-298.

17. SIMAO, L. and FRANCO, M., 2018. External knowledge sources as antecedents of organizational innovation in firm workplaces: a knowledge-based perspective. *Journal of Knowledge Management,* **22**(2), pp. 237-256.

18. SIQUEIRA, A.C.O. and HONIG, B., 2019. Entrepreneurs' ingenuity and self-imposed ethical constraints: creating sustainability-oriented new ventures and knowledge. *Journal of Knowledge Management,* **23**(10), pp. 1965-1983.

19. WANG, C. and HAN, Y., 2011. Linking properties of knowledge with innovation performance: the moderate role of absorptive capacity. *Journal of Knowledge Management,* **15**(5), pp. 802-819.

20. WIIG, K.M., 1997. Knowledge Management: An Introduction and Perspective. Journal of Knowledge Management, 1(1), pp. 6-14.

21. ZHENG, S., ZHANG, W. and DU, J., 2011. Knowledge-based dynamic capabilities and innovation in networked environments. *Journal of Knowledge Management,* **15**(6), pp. 1035-1051.

Knowledge Transfer

22. BALDÉ, M., FERREIRA, A.I. and MAYNARD, T., 2018. SECI driven creativity: the role of team trust and intrinsic motivation. *Journal of knowledge management,* **22**(8), pp. 1688-1711.

23. BARTOLACCI, C., CRISTALLI, C., ISIDORI, D. and NICCOLINI, F., 2016. Ba virtual and inter-organizational evolution: a case study from a EU research project. *Journal of Knowledge Management,* **20**(4), pp. 793-811.

24. BECKETT, R.C., 2000. A characterisation of corporate memory as a knowledge system. *Journal of Knowledge Management,* **4**(4), pp. 311-319.

25. GANGULY, A., TALUKDAR, A. and CHATTERJEE, D., 2019. Evaluating the role of social capital, tacit knowledge sharing, knowledge quality and reciprocity in determining innovation capability of an organization. *Journal of knowledge management,* **23**(6), pp. 1105-1135.

26. HOOFF, B., SCHOUTEN, A.P. and SIMONOVSKI, S., 2012. What one feels and what one knows. *Journal of knowledge management,* **16**(1), pp. 148-158.

27. LEE, J., 2017. Setting a knowledge boundary across teams. *Journal of knowledge management,* **21**(2), pp. 254-274.

28. PIAN, Q.Y., JIN, H. and LI, H., 2019. Linking knowledge sharing to innovative behavior: the moderating role of collectivism. *Journal of knowledge management,* **23**(8), pp. 1652-1672.

29. PRIETO-PASTOR, I., MARTÍN-PÉREZ, V. and MARTÍN-CRUZ, N., 2018. Social capital, knowledge integration and learning in project-based organizations: a CEO-based study. *Journal of knowledge management,* **22**(8), pp. 1803-1825.

30. RANUCCI, R.A. and SOUDER, D., 2015. Facilitating tacit knowledge transfer: routine compatibility, trustworthiness, and integration in M & As. *Journal of Knowledge Management*, 19(2), pp. 257-276.

31. WANG, X., XI, Y., XIE, J. and ZHAO, Y., 2017. Organizational unlearning and knowledge transfer in cross-border M&A: the roles of routine and knowledge compatibility. *Journal of Knowledge Management,* **21**(6), pp. 1580-1595.

Identity (sense making / knowledge utilization)

32. ABU-SALIH, B., WONGTHONGTHAM, P. and CHAN, K.Y., 2018. Twitter mining for ontology-based domain discovery incorporating machine learning. *Journal of Knowledge Management,* **22**(5), pp. 949-981.

33. BECKETT, R.C., 2000. A characterisation of corporate memory as a knowledge system. *Journal of Knowledge Management,* **4**(4), pp. 311-319.

34. CHINYING LANG, J., 2004. Social context and social capital as enablers of knowledge integration. *Journal of Knowledge Management,* **8**(3), pp. 89-105.

35. FERRARIS, A., SANTORO, G. and DEZI, L., 2017. How MNC's subsidiaries may improve their innovative performance? The role of external sources and knowledge management capabilities. *Journal of Knowledge Management,* **21**(3), pp. 540-552.

36. PÉREZ-BUSTAMANTE, G., 1999. Knowledge management in agile innovative organisations. *Journal of Knowledge Management,* **3**(1), pp. 6-17.

37. STURM, A., GROSS, D., WANG, J. and YU, E., 2017. Means-ends based know-how mapping. *Journal of Knowledge Management,* **21**(2), pp. 454-473.

Theoretical/summarizing papers

38. BONTIS, N. and SERENKO, A., 2009. A follow-up ranking of academic journals. Journal of Knowledge Management, 13(1), pp. 16-26.

39. BORGHINI, S., 2005. Organizational creativity: breaking equilibrium and order to innovate. *Journal of Knowledge Management,* **9**(4), pp. 19-33.

40. BUENO CAMPOS, E. and PAZ SALMADOR SÁNCHEZ, M., 2003. Knowledge management in the emerging strategic business process: information, complexity and imagination. *Journal of Knowledge Management,* **7**(2), pp. 5-17.

41. CALIC, G., HÉLIE, S., BONTIS, N. and MOSAKOWSKI, E., 2019. Creativity from paradoxical experience: a theory of how individuals achieve creativity while adopting paradoxical frames. *Journal of knowledge management,* **23**(3), pp. 397-418.

42. CHATZKEL, J., 2007. Conference report 2006 KM World Conference Review. *Journal of Knowledge Management,* **11**(4), pp. 159-166.

43. GAVIRIA-MARIN, M. & MERIGO, J.M. and POPA, S., 2018. Twenty years of the Journal of Knowledge Management: a bibliometric analysis. *Journal of knowledge management*, 22(8), pp. 1655-1687

44. GUISADO-GONZÁLEZ, M., COCA-PÉREZ, J.L. and GONZÁLEZ-BLANCO, J., 2017. Analyzing the relationship between exploration, exploitation and organizational innovation. *Journal of knowledge management,* **21**(5), pp. 1142-1162.

45. HEFFNER, M. and SHARIF, N., 2008. Knowledge fusion for technological innovation in organizations. *Journal of Knowledge Management,* **12**(2), pp. 79-93.

46. KAISER, A. and FORDINAL, B., 2010. Creating a ba for generating self-transcending knowledge. *Journal of Knowledge Management,* **14**(6), pp. 928-942.

47. LI, M., LIU, H. and ZHOU, J., 2018. G-SECI model-based knowledge creation for CoPS innovation: the role of grey knowledge. *Journal of Knowledge Management,* **22**(4), pp. 887-911.

48. LOWIK, S., KRAAIJENBRINK, J. and GROEN, A.J., 2017. Antecedents and effects of individual absorptive capacity: a micro-foundational perspective on open innovation. *Journal of Knowledge Management,* **21**(6), pp. 1319-1341.

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