CONTEXTUALISATION: TOWARDS A USE THEORY OF MEANING-MAKING

by

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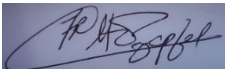Supervisors:

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ABSTRACT

Context: It has for many years been the conviction in Information Systems that the precise use of language holds the key to understanding and meaning of the inherent complexities of human-human-machine interventions. Unfortunately, the tension between machine precision and humans' imprecise use of language has not yet been solved comprehensively. Humans use continuous dialogue and impromptu interpretations to infer meaning, whereas machines are only interested in binary semantics and foregone conclusions – known as the form-function phenomenon. Meaning is not reducible to binary semantics because it is innately dependent on [an] interpretation. Interpretation unequivocally implies a dynamic of more than binary possibilities. Vitally, this dynamic relies on context to infer meaning. Context acts as the primary causal agent of 'use' for making meaning from instances of the form-function problem. The central question is how context can be operationalised innovatively. The answer: A 'use', central to the theory: an everyday 'use' called contextualisation. Contextualisation operationalises two common linguistic-cognitive mechanisms, indexicals and literary devices. The result is a constructive explanatory theory: a Use Theory of Meaning-making (UTMM)

Method: The Peffers *et al*. (2008) design science framework frees the theory-building process to integrate several methods to solve aspects of the problem. Methods such as the Constructive Grounded Theory ensure the theory develops according to the interpretive tenet of the human linguistic-cognitive process. The theory complies with the artefactual output required as a contribution to design science.

Results: The UTMM was subjected to a small focus group study to confirm the theory. The population was a typical agile team of nine plus one. Four short self-assessed surveys tested the historical and current experience and interpretation of the form-function problem using industry examples. The results showed the theory holds within the boundaries of requirements specifications. The researcher's arguments and interpretations proved to be plausibly acceptable.

Contribution: The UTMM was shown to improve the form-function problem and improve the human-human-machine intervention deliberately. Finally, the UTMM is transferable beyond the theoretical boundaries of requirement specifications to interventions characterised by

the form-function phenomenon, uniquely extending other UTM with a highly affordable means of constructing and transferring meaning.

ACKNOWLEDGEMENTS

1   CHAPTER 1: INTRODUCTION

> "Any human response to a situation or artefact is based upon a multitude of interacting factors. A human will see, and then interpret the situation knowing the history of the interaction, using their own cultural background, drawing upon their own experience, and with a specific perception of other people and artifacts in that environment, etc."
> Pavard & Dugdale (2002)

1.1   BACKGROUND INFORMATION

This thesis addresses the form-function phenomenon, i.e., the interpretive gap between a text and its representative notation particular to the requirements specification artefact. The gap is between the machine's static semantics and the human's dynamic inferential meaning-making. The question arising from this gap identification is *How to naturally improve the current poor 'use' of language forms and functions in requirements specifications?* The gap is closed via the novel use of everyday devices such as analogy, metaphor, heuristics, mental models and stories. Context operationalises these devices to construct and transfer meaning during continuous dialogue and interpretation. The resulting framework is known as **Contextualisation: a Use Theory of Meaning-making**. A small focus group study using an Agile team confirmed the theory's tenets and usability.

The topic of the thesis (boldfaced in the preceding paragraph) serves as a point of departure and a point of arrival. The point of arrival is denotative of a particular postulate (theory), which explains (because that is what a theory does) meaning-making via a specific type of theory – a 'use' theory. Connotatively, the topic implies what the theory is about, namely, **contextualisation**, but what is not immediately apparent is what this statement means aside from its role as the topic of this thesis. In another sense, the topic is indexical, a partial explanation that depends on the whole thesis for its meaning. As far as theories go, one can infer from this partial understanding that a definitive relationship will emerge between contextualisation and meaning-making. That relationship seemingly points to the word 'use', full of potential meaning yet uncertain at face value. The dictionary definition of 'use' affords a clue to its meaning as something, which is the "action or fact of **your** using it" (Collins, 2020). In the context of the topic, 'use' seems to point to contextualisation and

meaning-making. Contextualisation is the purposeful action of putting something into a context for interpretation (synonymous with understanding, meaning and explanation). However, an attentive reader should notice the particularity in the dictionary definition highlighted above, which can be interpreted as pointing to a human-subjective use. It seems conceivable then to rephrase the topic as a theory of subjective action of putting something (an uncertainty by implication) into a context for understanding, meaning or explanation. A plausible inference drawn here is that contextualisation is [also] a 'use'. This postulate (theory) assumes two 'uses': the subjective form of human intervention (activity/interaction) and a function of context (these two 'uses' are respectively labelled **dialogue** and **interpretation** - critical concepts of the use theory). **Context** plays the most prominent part in these uses because it acts as a mechanism for constructing meaning and relating 'use' to meaning (Cornish, 2013; Doyle, 2007; Spencer, 2006).

As a point of departure, the rephrase affords analysis of what problem such a theory might explain, how it develops an explanation, and ultimately why it is of interest to the information systems community (the audience). The interest raises questions, such as what is interesting to know about meaning in information systems, why it necessitates a theory, which type of theory, and what it contributes to the particular audience? These questions aside, a thesis about the subject matter of meaning-making is inadmissible if there is no problem worth investigating. The obvious question, hence, is what precisely the problem with meaning-making is?

"Meaning, the central problem of language" (Ogden & Richards, 1923, p. XV)

This quotation, the researcher believes, centralises 'meaning' as the problem *of* language. The presupposition highlighted joins the two nouns explicitly, distinguishing between meaning and language: 'meaning' signifies certain language features.
The thesis investigates this particularity based on the unique relationship between these two notions. Therefore, the thesis undertakes an in-depth investigation of the features of language problematised by 'meaning' to arrive at a postulate goal: the 'use' theory. This undertaking raises another question: what the theory presupposes about the use of language? The academic definition of a theory is "a coherent explanation or interpretation

of one or more phenomena" (Price, Jhangiani, & Chiang, 2013). It is conceivable then that the theory presupposes language use as a/the phenomenon of interest.

"If a system were badly constructed or insufficiently developed… it would not only be difficult but in fact impossible to find the most suitable form, for it is within the system that the forms have a meaning…predestining them for whichever particular contextual sense is required in discourse". (Guillaume, 1984, p. 81)

Although Guillaume's essay focuses on the linguistic-cognitive system in discourse, it metaphorically references the information system. Linguists (Halliday & Matthiessen, 2013) equate discourse to a text, only spoken or artefactual. The commonality between the two systems is twofold: 1) the origin of the text is in the cognitive system, expressed through the linguistic system with 'use' central to both instances, and 2) the use is a matter of form and function at different levels and in different contexts, e.g., at the system level contextual meaning (sense) of a form is unactualised, while the systemic (constructed) meaning is actualised (Guillaume, 1984). The use is thus a linguistic-cognitive systematisation, which invokes a sense of both solution and problem. The solution is a particular use (system) of specific linguistic forms that afford contextual meaning, which emerges from discourse. The problem is a condition of the system, making it nearly impossible to make meaning surface in discourse. Guillaume's essay explains in detail the relationship(s) between form and function at these different levels within the linguistic-cognitive system, and it is within this explanation that the researcher finds a link with information systems: the particular 'use' in the artefact produced during the requirements engineering process – the requirements specification. In this limited context, the researcher frames Guillaume's problem as three claims: 1) that the current form and function of language use in information systems are inefficiently constructed and developed, which 2) cause constraints upon users to find suitable meanings from that use, and 3) that this inefficiency necessitates contextualisation to correct or improve those effects of the language use. The third claim invokes the postulate of contextualisation; the theory emerges from the thesis's discourse. Therefore, one can expect the thesis to include an investigation into the distinctive 'use' of language, also known as the form-function problem (Newmeyer, 2000), the postulated alternative 'use' and the causalities among them. A distinction needs to be drawn here about theorising, which is not at the systemic or actualised level (i.e., the requirements specifications artefact). However,

at the linguistic-cognitive or unactualised level (i.e., individual or group articulation of thought), a feature of use to the researcher's knowledge has not been previously attempted.

An exemplar to support the first claim is the Agile movement's proposal to improve the communicative results between the participants in the requirements engineering process, with a distinct focus on discourse. It promotes regular discourse through user stories, a particular form, which assumes improved functioning or processing, yet at the same time enables the preference of implementation over articulation (i.e., working software over documentation)[1]. However, does this purport a dichotomy in hiding, for where does the content of the discourse go afterwards? The 'use' implies capturing the verbal discourse in a text, but the preferred functioning alludes to a possible negation. It seems the aims of either improved discourse (form) or an improvement via discourse (function) are dysfunctional from the start!

The second claim is known in the industry as poor requirements specifications. This problem has stood the test of time, being prevalent for the past twenty years without the outlook of a fitting resolve. It is characterised by words such as defect, error, fault, to name a few causes and their effects such as vague, inconsistent, incomplete, deficient, and imprecise; having as a summative description: ambiguity (Berry & Kamsties, 2004). A second characterisation uses words such as misuse and failure (Schwaber, 2006). A final description involves the inept human cognitive processes (Alshazly, Elfatatry, & Abougabal, 2014) to deal with the complexities and multiplicities of the 'use' in the current system context. This characteristic can be suitably articulated in reverse: the current 'use' is an unsuitable form and function for making meaning.

The third claim is contextualisation, which presumedly emerges from the in-depth investigation and theorising. The postulate of a use theory of meaning obligates the researcher to demonstrate a justificatory knowledge (Gregor & Hevner, 2013) from a theory base of kernel and reference theories from which the theory will emerge, i.e., "reference theories … inform your design." (Chatterjee, 2015). It fits then to investigate the mainstream scholarly works properly to contextualise the thesis within general meaning-making theories.

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[1] https://agilemanifesto.org/

The research focuses on a possible theory to explain the form and function of contextualisation and improve the form-function problem. The scholarly reference above is not without purpose. It positions the intended theory within design science, the reasons for which will be made clear in the thesis.

"A theory of meaning for artifacts in use addresses how individual users understand their artifacts and interact with them in their own terms and for their own reasons. Granting users the ability to understand in their own terms, defines the understanding of users' understanding as second-order understanding and distinguishes it from the ordinary understanding of tangible artifacts, artifacts that may be understood but cannot understand. Designers are concerned with proposals, plans, drawings, models, prototypes, and arguments for how to realise them, which are artifacts that are quite different from what their stakeholders or users live with: products, objects of exchange, services, appliances, consumable goods, gifts, markers of identity, and means to accomplish ends. Thus, a theory of meaning for artifacts in use by others has to be embedded in second-order understanding". (Krippendorff, 2005)

This quotation frames the theorising about the form-function problem and subsequent postulate emerging from a methodological undertaking in the constructivist grounded theory tradition (Charmaz, 2008b). After an in-depth investigation into the problem, the researcher will set about theorising, intending to find plausible explanations for its prevalence, solution, and causation. An explanatory hypothesis from the researcher's previous work will be used to reframe the problem and potential solution (Holzapfel, 2017) and serve as a reference for the comprehensive development of a functional explanatory theory in the design science tradition (Baskerville & Pries-Heje, 2010). Why design theory? Design theory concerns itself with either the production of an artefact or the human interaction with the artefact. The thesis's primary focus is the second, but it also holds implications for the first. What Krippendorff means by second-order understanding reifies the thesis focus: the linguistic-cognitive processing that foregoes the production of the physical artefact (Krippendorff, 2005, p. 77). The quotation highlights the intended Use Theory of Meaning-making's concerns and purposes: improving the use of language such that users explain the problem in a form and function that articulates **their cognitive processing**. Such a 'use' fits design theory in general and alludes to the characteristics of an appropriate form of design theory. Another reason is that the process of theorising undertaken aligns with the principles proposed for information systems and technology (Gregor, 2009).

The Use Theory of Meaning-making will springboard off the explanations of the phenomenon of interest via general theories of meaning and develop a specific explanation of the phenomenon through the emergent theory. The theory postulates a novel form and function, called contextualisation, as an invention and intervention - both design science principles (Purao, 2002). Its innovation contradicts the tradition of justification of the theory, focusing on discovery during the theorising process. It is inventive by using commonly used everyday linguistic-cognitive mechanisms, enabling anyone to express their understanding of complexities, uncertainties or sophistication in a shareable common way. It involves human intervention in a novel way, one which encourages and maintains continuous dialogue and interpretation.

An explanatory theory is obligated to explain causation, the notion of a causal relationship between language and meaning, context as the causal factor of meaning-making, and the causal relationship between the theory and the phenomenon. The typologies of possible approaches (Gregor, 2006) suggests the 'use' theory of meaning-making to fall in type II: Theory of Explaining, acting first to raise users' awareness of the problem's cruciality and a possible natural resolve. Secondly, it explains why they are negatively affected by the prevailing problem and how to construct meaning as a resolve. Additionally, it provides a testable hypothesis, which potentially positions it as a type IV: Theory for Explaining and Prediction. It is characterised by the additional description of the causal relations between the theoretical constructs (Ibid., p.626).

Any postulate inevitably discloses the orientation from which it is developed. Orientation means the ontological and epistemological foundations that underlie the researcher's reasoning during theorising. In this regard, the Use Theory of Meaning-making in design science is associated with a constructivist interpretive holistic orientation; the reasons are expounded at length and analysed against other mainstream orientations to clearly understand the researcher's convictions.

1.2   THE MOTIVATION

What motivates an attempt to contribute a use theory to academia and industry? Perhaps dissatisfaction with the status quo, an affinity for problem-solving or improvement, the defence of some moral or ethical position or in the researcher's case seeking a solution to

a common linguistic-cognitive phenomenon, which he has observed over 23 years in business analysis: the form-function problem of language use or simply the current 'use'. The problem needs some context and explanation. The researcher repeatedly observed a paradoxical 'use' of the prescribed industry forms and functions. E.g., the Unified Modeling Language (UML), among several others (Kuhn, 2014), aims to articulate business users' thoughts into an artefact, intending to reify the conversational expressions of their cognitive understanding and problem-solving in the artefact.

At the end of such a conversation in some industrial context, the current 'use' seems successful. All participants seem to share an understanding of the problem as articulated in the constructed artefact. However, the understanding later proves uncertain because the question - what is meant by this or that? - is repeatedly asked during subsequent conversations? This utterance is vividly apparent between technical and non-technical workers presented with textual descriptions or notational depictions (the current forms and functions), which begs whether the 'use' means what it intends to mean. This seeming dichotomy between 'use' and meaning is exacerbated considering UML is not the only 'use'. Unfortunately, as far as one form goes, there are an estimated 100 Controlled Natural Languages (Kuhn, 2014) among several others (for an extended list, visit https://www.omg.org/about/omg-standards-introduction.htm).

Advocates for the current forms/variants of information systems language will argue that business problems must correctly use formalisations (Cockburn, 2000; Harel & Rumpe, 2004; Herbert, 2013). On the contrary, research suggests that non-technical workers shut down cognitively to a great degree when confronted specifically with notations despite a widely accepted standardisation of the language form or function (Baisley et al., 2005; Glinz, 2000). On the other hand, technical worker's refuse to entertain large sets of textual descriptions (Bures, Hnetynka, Kroha, & Simko, 2012; Ilieva & Ormandjieva, 2005). Additionally, it seems "illusory" that the number of forms will diminish or that a homogenous audience will emerge soon (Tack, 2002, p. 218). Other research points to these phenomena as the wicked problem (Kroeze, Travica, & van Zyl, 2014b), which at the surface level features resistance to the complexity and multiplicity of the current form and function.

This study claims that a subliminal problem may be at work at the cognitive level. The unfamiliarity with the languages (text or notation) invokes social anxiety called psychological safety (Kakar, 2018). This claim is specific, delimited to the possible carry-over of hostile or compromised linguistic-cognitive processing due to problems experienced when attempting to solve notations in early learning. A short survey among a focus group will be conducted during the confirmation phase to validate this claim.

1.3   PURPOSE OF THE STUDY

The work of Neuman (2006) resonates well with the purpose of the study. In his article, also a theory of meaning, he proposes two axes necessary in information science. The first relates directly to the formalised features of language use (formal representations), alluding to the form-function problem in the requirements specification. The other relates to 'meaning' as the interpretations of the users of such representations. He points out that the former purposes "the formulation of a precise, qualitative conception of information…has proved elusive, despite the many other successes of computer science" and the latter has been scarcely studied because of the "obscurity of concepts … such as 'meaning' and 'context'" (Ibid., pp.1435-1436).

A first correlate is between his semiotic axes and the two-axes framework posited by the researcher in an earlier work (Holzapfel, 2017), which expands the semiotic axes into a dialogical axis and an interpretive axis. This bifurcation may address what he calls a problematic state of affairs, referring to "the failure to reduce meaning to information content" (Ibid., p.1436).

But it is his conclusory remark, which particularises the second correlate. The meaning-making process adds to the mere understanding of the 'sign' used – a purpose. However, the purpose is incommensurate with the current computational methods because "we still do not have a satisfactory answer to the question of how meaning emerges in context". The gap invites future research for a new approach "to modelling the emergence of meaning" (Ibid., p.1447).

The preceding correlates with the overall purpose: to develop simple means to solve the form-function problem. The researcher believes that the everyday use of context-over-

formalisations affords users a means to understand formalisations on their terms. Contextualisation (the means) accommodates the linguistic-cognitive aspect of meaning-making in the socio-cultural semiotic system: the surface problem of language use, and the cognitive model of the surface problem (Mesquita, Barrett, & Smith, 2010)

1.4 PROBLEM AND THESIS STATEMENT

The preceding summarises the current 'use' as constraints of formalisations in the objectivist/generativist tradition. The traditional methods predetermine or prefix the meaning of language's form and function, claiming that the meaning so formalised is suitable to all users for mutual understanding. Formalisations contrast the notions of dialogue and interpretation - a constructivist orientation. These formalisations constitute **the thesis's problem**: a poor 'use' of language in information systems artefacts (the requirements specification), which, although they intend a mutual understanding, contrastingly constitute an immutable use. Such use complicates interpretation among an audience that is neither scientifically orientated nor trained in every form or function of use.

Since the '70s, the formalist approach to solving the issue focused purely on form and function. This focus is witnessed by the many taxonomies, ontologies, and types of controlled language functions (Kuhn, 2014) in use without attending to the non-formalistic features necessary for comprehensive articulation and expression of thought. Presumably because of the unilateral view of language. Therefore, it seems plausible to extend this view by including the underlying views of other disciplines, e.g., Linguistics, Psychology and Cognition, to enlighten the information systems fraternity to new and innovative possibilities that significantly improve the current 'use'.

Meaning-making entails two distinct concepts: 'meaning' as a thing or outcome and 'making' as a process. The first concept relates directly to the interpretation of whatever is expressed and transferred (communicated) via the language 'use', and the second relates directly to the construction of the 'use'. What then causes the 'making' of meaning? The thesis argues for contextualisation as an alternative, which employs context as the alternative 'use'. As it will be argued, context causes meaning to be made (Mesquita et al., 2010); the novelty being everyday linguistic-cognitive constructs. Furthermore, context is dynamic or changing, which obligates the language-meaning relationship to be dynamically

constructed and transferred along a continuum, causally intertwined; summarised in the **thesis statement**:

Contextualisation dynamically augments the current language use in an information systems artefact, acting as a causal mechanism to construct and transfer meaning via continuous dialogue and interpretation.

1.5 RESEARCH QUESTIONS AND OPERATIONAL GOALS

Central Research Question:

How to naturally improve the current poor 'use' of language forms and functions in requirements specifications?

The question is directed at a theory of meaning-making; how it could assist a diverse audience of non-technical and technical participants to get the meaning of the current forms and functions in use to achieve the following operational goals:

- To decrease in interpretive misunderstandings and an increase in the shared meaning potential;
- To improve understanding without increasing the already sophisticated conceptualisations, and
- To improve the dialogue between participants without increasing time and effort. These objectives are perhaps an inverse of what Avison, Baskerville, Myers, and Wood-Harper (1999) had in mind; to create a process [of meaning-making] and evidence its efficacy applied to an information systems artefact.

The following thematised secondary questions support the central question:

Theme 1: 'use' generalised

SQ 1 – How is meaning explained within general theories of meaning?

Theme 2: 'use' problematised

SQ 2 – What constitutes poor use?

SQ 3 - What causes poor use?

Theme 3: 'use' particularised

SQ 4 – Why an alternative use is necessary?

SQ 5 – What is the alternative use?

SQ 6 – Why is a 'use' theory based on design science?

1.6   RESEARCH METHODOLOGY

Design science offers appropriate methods for the design and development of an emergent theory. One such framework is particularly suitable for this study because it allows for theories within a theory and allows multiple sub-methodologies (Peffers et al., 2006). This dualism offers the thesis a means to address the complexity and size of the problem phenomenon and theorise across disciplines due to the holistic approach to solve the problem. This thesis's problem is purported as an observable phenomenon, referred to as 'poor requirements specifications', the meaning of which affects how the method directs the thesis and theory development.

The components of the method, which are reiterated in the literature review and comprehensively developed in the methodology (chapter 3), are adapted to suit the problem definition and solution as follows (Ibid., p. 89-92):

- Show the problem's complexity at an appropriate level of refinement, and establish a plausible reason for its resolution,
- Constitute the objectives of a solution by inference from the problem definition,
- Construct the theory, i.e., an emergent functional explanation of how the theory supports the phenomenon in the design artefact,
- Employ demonstrable instruments such as focus groups or case studies to show how the insights from the solution sufficiently solve the problem,
- Draw comparisons between the theory objectives and the observed outcomes, using surveys, and finally
- Articulate the contribution(s) of the theory to solve the specific and or general phenomenon.

1.7   ASSUMPTIONS

An interpretive constructivist approach cannot be free from bias or assumptions. The particular assumptions made after this purposefully shape the approach to and theorise the

problem or phenomenon of interest. The problem itself reflects the researcher's experience as a business analyst and observance of the problem's effects on the use of language throughout the requirements engineering process and particularly on the requirements specification artefact. The researcher makes the following assumptions:

- The current constructs and models in requirements specifications are form-function uses by design,

- the unilateral (computational) view in requirements engineering is the leading cause of the problem (phenomenon).

- While meaning-making is not explicit in either the requirements engineering process or the requirements specification artefact creation, users are tacitly aware of and possess enough common sense to make meaning in the technical context similar to an everyday context.

1.8   LIMITATIONS

The participative (focus group) study is limited to a single instance of an agile project in a salient industry setting. The agile approach of 'feedback-learning-decision' (Stapleton, 2013) affords this thesis all the necessary features to demonstrate and evaluate the theory: dialogue, interpretation, (individual and group) construction transfer and use in an artefact. The researcher takes control in a focus group research study, elaboratively discussed and attested by Avison, Baskerville, and Myers (2001). The method's measurement and testing are limited to surveys, questionnaires, and summative evaluations of expert and non-expert feedback.

1.9   SIGNIFICANCE OF THE THESIS

The qualitative significance of the emergent theory is the practicability of the meaning-making process. It affords a more natural means for a diverse interpreting audience to reach a common understanding via continuous dialoguing and interpretation. It closes the gap of understanding between technical and non-technical persons. It enables the transfer of meaning before, during, and after creating the requirements specification (the documented artefact).

In the future, the researcher or practitioner may occasionally or intentionally observe better ways of using natural language patterns (literary devices) to aid the meaning-making

process, such as constructing graphic representations of the literary device that constructed the meaning. Such a development is an opportunity for research into the field of Behavioural Linguistics.

In sum, the researcher's contribution is threefold: making researchers and practitioners acutely aware of the potential of the application of this natural use of language; adding to the body of knowledge a scientific orientation from fields other than computation that offer a unique synthesis into information systems; and a functional explanatory theory, which confirms the value and effectiveness of design science research in information systems in a transdisciplinary application.

1.10 STRUCTURE OF THE THESIS

In the first chapter, the reader is introduced to the background of current computational thinking in the context of requirements engineering. Several observations are made regarding the underlying complexities in requirements engineering related to the use of language. The observations show the inherent limitations of the current use and its impact on understanding and meaning-making. The introduction concludes with the identification of everyday uses, which act as mechanisms to make meaning. Finally, these everyday uses are considered the theory's components to be developed, then explained relationally, followed by a demonstration, confirmation, and evaluation.

Chapter 2 is an integrative literature review, which features themes that also align with the structure of the design science research method (chapter 3) as follows: an exposition of the underlying theory base (theme 1) via a context review; the problem (theme 2) is defined by a systematic literature review which details an investigation of the literature on the phenomenon of 'poor requirements specifications; followed by a dialectical inquiry into the cause of the phenomenon; and theme 3 defines an alternative to the problem and develops the novel components of the emergent theory: context, indexicals and literary devices; followed by a synthesis of specific theories of meaning; and finally a theoretical review focused on the emergent theory.

The method (Chapter 3) explains the seven steps of the design science method applicable to the theory's focus (Peffers et al., 2006). The order in which the method is

applied depends on whether the researcher observes a problem (phenomenon) or observes an artefact's inefficiency. The thesis, essentially problem-centric, is concerned with both because they are closely related, which requires a sequential follow-through starting with the problem definition according to the method. Because the problem is linguistic-cognitively rooted, it manifests in the artefact, which focuses the thesis on the human interaction, i.e., the dialogue with and interpretation of the inefficiencies of language use. This chapter presents the guidelines the researcher used to comprehensively interpret the scholarly reviews, explaining the method for interpreting and detailing the focus group results.

After the method, the thesis chronologically presents the three themes of 'use', starting with USE GENERALISED in Chapter 4. This theme elaborates on 'use' in general, specifically regarding theories and their relation to phenomena. A contextual review positions the topic within the broader context of meaning theories.

Chapter 5 investigates USE PROBLEMATISED - the phenomenon of interest, poor requirements specifications and its relation to language use. First, a systematic review expounds on 70 studies, the remnant of an extensive search on the topic (section 5.1). Second, a dialectical inquiry is launched to investigate the cause of the problem (section 5.2). The inquiry invokes a debate between opposing worldviews and expects speculation to answer the problem.

After that, an alternative to the problem is investigated as the USE PARTICULARISED (Chapter 6). First, a narrative review tells the story of context and how the positivists are guilty of neglect. In contrast, interpretivism has been having a field day using context. Second, the narrative highlights the developing thinking on context across several disciplines. Third, this section connects language, context and meaning distinctly, and new concepts purport the possible novelty or innovation for an emergent theory (section 6.2).

Chapter 7 develops the USE THEORY OF MEANING-MAKING, hence the theoretical review. It investigates and discusses works related to a theory of meaning. The thesis' objectives (section 7.2) are inferences from the earlier definitions. Once the goals are defined, the theory's design and development commence, including a comprehensive

explanation of the theory in use (section 7.5.3&4). After that, follows a demonstration and evaluation of the theory in a focus group study.

Chapter 8, the final Chapter, contains the summative findings and concluding remarks and ends with a summation of the future contributions of the Use Theory of Meaning-making.

2 Chapter 2: RESEARCH DESIGN

> "The infiniteness that characterizes meaning has to do with the infiniteness of language" (Dahlberg, 2006)

2.1 INTRODUCTION TO AND OVERVIEW OF THE INTEGRATIVE LITERATURE REVIEW

The thesis concerns itself with a complex problem, opposing a dominant objectivist orientation and postulating a theory that relies considerably upon data from disciplines exogenous of information systems because of the solid linguistic-cognitive focus. The researcher decided to enlist a literature search (research) design and research method to complement the challenge and correlate features, aim, structure and process.

The choice of research design (this chapter) is the 'integrative literature review', which by definition allows the presentation of multiple studies to summarise a current "state of knowledge on a topic and highlighting agreements and disagreements" (Lawrence Neuman, 2014). It provides a structure that enforces "detailed and thoughtful work…is summarised by drawing overall conclusions from many studies" (Cynthia, 2005). The form of the integrative review is five steps, which also functions as a process, i.e., they flow logically one into the other:

- the identification of a 'complex' problem
- an exposition of what literature was searched and how collected.
- what and how the data was evaluated and the quality assured
- whether quantitative or qualitative measures were used, and
- what guided the interpretation and presentation of the results?

The study follows the first four steps of the integrative review to effectuate a sensible flow detailing the scholarly collection's search, quality assurance, and data collection method. Then follows the findings (results) and analysis as a whole. The last step, interpretation and presentation, are strategically positioned to explain what guided the research and introduce the design science research process or method (Chapter 3), which commences after that.

The method described in the preceding can be compared to Cooper's (1998, as cited in Cynthia, 2005) basic integrative review structure: an introduction (section 2.1), methods (sections 2.2), results and discussions (sections 3.2.1 – 3.2.10). The following section explains what an integrative review is about and what the reader can expect from the methods' similarities. The research is designed similarly to a systematic review, not as formal. The review complies with the requirements of rigour and reliability because "the concept of *dependability* provides an alternative to reliability in more naturalistic approaches to inquiry...valuing the trustworthiness of knowledge, instead of its truth value" (Baskerville, Kaul, & Storey, 2018, p. 4). The protocol defines and presents the literature searches and quality assurance depth, collecting the primary and secondary data and the findings. The findings show the development of data sets or themes, which carries over into a thematic analysis of the last section's data.

The results and discussion are moved to chapter 3 to complement the design science research process, which takes on an intuitive structure and the chronology of the thematic reviews.

The thesis topic is all about 'meaning-making', which, as pointed out in the introduction, necessitates an in-depth study of language, defined explicitly as the form-function problem – the phenomenon of interest.

Language is the *sine qua non* to meaning: the cause or condition without which meaning cannot be made, and to understand the meaning of the form or function, one has to understand the 'use' "within a particular paradigm of language" (Sethy, 2013, p. 151). 'Meaning' and 'meaning-making' cannot be sufficiently studied in isolation. A much broader or holistic approach is necessary because the ",… atomistic theories of meaning by nature are too narrow. It does not capture the complexities of meaning. So we need to look for an alternative conception of meaning, i.e. holistic approach to meaning" (Ibid). Such an approach necessitates taking into account general and specific theories of meaning. These theories are varieties of explanations of phenomena, in this case, within the language-meaning context. The endeavour to explain phenomena is theorising: the human activity, which results in the development of theories. Once a theory emerges, a causal relationship

or causation must be evident between it and the phenomenon such that a particular or general explanation of an observed regularity exists.

Causation (causality) refers to the factors that make something else happen. It is vital in theory development because it provides the explanatory glue between the concepts and the relations between the theory's concepts. In summary, a particular 'use' of language causes meaning; and the theorising about related phenomena generates explanatory theories. The 'use', which is the focal point of the thesis, happens at the intersection of these closely related concepts. The literature review endeavours to probe into the depths of this 'use', describe and categorise it, and delineate it for theory development purposes.

'**Meaning**' needs an in-depth investigation because it is intertwined with the concept of language; more importantly, it is currently underdetermined in information systems, other than the semantic assignment apparent in requirements specifications, e.g., additional text used in diagrams. However, semantic meaning is far too narrow in form or function to achieve the holistic purpose of language, namely the construction and transfer of 'meaning' for which dialogue is necessary. Such dialogical necessity does not feature in the current 'use' in requirements engineering. Note the mentioning of requirements specifications and requirements engineering. The requirements specification captures a language's varied forms and functions, using the constructs (text) and models (diagrammatical or graphical notations). These are partial constructs that make up the artificiality (the artefact or specification document). Requirements engineering entails developing the artefact as a representation of the linguistic-cognitive interactions between the human and artefact. Language, causality/causation and meaning are comprehensively explained in Chapter 6, but after that, they are regarded as familiar to the reader.

2.2   RESEARCH DESIGN AND METHOD

2.2.1   The problem identification

An integrative review defines the primary and secondary concepts and operations expected to surface from the literature and define the problem's boundaries. The general relationships between language and 'meaning' define the research boundary, ring-fenced by the relationship between theories and the phenomena they propose to explain. Inside this boundary, a detailed review of the particularities of language and meaning and the particular definition of language use as the form-function problem features. The problem is limited to

the partial artefacts that make up the requirements specification document: language constructs such as texts and modelling languages such as UML (excluding methodologies and instantiations). Since relationships govern these primary concepts, it necessitates to detail the causal factors of such relationships to explain them. The golden thread considered throughout the thesis is the notion of 'use'. The operational definition is a 'form and function of language use' (the current 'use'), which relates directly to the concepts and characteristics of the current constructs and models that dominate the information systems literature. Similarly, the same concepts apply to the development of the expected postulate, with a similar causal explanation; only, in this case, the 'use' is an alternative form and function of language use (the alternative 'use'). Finally, the particularities of the problem identification allude to the emergence of a particular theory.

2.2.2 The literature searches

The first search includes general phenomena and theory (including kernel and reference theories) about 'meaning' and the causalities between theory and phenomena. The literature finds a definitive relationship between an observed problem (phenomenon) and explanation (theory). This search particularises by forwards and backwards searching using the first two categories as guides. These categories contain the mainstream scholarly works in design science, complemented by a specific parameterising "embedded phenomena". The selection of works forms the theoretical base from which the later emergent theory 'emerges'. A context review positions the topic of meaning-making within the context of theories.

Table 1: The positioning of the phenomenon of meaning within meaning theories

Results of the specific search: a total of works selected	49
# related to embedded phenomena	4
# related to design science	5
# supporting works	8
# works specifically focused on the theories of meaning	32

For the second search, an inductive approach was followed in reviewing a body of literature featuring the phrase 'poor requirements specifications' closely associated with the phenomenon of interest: the current 'use'. Due to the extensive nature of this phenomenon, all the literature that relates to the description of the term includes a baseline and the following array of defined words or phrases: ambiguity, disambiguation, issues in the requirements specification, failure in requirements engineering, problems in the requirements specification, challenges in Software development, imprecision, misunderstanding and misinterpretation. The search aims to answer the main question on language use in particular and how it is established in the requirements specification, explicitly focusing on the constructs and models definition.

The initial phrasal string produced an enormous corpus related to 'use' (Table 2). It is fitting to illustrate the decreasing corpus due to a refinement strategy of applying filters to the retrieved documents in such a case.

Table 2: Search results of the current 'use' in requirements specification

Initial search results:	
"poor requirements specifications in requirements engineering."	18200
("ambiguity" OR "misinterpretation" OR "misunderstanding" OR "failure" OR "poor" OR "imprecision") AND ("Requirement Specification Document")	2950
Secondary refinement:	
"poor requirements" AND "requirements engineering."	1150
Primary refinement: Cross-checking relations inside the refinement:	
"poor requirements" AND ("syntax" OR "grammar" OR "semantics" OR "pragmatics")	485
"misinterpretation" AND "requirements language."	87
"language use" and "requirements specifications."	54
"misunderstanding" and "language use" and "requirements specifications."	43

Usable results after refinement:	Retrieved	Candidates	Selected
	267	95	70

Table 3 lists the result of an inferential based search, which assumes a root cause delimits poor requirements. The body of literature of this search is an inference from the following concepts: determinism, computational, positivist/generativist, formalism. The literature spans reference disciplines such as Linguistics (including Computational), Cognition, and Psychology/Social Science/Humanities. Suffice it to mention that the high number of works appearing in computer science alludes to the causality discussed in the presentation of the secondary data.

Table 3: The location of poor requirements in the reference disciplines

Results of the third iteration: total selected	66
# Computer Science (including Cybernetics)	49
# Linguistics (including Semiotics)	9
# Cognitive Science	2
# Psychology, Social Science and the Humanities	2
# Other (Standards Groups)	4

The third body of literature falls within the ambit of theorising or theory development and the emergence of a theory. Theorising references the constructive use of language, context, and meaning in a novel and innovative proposition: the alternative 'use'. The notion of context plays a definitive role in the following search, including works that specifically address the novel mechanisms appropriate for the emergent theory: the literary device and indexicals as possible causal mechanisms for constructing and interpreting.

The initial search explicitly includes literature from Design Science, Design Theory, and Theory of meaning found in reference disciplines, giving instructions or providing guidelines for a theory's characteristics, design, and development. The results are literary works that refer specifically to the two axes of meaning-making: dialogue and interpretation.

Finally, the results include works that focus on causation and a causal mechanism (an essential element of theory development).

Table 4: Literature relating to theory development

Results of the fourth iteration where the search term directly relates to the development of theory	Retrieved	Candidates	Selected
	293	293	94
'Use' orientations in terms of 'context'	183	90	11
Theoretical underpinnings (underlying theories)			12
Theory construction			44
Causation: interpretive mechanism – literary devices	70	35	16
Causation: dialogical mechanism - indexicals	40	20	11

Next are the literature reviews relating to constructing an explanatory theory of meaning-making: the forming of propositions and their governing rules; the direct application of the concepts in a theoretical or practical manner; and considering evaluation methods such as case studies and participative studies. The second search resulted in works that specify what makes a theory 'usable' and how such criteria should be demonstrated and evaluated. Due to the limited number of selected works, they are explicitly discussed later on. Search strings used: "theory evaluation" AND "design science"; "theory contribution" AND "design science".

Table 5: Literature related to the justification of the theorising

Results of the fourth iteration where the search term directly relates to the demonstration, evaluation of theory and contribution to the body of knowledge	Retrieved	Candidates	Selected
	104	21	17
Demonstration			8
Evaluation			5
Contribution			4

Apart from works from the reference disciplines the following seminal works (Table 6) restrict the scope and timeline of the literature organised by crucial concepts (underlined in the titles) with the inclusion of the number of citations to justify their inclusion.

Table 6: The list of seminal works with related topics for inclusion

Authority	Related Topic	# citations
(Ogden and Richards, I.A., 1946)	The meaning of meaning: A Study of the Influence of <u>Language</u> upon <u>Thought</u> and of the Science of Symbolism	5499
(Putnam, 1975a)	The meaning of '<u>meaning.</u>'	7391
(Belkin & Robertson, 1976)	Information science and the <u>phenomenon</u> of information	437
(Papineau, 1979)	The <u>theoretical</u> account of meaning	3704
(Fodor, Garrett, Walker, & Parkes, 1980)	Against definitions	563
(Van Fraassen, 1980)	A theory of <u>explanation</u> (of context)	8000
(Halliday & Hasan, 1989)	Language, <u>context</u>, and text: Aspects of language in a <u>social</u> <u>semiotic</u> perspective	7521
(Whetten, 1989)	What Constitutes a <u>Theoretical Contribution</u>	3468
(Bühler, 1990)	Theory of Language: The representational <u>function of language</u>	985
(Bell & Candlin, 1991)	Translation: the situatedness of context (the <u>location of the meaning</u>).	3688
(Lindstrom, 1992)	<u>Rethinking</u> context: Language as an interactive phenomenon	2304
(A Ortony, 1993)	<u>Metaphor</u> and Thought	3900
(Nunberg, 1993)	<u>Indexicality</u> and deixis	498
(Myers, 1994)	<u>Dialectical</u> hermeneutics: a theoretical framework for the implementation of information systems	308
(Simon, 1996)	The sciences of the <u>artificial</u>	26670

(Kögler, 1997)	The power of dialogue: Critical Hermeneutics after Gadamer and Foucault	325
(Davidson, 2001)	Inquiry into truth and interpretation	5532
(Van Lamsweerde, 2001)	Goal-orientated requirements engineering	2263
(William R Shadish, Thomas D Cook, 2002)		
(Krauss, 2005)	Research Paradigms and Meaning Making: A Primer	1465
(Van Lamsweerde, 2014)	Requirements engineering in the year 00: a research perspective	983
(Zikmund, Babin, Carr, & Griffin, 2013)	Survey method of evaluation	13712

2.2.3 Quality assurance

The results of the individual searches and strategies support each secondary question. The following undertaking ensures the quality of the body of literature:

- checking against the list of recognised and accredited journals,
- including established authorities (indicated by the number of citations) on particular topics, themes and concepts,
- including seminal works directly related to the purview of the study, and
- A date range of literature post-2000 was included as the most recent time-frame unless included explicitly as seminal works tabularised and described in Table 6.

2.2.4 Data Collection

The **secondary data** retrieved from the literature sources were electronically captured and documented using Endnote x9. The table below tabularises the literature sources.

Table 7: The data sources used for the searches

Source	Documented as
Electronic database	Type of Publication; Article Title; Author(s); Journal Name; Year; Volume (optional); Issue (Optional); Paged; Abstract (if available); Author Keywords; Date accessed; URL (if applicable); and Catalogue ID (e.g., DOI, ISSN, PMID)

Conference Proceedings	Type of Publication; Title; Author(s); Proc. Title; Year; Abstract (if available); Author Keywords; City; Editors (if applicable); Publisher; URL (if applicable); and Catalogue ID (e.g., DOI, ISSN, PMID)
Hand sourced (e.g., Books)	Type of Publication = Book Section; Section Title; Author(s); Book Title; Year; Pages; City; Editors (if applicable); Publisher; and Catalogue ID (ISBN)
Unpublished works	Type of Publication = Thesis; Thesis Title; Author(s); Year; Pages; Abstract (if available); Author Keywords (if available); Department (Optional); University; URL (if applicable); and Catalogue ID (e.g., DOI, ISSN, PMID)

The **primary data** is collected via secure online surveys, using two platforms:

1) the Microsoft Teams platform (https://www.microsoft.com/en-za/microsoft-teams/group-chat-software) for facilitating the interactions between researcher and participants and among participants, and

2) Qualtrics^{xm} (provided by the University of Pretoria) to design, implement and record the feedback given by experts and non-experts. In both cases, the University of Pretoria will hold the electronic records for safekeeping and compliance with the Ethics regulations (*Appendix A: Ethics approval letter from the ethics committee*). Both platforms are well-established, secure and fully Protection of Personal Information Act (POPIA) compliant.

2.3   SEARCH RESULTS

The secondary data extracted from the literature were collated into data sets: The first data set pertains to the literature on theories of meaning in general and the relationship with related phenomena in general. This data set contains references in information systems literature and Reference disciplines expressly relevant to the topic and the development of the 'use' theory. The data elucidates two prototypical mainstream orientations of meaning theories and further differentiates them into three fundamental types of validations of theories of meaning. The data set is particular to the answering of Sub-question 1.

The second data set pertains to the current 'use' (form and function exhibited in information systems), particularly in the requirements specification artefact and

requirements engineering process. The data set contains explicitly literature that limits the 'use' to natural language (NL) and modelling language (notation). The purview of this list includes references to grammar, semantics and pragmatics. The data set funnels the literature from the general to those that specifically address concepts synonymous with the problem statement, specifically, Sub-questions 2 and 3. A list of Controlled Natural Language (a form of language used in requirements specification) is included but not reviewed purely as a testimony to the identified problem in a requirements specification. Once the problem is identified, the focus turns to probable cause(s). The review considers the central thinking paradigms/orientations driving the appearance of the current 'use'. The data set includes the effects of the orientations and, as a result of the dialectic inquiry, elucidates a counter-argument of possibilities for improvement.

The third data set pertains firstly to a body of literature on the alternative 'use' of language; further conceptually categorised as follows: 'context' and 'contextualisation'; 'indexicals'; 'dialogue'; 'interpretation; and 'literary devices. This data set addresses Sub-question 4. The main finding is that 'context' proffers an alternative, which indicates the possibility of everyday use. After the finding of everyday use, the second data set explores that possibility via a narrative review. The finding is that a particular mechanism closely related to 'context' features prominently favouring the finding of everyday use. After that, the body of literature on developing a Use Theory of Meaning-making completes the integrative review. The literature on meaning and meaning-making contains only those relevant to an emergent theory. The data set cross-references literature on theory in general and those that specifically address the topic in the context of theory design, development, demonstration and evaluation. The data set addresses Sub-questions 5 & 6.

2.4   DATA ANALYSIS

This section highlights any patterns, themes and relationships discovered via the searches and findings. A thematic analysis was employed, which provides a suitable method for analysing the secondary data from mainstream articles. The thematic analysis works "with a wide range of research questions, from those about people's experiences or understandings to those about the presentation and construction of particular phenomena in particular contexts [it] can be used to analyse different types of data, from secondary

sources such as media to transcripts of focus groups or interviews." (Braun & Clarke, 2006).
It works in all of the following ways:

- it is "theory agnostic",
- supports a constructivist ontological orientation,
- has a clear focus on the context and meanings of the corpus data,
- effectuates the interpretive naturalist inquiry, with its emphasis also, on the whole of the socio-cultural context,
- supports an abductive approach,
- pronounces both the semantic (explicit) level and interpretive (tacit) level of thematic discovery,
- the process of thematic discovery fits eloquently into the design science methodology wherein a theory emerges through the process,
- supports action and participatory research,
- works as well with secondary data as with primary data,
- The analysis method helps the cohesion between the research questions and the "phenomenon within particular contexts" (Clarke & Braun, 2013). The article points out that this method of analysis promotes the value and importance of context.

In sum, this section synthesises the literature selected from each review and explicates three themes that emerged from the data. The three themes and the respective reviews help depict a mental model for reference. Figure 1 visually distinguishes each study reserved for interpreting and presenting the search results.

2.5   INTERPRETATION AND DATA PRESENTATION

The integrative review has similar criteria to a systematic review for reporting the findings of the research. One criterium is that the findings must be published to an expectant audience; so that another researcher must find it reproducible. The research design chapter and method chapter provide concise, practical, and repeatable structures used in each chapter. The researcher's constructivist-interpretive-holistic worldview guides the interpretation because the "key to meaning-making in qualitative work is an awareness of one's worldview and perspectives" - Dr Paula Lusardi, calling herself a traditionalist in qualitative research (Hunter, Lusardi, Zucker, Jacelon, & Chandler, 2002). She stresses that qualitative work entails, to a large degree, the researcher's immersion in the data that reflects her

perspectives in specific contexts, which includes the emergent meanings of the people under observation in a real-world study, as is the case in this thesis. Thus, the researcher's perspective influences the dissemination, analysis, and interpretation of the scholarly works from which he invents an innovative solution (Ibid., p.389). The worldview also guides the structuring of the data and the emergence of the fundamental concepts. The emergence of the fundamental concepts results from the immersion, an activity crucial to the consequential theory development period during the research period. The immersion period is where the interpretation labours, guided by the integrative structure.

Although the integrative review guides the presentation of the data, the wicked problem calls for a thematic way to present it (Figure 1).
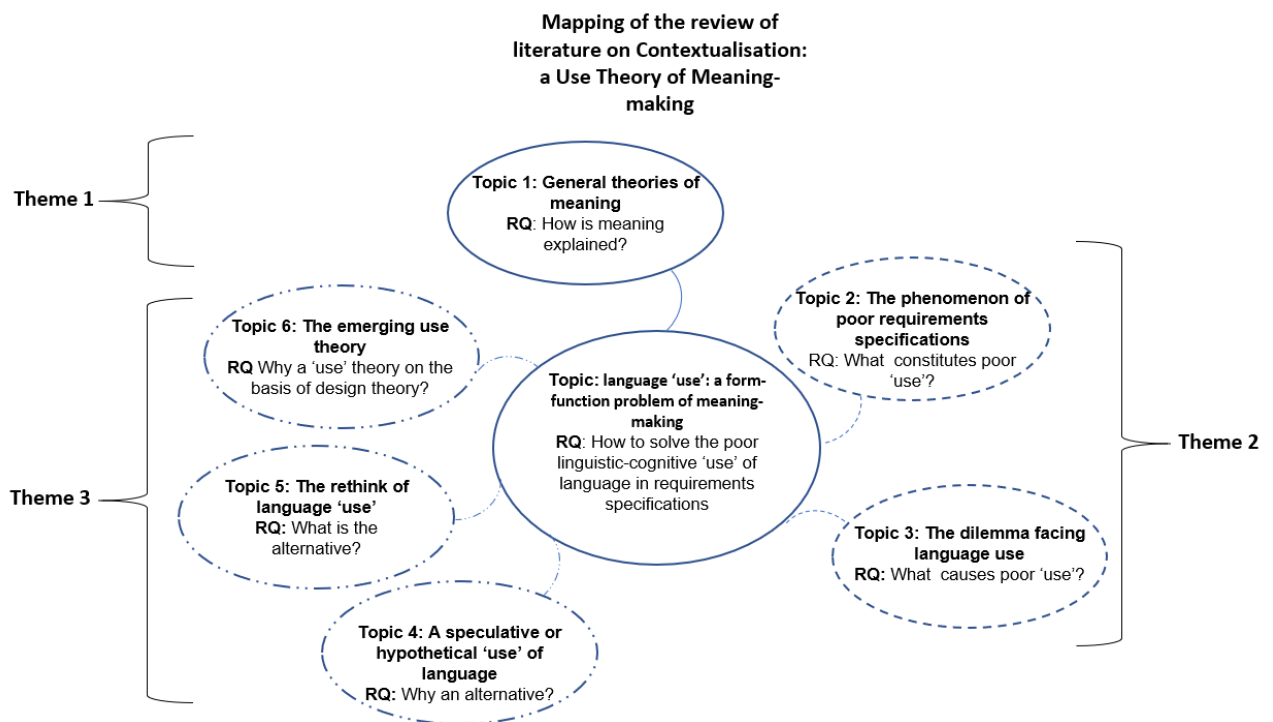
Figure 1: A thematic mapping of the individual literature reviews ordered by theme

The map exhibits the three themes from the searches; each theme separates a relevant topic and a related sub-question (section 1.6). The themes that emerged from the analysis are:

- 'use' generalised within theories of meaning (theme 1);
- 'use' problematised within requirements specifications (theme 2);

- 'use' particularised as the solution to the problematic use (theme 3). The centre of the analysis is the central question, which relates to the problem statement. Like the entire thesis, the problem focuses on the concept of 'use' within the topic of meaning-making.

2.6 CONCLUSION

The integrative literature review allowed for multiple research methods to be employed going forward as follows:

- A contextual review of the theoretical orientations in theories of meaning (Chapter 4)
- A systematic review of the phenomenon of interest (Chapter 5.1)
- A dialectical inquiry reflecting on the tension between the current and alternative methods (Chapter 5.2)
- A narrative review of the alternative use (Chapter 6)
- A theoretical review of specific theories of meaning that relate to the Use Theory of Meaning-making (Chapter 7)

The reason for this design was shown to be linked to the complexity of the problem identified. Central to the research design was the golden thread concerning the concept of 'use'. In turn, the problem necessitated a broad search starting with literature concerning theories of meaning in general, narrowing it down to literature concerned with the problem and alternative use, and panning out with literature particular to the theorising process. The complexity of the problem further necessitated a solid strategy to ensure the quality of the searches.

The results highlighted the underlying theoretical underpinnings of the phenomenon of interest and the extent of the problem. It also indicated the vast potential for an alternative through the analysis. Appropriately, the data collection, which included primary and secondary data, was analysed thematically. Finally, the research design and method compared well with the design science research process in structure and content. Apart from sharing the identification of the problem, the requirement for presentation and interpretation fits appropriately in the latter structure, positioning it at the end of this chapter to introduce the research process.

3 Chapter 3: DESIGN SCIENCE RESEARCH PROCESS

> "an object of inquiry should not be divorced from the context in which meanings are ascribed supports a more holistic understanding of phenomena in changing contexts" (Hult and Lennung, 1980)

3.1 INTRODUCTION

The researcher's orientation/worldview influenced the research to be undertaken, and albeit subjective in the case of this thesis, it is legitimate nonetheless (Bitsch, 2005; Charmaz, 2008a; Van Zundert, 2016). Paradoxically an objective orientation to research, while independent, used the research and achievements of [subjective] scholars in various disciplines. This reciprocation between subjectivity and objectivity encouraged a multi-faceted approach to this thesis. The researcher's subjectivity required a research process or methodology suitably aligned to the initial research design process, allowing integration of multiple sub-methods.

The choice of a research method (Chapter 3) went to a design science process known for developing a theory (Peffers et al., 2006) and allowed for the integration of theories within theories. This method correlates structurally with the preceding five steps, and in particular, the methods' five stages which can be construed as the research interpretation and presentation as follows:

- Problem identification and solution justification (this Chapter),
- Objectives of the solution (Section 7.2),
- Theory design and development (Section 7.5),
- Demonstration (Section 7.6),
- Evaluation (Section 7.7)

Each of the five stages was sequentially indicated by the representing part of the following pictogram (Figure 2) adopted from Peffers (2006) to pinpoint the applicable activity in the Design science research process at the appropriate point in the thesis.
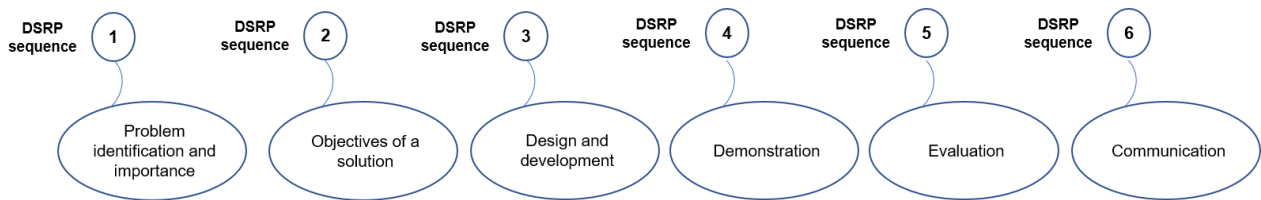
Figure 2: The nominal process sequence according to the DSRP model (Peffers et al., 2006, p. 93)

At this stage, it should be clear to the reader that the researcher considers meaning as something constructed during the realities of human interactions, more so interventions, and the subsequent interpretations of the real-world contexts. Meaning is made during subject-object-subject interactions in continuously changing contexts (Krippendorff, 2005, p. 83) - continuous flux. It should also be clear that the thinking paradigm is most closely aligned with interpretivism. This epistemological foundation's perspective is the naturalist inquiry (holistic), which holds that phenomena cannot be studied in isolation but only within their respective contexts (Gray, 2013).

According to Gray (2013), this perspective fits participative studies and document analysis (Ibid., p.27) and allows a research design to emerge. Shannon-Baker (2016) describes another perspective that fits the inquiry into the divergent and conflicting views of use in requirements engineering as dialectic. In the thesis, the research is expressly "focusing on the tensions and new understandings that arise" (Ibid., p.328) from the conflicting paradigms of natural language and notation, which is evidenced by the literature reviews in theme 2, respectively in the systematic literature review and the dialectical inquiry. As mentioned before, this perspective requires data collection, analysis and reflection to encourage dialogue between the participants, particularly in a participative approach.

Naturalistic inquiry (Gray, 2013, p. 27), also referred to as "evaluation against the real world" (Sonnenberg & Vom Brocke, 2011), engages users explicitly in an everyday application. A focus group study favoured unobtrusive ways of evaluating the theory. It used, among others, summative evaluations or feedback from experts. This type of inquiry lends itself to comply with the reliability criterium for evaluating the outcome of this design science-based thesis. It can be tested via a recommended framework, which in the case of the thesis "impacts the quality of the artifact…" through the intervention of the human user during the

process of artefact development, and "so must be assessed differently from the artifact itself" (Baskerville et al., 2018, p. 5).

The study's timeframe is cross-sectional, as seen in a small agile project, hopefully extending to increasing size and duration projects. A project of this kind offers discrete and sufficient observations of the effects of the theory on the possible intervention points in the process, called ceremonies: Sprint Planning, Daily Scrum, Sprint Review, and Sprint Retrospective. These events correlate with the theory's application scope, mentioned above in the *Significance of the thesis*.

3.2   PROBLEM IDENTIFICATION

A synthesis (Table 8) followed the synergy between the research design and the design science process regarding the themes, research questions, and individual methods: both allow multiple constructs.

Table 8: Synthesis between the research design and the research process

Theme	Research question	Location in the DSR framework	Method
[1] a theoretical generalisation about meaning-making (Chapter 4)	[1] How do general theories explain 'meaning.'	[1] Problem identification, definition, and solution justification [2] objectives of a solution	Context analysis
[2] the language-meaning problem and solution (Chapter 5)	[2] What constitutes poor use		Systematic protocol
	[3] What causes poor use		Dialectical inquiry
	[4] Why alternative use is necessary	[3] Theory design and development	Thematic analysis with Constructivist grounded theory
[3] a theoretical specialisation about meaning-making (Chapters 6-7	[5] What is an alternative use	[4] Demonstration and [5] evaluation	A focus group study and Constructivist grounded theory
	[6] Why a use theory	[6] Communication	

3.3 RESEARCH INSTRUMENTS

The study made use of a combination of instruments, the first of which is secondary data. The bulk of the data is from accredited journals, primarily sourced through the University of Pretoria and *Te Whare Wananga o Waikato* (The University of Waikato, Hamilton, Waikato, New Zealand) libraries.

The second instrument was the postulate (Holzapfel, 2017) to develop an explanatory theory of meaning-making. The researcher became an instrument to research, analyse, interpret, and theorize about the research problem itself (Maguire & Delahunt, 2017).

The third instrument that formed part of the naturalistic evaluation strategy (Sonnenberg & Vom Brocke, 2011, p. 7) was a survey or questionnaire tailored to focus group study participants during an agile requirements development lifecycle. The intent was first to educate the focus group in the use of the new language use, secondly to guide the team members through active use during the demonstration process and thirdly to evaluate the effect on the outcomes of the use; thus, in addition to the above, the researcher fulfilled the role of a facilitator. The particular evaluation instrument used is the Likert instrument (Hsu, 2006). The multiple-indicator methods, mental model measurement and open-ended questions were effectively used to measure the effectiveness of metaphor on metal models. The motivation for using this method is that it allows inferences of the **usefulness of the artefacts used**; in this case, the context of use and context in use. The surveys consisted of primary and secondary surveys (see section 7.6.2.6.1):

The primary surveys -

1. The first questionnaire captured the participant's individual and collective experiences with two industry examples of the form-function problem – the pretest.

2. The second questionnaire captured the experiences after being exposed to and trained in contextualisation – the post-test.

The secondary surveys -

3. A baseline questionnaire captured the historical or extant mental model regarding the notion of fallout, e.g., imposter syndrome, and its possible recurrence in requirements engineering – the baseline.

4. A final questionnaire captured the participants' opinions about the theory's success and future application – the debriefing.

The fourth instrument regarding evaluation was a merger between statistics and plausible evidence of the impact in the field as a proof-of-concept (Gregor & Hevner, 2013).

3.4   SURVEY METHOD

A focus group study drew upon the O'HEocha, Wang, and Conboy (2012) operationalisation of the seven principles explicitly designed for field research (Klein & Myers, 1999) in Information Systems. The focus group study was conducted in three phases to cover the three themes of the thesis but with slight variation. The style of the study was self-assessment. First, the survey was done via a single interactive online session. Second, the use of the Microsoft Teams Platform allowed for the facilitation and collaboration of the interactions. The interactions served to familiarise participants with the materials and method of the focus group study and assisted with the discourse among participants. Third, the interactive sessions were concluded with a questionnaire to establish the individual user and group experiences before and after the facilitation. The data collected from the survey was used to determine the theory's degree of improving the explanation of the problem. The type of questions included in the surveys correlates to the categories and process recommended by Lawrence Neuman (2014, p. 370), discussed next.

Phase 1 was about general explanations of 'meaning' and included the relationship such explanations have with phenomena related to meaning and meaning-making. The researcher used this theme to survey users' general knowledge of and appeal (or not) to explain the phenomenon of interest and survey the reality of the cognitive effects of the wicked problem as mentioned before.

Phase 2 was about the participant's knowledge of and experience with the phenomenon of interest, i.e., the language in its current 'use' in requirements specifications. The interaction provided two exemplars of the current use, purposing to get a discourse going around this topic and to scope the problem in the minds of the individual and group participants. The subsequent survey reified the current use and effects – linguistic and cognitive.

Phase 3 was about the alternative 'use', which firstly necessitated creating an awareness of the concepts and their relationships using examples to explain its

operationalisation. After participants had mastered the concepts and operationalisation, the researcher facilitated the application by recycling the exemplars used in Phase 2. The subsequent questionnaire captured the results. That data provided the basis for comparison to determine if and to what extent the theory holds.

3.5   MEASUREMENT

The measurement process and measures of the constructs drew upon the work of Lawrence Neuman (2014). The process entails a conceptualisation and operationalisation of measures. The rigour of this process is based on two criteria:

- Reliability, which translates to dependability or consistency in a qualitative study. The test of this measure is that the same expectation repeatedly occurs under similar conditions and
- Validity translates to trustworthiness or plausibility in a qualitative study. The test of this measure is whether the data and theoretical statements form a coherent whole (Ibid., p.467).

The measures, in turn, relate to the theoretical constructs as follows:

- Conceptualisation has a single measure: the unambiguous definition of constructs, concepts, theoretical terms, associations and boundaries.
- Operationalisation has a single measure of the connections between the theory's language and the measurement's language. The conceptual definitions are linked to a set of measurements, e.g., particular survey questions, actions or interventions.
- The confirmation has a single measure: the accuracy level of the theory. Accuracy translates to what has been observed from the focus group study to the connection with the contribution.

The survey design was discreet and continuous (Zikmund et al., 2013) to support a flow of dialogue and interpretation between participants and the questioning was sensibly structured to encourage participation. The first collected decisions/answers based on a definable value such as yes/no. The second collected decisions/answers based on levels of agreement (e.g., strongly disagree strongly agree) – similarly Likert Scales (Lawrence Neuman, 2014). Using Likert Scales afforded the researcher to evaluate the degree of improvement in understanding and meaning between the current 'use' and alternative/postulated everyday use.

3.5.1 Pre-testing

The purpose of the pre-test was to determine whether the group recognised the phenomenon of interest, i.e., poor requirements specification and, more specifically, that these were associated with language use, the constructs and model notations with which they are familiar. The idea was to test the significant assumptions against the hypotheses applicable to the participants, the problem and the solution. The reason for doing this pre-test was that it reifies the basic tenets of the thesis before conducting in-depth studies, which elevate cost and effort (Zikmund et al., 2013).

3.5.2 Sampling

As mentioned earlier, the intent was to structure the focus group such that it represented an agile team, a maximum of nine participants plus one observer. While the observer in this team participated in his capacity as a developer, although holding the position as a Development Manager. The sample consisted of three functional groups (users, analysts, and developers), including several roles (sponsor, team leader, administrator, product owner, business analyst, data analyst, programmer). The sample was constrained to a single agile team but in future should be extended to multiple teams in a cross-functional organisation context.

The reason for using an agile team was twofold: 1) it represented the current human element and preferred process of interaction in the requirements engineering process, 2) it represented the scope of participants presumed to be affected by the problem definition, and 3) it afforded the researcher a manageable contingent who has experience with the current language use in requirements specifications.

3.5.3 Target population

The context of the study is the totality of an agile project, which spans four distinct events, which demand a discourse as intended by the Agile. The population targeted is categorised by role:

a) the system users, e.g. a product sponsor, project manager and team member,

b) the analysts, e.g. product owners, business analysts and

c) the developers, e.g. architects and (code) developers, interact with the requirements specification in whatever way and to whatever degree. Age was not a population parameter but years of experience of eight years and above and an expertise level indicator.

The population was purposefully selected to represent a diverse socio-cultural mix (backgrounds, orientations/worldviews, training, education, and experience); however, such identification was not captured, i.e., not a parameterised survey attribute.

3.5.4 Sampling method

One can infer from the above that the most plausible sampling method for the survey was non-probability sampling refined in the quota system/feature (Lawrence Neuman, 2014). The quota was partially defined in terms of the focus group and the agile event and further refined by categories representing the number of cases among the population. The sample ranged across the three themes, each presented with three examples of the three roles in the population.

The reason for this was that the three examples were representative of the dominant language forms, i.e., the constructs and models used in most requirements specifications. Furthermore, the number of cases was fixed across the themes, promoting a simple statistical model from applying the above measurements. Finally, the population represented diversity in the social-cultural aspect.

3.5.5 Sample size

The focus group for theory testing was limited in numbers to a single team of nine plus one participants. In an organisation that engages in Information Systems development via an agile requirements engineering process, single teams collaborate across functional areas at scale.

The advantage is that such teams are knowledgeable about the artefacts associated with the requirements specifications (Weber, 2012), and the agile process affords four separate events suitable to test the postulates. Furthermore, the events were simplistic and short enough to encourage continuous dialogue without tiring the participants.

A disadvantage is that such a limited interaction is perhaps inadequate to draw conclusive inferences of the efficacy of the hypotheses. The interaction time limited the sampling size, i.e., the focus group was engaged for a day. Iterations may be necessary depending on the outcomes from the initial survey.

One might object to the sample size for the evaluation of the theory. However, the motivation behind such a decision was that the participants have vast experience across functional disciplines. Over many years they have been exposed to various engineering methods such as the standard software development lifecycle, waterfall, spiral, prototyping and design patterns, such as object orientation and service orientation. The team's composition was testimony to the level of experience and industry expertise, but most of all, they functioned together in the same commercial/industry and corporate context. Following is a brief exposition of the target population's experience and expertise defined by role.

Table 9: Team composition of participants

Functional category	Applicable roles	Number of participants
Business user	Sponsor, Team Leader, Team member,	3
Analyst	Business and systems analysts	3
Technical	Developers	4

3.6   CONCLUSION

In this chapter, the notion of 'use' remained the golden thread, and during the expositions, language use shifted to context as a centrality away from the problematised 'use'. However, the notion of context implies meaning, which likewise is ineffective without context. This insight confirmed the direct language-context-meaning relationship as is pronounced after the problem identification.

Notably, a context is not the object or referent. Instead, it is the point of reference. It is itself a dynamic mutability, a form, which can be constructed and changed. It causes meaning to emerge from the interaction between it and variables whose meaning is initially uncertain. The class of ambiguous, ambivalent, fragmented, or interpretatively sophisticated concepts is defined as uncertainty. Uncertainty, in this thesis, takes on a broader meaning within the bounds of context. These concepts are all deemed contextually bound for their meanings. The researcher's definition probably opposes the Ehlers (2011, p. 79)

segregation between ambiguity and uncertainty characterised by a "lack of information" in the case of uncertainty. Is not ambiguity solved by extending information (context)? Ambiguity is characterised by unclear, confusing or potentially more than one meaning (Collins, 2020), which points to uncertainty.

The context acts as a causal agent in meaning-making (already defined as contextualisation: a product and a process). Its operations are aptly explained as a reciprocation in which variables affect one another. Reciprocation is a dynamic exchange of use and reuse of a collection of interpretations and contextual resources. As a critical feature, reciprocity designates the language-context-meaning relationship and the shaping of human cognitive operations. Therefore, meaning-making alludes to two operational processes: outer operations of dialogue and interpretation and inner operations of construct and transfer. Within the purview of this paragraph, a vital link should be noted in findings that the mental and social context directly influences the construction of language 'use' (Tsvetkova, 2017). This insight counters the problematic use of form and function. If 'use' originates from mental and social delimitations, it extends to the partial and whole artefacts. An intuitive solution obligates a holistic account of language use, which is expected to show in the development and design of the emergent theory. Another feature of context that emerged from within this chapter is the notion of a mechanism. Context acts as a mechanism of abstraction from the interpretations in contexts and acts as a mechanism of reference to reinterpretations (Ogden & Richards, 1923). The mechanism has already been shown to operationalise the primary concepts and the human reasoning faculty (intervention). The mechanism enables the two distinct outer and inner operations via literary devices and indexicality.

The explanation of meaning-making concludes with a distinct definition of contextualisation as a product and process. The process is eschewed in current information systems literature favouring a context as a static entity/object of informational content. However, context dynamics extend beyond the static 'use', illustrating a broader holistic 'use' of context and its obvious potential in meaning-making. Contextualisation further implies the mechanisms explained in the preceding. The mechanism of indexicals operates during dialogue, resulting in a construct, and the literary device during interpretation resulting in transfer. Finally, a more apt use explained above can hardly surpass the definition of an

adaptive heuristic, which is used here collectively for all the devices as "… simple, unsophisticated, simplistic, and myopic … it leads to *movement* in seemingly "good" directions (like … reinforcement)" (Hart, 2005, p. 1401).

The above can be summarized or converged into the two explanatory frameworks: one outer (Figure 10), one inner (Figure 11), which operationalises dialogue-and-interpretation, and construct-and-transfer, respectively. Finally, this chapter pre-empts the requirements for theory development, design, demonstration, and evaluation, discussed in detail. Chapter 4, next, is a context review to position the Use Theory of Meaning-making in literature consisting of general theories that support such a theoretical development.

4 Chapter 4: THEME 1: 'USE' GENERALISED

4.1 THE THEORETICAL ORIENTATION OF MEANING-MAKING: A CONTEXT REVIEW

Topic 1:
General theories of meaning

Sub-question 1:
What do general theories of meaning contribute?

4.1.1 Introduction

Theory *per se* aims to explain or interpret phenomena (Price et al., 2013). Explanation and interpretation happen through the use of both linguistic and non-linguistic expressions, i.e., the use of language. In turn, the use of language is tainted by whichever paradigms of thought is adopted, which influences the articulation of expressions in certain forms and functions. Subsequently, both form and function characterise multiple particularities of 'use'.

4.1.2 A contextual review and synthesis of related works

Theories about meaning attempt to answer two questions:

- the ontological question of what constitutes 'meaning' and
- the epistemological question of obtaining 'meaning'. The preferred term in this thesis is how meaning is made.

Paradigms of thought play a definitive role in answering both these questions. The possible paradigms disseminate into three basic categories illustrated in Table 10 (reproduced from Denley (1999, p. 52)). The associative research methods (Hassan & Mingers, 2017, p. 10) are added for completeness.

Table 10: Possible paradigms of thought

	Positivism	Post positivism	Critical Theory	**Constructivism**
Ontology	Realism	Modified Realism	Historical Realism	Relativist
Epistemology	Objective	Modified Objective	Subjective	Subjective
Methodology	Manipulative	Modified Manipulative	Transformative	Facilitative
Research Method	Positivist	Positivist	Critical	Interpretive

The above demonstrates that the theories of meaning have not escaped the influences of these orientations, with positivism by far the more significant, as echoed by Chen & Hirschheim (2004) cited in Hassan and Mingers (2017). The synthesis (Table 11) should make it apparent that there is much dialogue between the modes of thinking in the available literature. The discussion explains that interpretation is a matter of orientation. Orientation means that even an objectivist via the assignment of meaning does so by convention, i.e., according to the discipline's agreeable interpretation. On the flip side, interpretivism could be accused of the assignment of arbitrary meanings. The objectivist/positivist truth-driven interaction is closed-ended. In contrast, the non-positivist socially-driven interpretation is open-ended (Carston & Powell, 2006).

From the review of the literature *Table 1: The positioning of the phenomenon of meaning within meaning theories,* two theoretical primacies are apparent: constitutive theories and interpretive theories. The constitutive theory postulates 'meaning' as fixed, pre-determined, rule-based, designated or determinable variables. In short, 'meaning' is an assignment from the symbols used. In contrast, an interpretive theory postulates 'meaning' as acquired, dynamically assigned according to the symbol's use. Herein, the assignment is exogenously informed from the grammatical structure and contextually determined. In the table below, the individual theories within the paradigms are colour coded for easier

reference. The Constitutive theories entail the strictly semantic theories (dark grey) and parts of the pragmatic theories (white); the Interpretive theories entail the non-mentalist theories (light grey) and parts of the Mentalist theories (white). Both pragmatic and mentalist theories with the same colour coding merge on some degree of contextual influence. The same colour coding is used throughout about the philosophical stance, ontological and epistemological orientations. Arrows indicate similarities across theories, and brackets indicate inclusions.

Table 11: A synthesis of the more pertinent theories of meaning

Constitutive: truth-value validation			Interpretive: acceptance validation	
Semantic theories Cognitive (Coulson & Oakley, 2005) 2-Dimensional (Jaszczolt, 2012) *De* se (Roberts, 2015) Dynamic (Van Eijck & Visser, 2010)		Pragmatic theories	Mentalist theories (non-representational explanations of content and representations)	Non-mentalist theories Causal origin Truth-maxims (Davidson, 2001) Reference magnetism (Putnam, 1974) Regularities/patterns of use (Horwich, 2004; Piwek, 2007) Causal social norms
Non-propositional	Propositional	Broadly pragmatic		Societal determinacy
Structure and semantics are inseparable but not equitable	Possible worlds (Russellian, Tarskian)	Meaning is declarative of context-sensitive facts (Gricean, ◄ (Levinson, Stephen, &	Meaning is inferred by implication or representation ◄(Gricean, Bach, (Carston, 2002))	Meaning is whether the individuals' or the societal acceptance of language, which determines its meaning – relates to

	Reference theory ↔ (Fregean) Assigned meaning and the symbol meaning must correlate	Levinson, 2000)); truth-value decided by context ((Austin, Searle, Kaplan in (Barber & Stainton, 2010)) or facts that are relevant to the related context, assert meaning		the 'Interpretive social sciences.'
		Narrowly pragmatic Facts beyond the expression are used to determine the meaning: e.g., indexicals determine the situational and socio-cultural contexts or what is socially acceptable (Marsen, 2008) Relevance theory (Carston & Powell, 2006; Sperber & Wilson, 1986; Wedgwood, 2007) A fact is linguistically determined but may refer to different meanings in different situations. Affordance-of-use validation: facts are worth interpreting and capable of being interpreted. The context explicatively informs constitutive meaning and contextual meaning constructed from the available contexts, i.e.,		

		facts of use (Ogden & Richards, 1923; Woodward, 2010)	
Philosophical orientations			
Literalist (Horwich, 2001)	Minimalism (Cappelen & Lepore, 2002)	Contextualism (Perry, 2017; Rast, 2007; Recanati, 1989; Recanati, 2004) bifurcation into weak contextualists, moderate and strong contextualism.	Subjectivism (Lawrence Neuman, 2014)
Constitutive meaning is a single assertion pre-agreed and assigned to single facts.		Constitutive meaning and contextual information, which directly relate to the fact, i.e., declarative of a narrow definition of concepts	Constitutive meaning is the particular explanation being part of the shared explanation.
Ontological orientations			
Meaning is the fact which is objectively real; determinable variant validated by a truth-value		The interpreter's hypothesis of meaning agrees with the interpretive demand either contextually and or socially.	
Epistemological orientations			
The sentence meaning **equals** the propositional meaning; meaning is assigned and represented by the symbol system.		The sentence's use **gives** a meaning, purely contextual or whatever the user specifies the symbols' meaning.	
Summative characteristics:			
static		dynamic	
Exceptions:			

Devitt (2013) argues that pragmatics is not a case of intentions inferred from semantically declared sentences but rather an interpretation process. He argues that the speaker/writer constitutes conventional meaning as expected from the lexico-grammatical governance, leaving the hearer/reader to *discover* the meaning by applying several processes to assign a meaning. He argues for a clear distinction between what constitutes meaning and its results from external processes, yet using the conventions contained in the constitutive parts of the proposition. Thus, a proposition's constitutive

> role is to set up a mental state using several meaning-making functions. This notion of mental state points to the product of the meaning-making process – meaning, and is similar to the mental file conceptualised by (Recanati, 2015)

> For Marsen (2008), interpretation is vital in deciding 'meaning', starting with the interpreter. The subject's experience is interpreted individually and merged, a semiosis process unaffected by truth or reality. Thus, meaning is much closer related to conceptual thinking. However, no theory of meaning is discussed.

4.1.3 Discussion

The above synthesis requires a more detailed discussion of these theories of meaning. The following outlines gaps or opportunities which may provide the early tenets for an emergent theory of meaning. The outline is diachronically time-lined, set into motion by the three distinct idiosyncratic classifications or validation types: truth-conditional [tc], acceptance [ac], and affordance [af], each distinguished by the superscripted indicator (Speaks, 2017).

1923 [af] - Back to the beginning. The extensive seminal work on meaning (Ogden & Richards, 1923) espouses semiotics with theories of meaning; accordingly, 'meaning' is about a theory of signs. Signs and thoughts are intertwined; an inescapable process relates the thinking about the object with the object of cognition. Interpretation is vital in the process to arrive at meaning. The sign being a stimulus for interpretation is influenced profoundly, contextually in a holistic sense at the first instance, which depends only on parts of the context in any subsequent cases of interpretation (Ogden & Richards, 1923, p. 53). Interpretation is instantiated due to the resurgence of whole or partial contexts. These can be construed as re-interpretations. The process is a continued resurgence of the contexts, which act as a referent in the form of one or more determinative contexts, in which case it is held together by a relation/cohesion.

1974 [tc] – The seminal work of (Putnam, 1974) addresses the problems facing the positivist's truth-value theories, which ignore two fundamental realities of life: everyday use of language and the societal differences that influence it. The positivists claim that meaning is merely a correlate between an expressions' "intension and extension" (referent) (Putnam, 1974, p. 709), i.e., an expression means (intension) whatever its referent (extension) is. The positivist rule is that if the intensions of two expressions bear the same relations, then the referent must be the same thing referred to; however, that is far from correct because it holds only in a context where the users know the relations between the meaning and the

referent. Truth-based or propositional semantics in opposition to natural language implies a binary end because, as Putnam (1974) explains, the positivist uses language like a "hammer or a screwdriver which can be used by one person; and then there are tools like a steamship which require the cooperative activity of a number of persons … Words have been thought of too much on the model of the first." (Ibid., p. 706). Therefore, many users assume many uses (meanings) of the same referents, enabling the same token indexically, i.e., taking its meaning from the context to which it relates. Meaning is thus not a discovery from correlations because "…words in natural language are not generally 'yes-no" (Putnam, 1975a, p. 133), but the outcome of a process from which two or more come to a shared understanding "fixed by the community, including the experts, through a complex cooperative process" (Ibid., p.186).

2000 [ac] –   The notion of a preferred meaning (Levinson et al., 2000) appears, based on the Gricean model of implicatures (Ibid., p.13), mixed with a broad orientation of pragmatics. Preference considers implications as a phenomenon of the language used to be explained by meaning re-construction, opposing the Relevance Theorists' route who promote meaning as a cognitive instantiation of a pragmatic output from semantic input. The preference-theorist makes an essential claim that cultural influences are greater from a constructive point of view than 'use' itself; a faculty shared more common than any language user group, irrespective of cultural differences (Levinson et al., 2000, p. xiv). This theory's implication is defined as a generalised inference after considering supplementary attributions such as presumptions (background information). The rule is a sort of elimination by inversion or generalisation by expected implication, e.g., a type of syllogism with the difference that it always results in a generalisation:

(1) A looks like a B

(2) Some B's are like C

(3) <u>(Some B's are C's)</u>

(4) Not all C's are like B's (preferred implication); therefore, this theory applies mainly to the generally accepted use of idiomatic expressions.

2003 [tc] –   In a paper by Woodruff Smith (2003), the primary thoughts of Husserl regarding meaning is discussed, which inevitably revolves around the phenomenological aspect. A phenomenon is considered an object of the mind, which logically describes and explains it, a logical semantic theory of meaning. However, Husserl refuses to instantiate

'meaning' as a psychological formation, maintaining that the phenomenon's shareability is based on an experienced reality.

   2004 [ac] –   A 'use' theory of meaning based on the acceptance validation, i.e., the acceptance of sentence structure and properties that convince any competent user of the affordance of use, is proposed (Horwich, 2004). The theory, however, does not address changes in the pragmatic or contextual import. Instead, it purports a literal theory of meaning: the totality of what attributions constitute meaning and other facts explain a phenomenon of acceptance. The relationship between phenomenon and theory is enunciated in this work.

   2006 [ac] –   A different approach is evident in explaining the principle of composition (Jaszczolt, 2006), which consolidates the lexico-grammatical form and function, and contextual imports into one whole (Jaszczolt, 2010), processing both truth-value or truth-
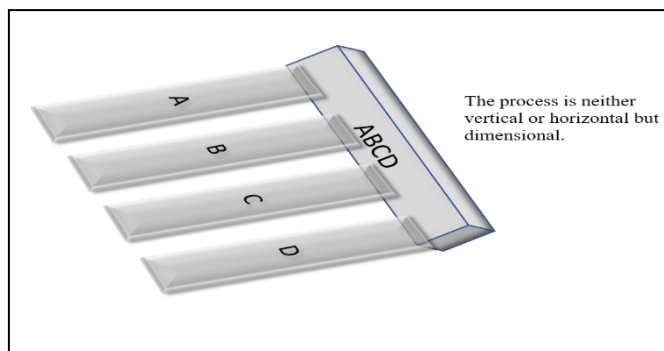
**Figure 3: An adaptation of the 2-dimensional theory
of meaning**

conditional expressions and implicatures. Thus, this theory's meaning is a composite of the partial meanings output from the various sources: lexico-grammatical, pragmatics, general cognitive, and sociocultural influences (Figure 3 adapted for illustration purposes). However, the process is not boundaryless; conditions bind A-D together. Thus, the theory opposes proponents of the atomistic (decomposition) theory of meaning.

   2007 [ac] –   An inferential-based theory of meaning explicating a dialogue's coherence, validated by logic (Piwek, 2007). Meaning is inferred conditionally from the partial variants (lower inferences), which match a global variant (higher inference). For example, suppose 'rain' is present and 'a wet object', then from the meaning of the global variant 'rain,' the object is 'wet' by inference from the matching meaning. The theory takes no cognisance of the actuality of propositions like this—the theory ring-fences both reality and beliefs favouring logical relation.

2010 [af] –   This use theory of meaning presupposes that language use's human intentionality enables meaning-making between technical and non-technical language users (Rauti, 2010). The argument opposes other proponents of use theories that it claims cannot explain the fragmentation of partial meaning within the context of multiple users' interpretive individuality to accomplish shared meaning. A basic heuristic of meaning-making is demonstrated: a shared environment in which the same object is situated or observed does not certify the same meaning from use because use can be individualized *per se*. Similarly, it opposes general use theories of meaning (UTM (Horwich, 2004)) regularities of use and where such use is accepted for its particular use. The first premise defers meaning as a correction of use by the addressee, an expert user, upon receiving an incorrect use; henceforth, a shared meaning results from the corrective use (Rauti, 2010). This theory, like the previous one, negates reality, e.g., the use of 'if' statements is problematic because it allows a gap in the practicability of the theory; how it explains the notion that a user who can defer meaning for correction even though the corrective source is fictional? The theory claims that all that is necessary is for such a resource to be possible.

2013 [af] -   The atomistic theory of meaning is under attack for its failure to uphold its claim to self-explanation. It postulates that neither linguistics nor cognitive expression needs other expressions to make its meaning known (Sethy, 2013). Thus, each concept or sentence carries its sense/meaning, which implies the expression's referent. The expression correlates with the referential phenomenon. This attack is primarily against the propositional semantic theories of Frege and Tarski. A particular claim is that atomism cannot explain the complexities of interpretive possibilities associated with an expression, apart from analytic or synthetic expressions, i.e., expressions that state an apparent binary (true/false) via validation. This kind of theory (semantic) requires a finite set of possible explanations. Sethy (2013) argues that meaning is decided from the reciprocation of interconnected sentences, which only a holistic approach to meaning makes tenable.

Whereas the thesis attempts to develop a theory of meaning, it seems appropriate at this stage to enunciate a preliminary statement and validation type for such a theory, under the pretext that the emergent theory shall espouse them in detail through the design and development phases:

A usable meaning theory [af]*: the reciprocation of linguistic-cognitive explanations for one or more interpretations of a particular phenomenon or class of phenomena.*

The use of the words 'one or more' alludes to the notion of reciprocation, which in terms of *one* means the reflexive function of dialogue: 'self-talk' (Weigand, 2016). The reciprocation of interpretations further alludes to how meaning-making relates to or explains the phenomenon.

A notable omission observed from the works discussed above is a definition of meaning. Besides one explanation of meaning, none other could be found among the different orientations. All say something about what meaning is and how it is produced. The single definition comes from a semiotics perspective as "the judgment and evaluation of an object, word or phenomenon that leads us to see, feel and understand this object, word or phenomenon in a certain way" (Marsen, 2008, p. 2).

Therefore, the researcher attempts an intuitive definition of meaning at this early stage in the thesis as a form of contextualisation (positioning it for later re-interpretation): **meaning is the interpretive consequence of a linguistic-cognitive dialogue in [a] particular context(s)**. A subsequent definition must be added to explain interpretive consequence as the referent (a yield, product, impact or significance). The primary description alludes to arriving at a goal via the means of interpretation and dialogue.

4.1.4 Conclusion

Theme 1 dealt exclusively with the scope of theories of meaning to circumscribe the boundaries of kernel and reference theories applicable to a review of the central notion of language 'use' and meaning as phenomena. Two categories of theories surfaced, indexing the scope of the various thinking paradigms/orientations/worldviews: constitutive theories of meaning and interpretive theories of meaning. These represent several views on the location of meaning. The theme ends with a pre-emptive statement of what type of validation the emergent theory of meaning may pronounce. This synthesis illustrated the outcomes of the different thinking paradigms on meaning across a broad disciplinary spectrum. What meaning is and how it is obtained features three types of validation criteria. On the far left of the spectrum sits the positivist orientation ensconced within the parameter of semantic-meaning enforcement. On the far right sits the liberated few ensconced in societal acceptance. However, it seems that a pragmatic approach moves away from enforcement to affordance via the middle ground of contextual influence. The middle ground, although

initially broad, merges assertion and inference, moving away from a sensitivity to the factual context to dependence on the context in the broadest sense.

The golden thread throughout the discussion illuminates 'use' in one form or other, whether strictly semantically validated or loosely accepted. The difference, it seems, lies in the linguistic-cognitive employment of use. At the positivist end, use is where the semantics (predetermined meaning) fixes the linguistic-cognitive outcome. At the other end, use is also where the societal influence determines the individual's linguistic-cognitive outcome. **The middle ground of narrow pragmatics affords a linguistic-cognitive movement, a reciprocation between the two extremes made possible by validating the interpretations of context-dependent constructions.**

In the first section of the next chapter, use is situated in a problem (the phenomenon of interest). In the subsequent section, the cause of the problem is investigated. The dilemma of increasing complexity and multiplicity in form and function are the main foci of Chapter 5.

5 CHAPTER 5: THEME 2: 'USE' PROBLEMATISED
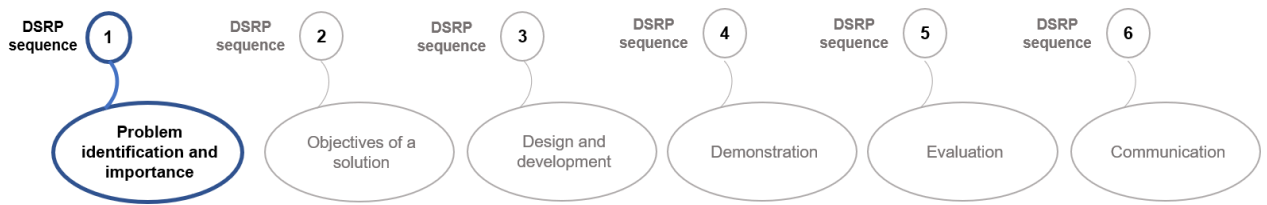
5.1 POOR REQUIREMENTS SPECIFICATIONS: A SYSTEMATIC LITERATURE REVIEW
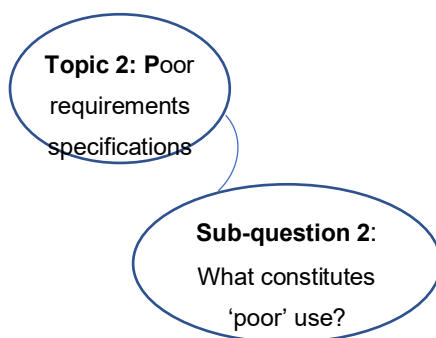
5.1.1 Introduction

"What do you mean?" is an expression often heard during informal, semi-formal or formal conversations. The problem with dialogue is that even when the utmost care is taken in selecting words, some meaning is lost in conversation. It gets even worse if the conversation is afterwards documented. The difficulty is to express what is to be conveyed to the mind of another participating conversationalist. Meaning can be expressed in three possible ways:

- A denotation or domain-defined meaning,
- a connotation or possible inference or
- a contextually dependent reference or indexical.

These possibilities are known to be contentious affairs in verbal communication. When these contentions are subsequently transferred into an artefact, the argument becomes exacerbated by a loss of meaning in translation. Since information systems and the related disciplines (computer science, software engineering and design science) are interested in artefacts per

se (Iivari, 2019), it makes sense to pay special attention to the artefact's whole and partial perspectives.

Additionally, the artefact with which the discipline is concerned is simultaneously whole and partial. As an entire specification in computer science, the artefact acts as an informant for the instantiation of design (Iivari, 2019, pp. 3,4). In design science, the artefact culminates in the theoretical knowledge or contribution to improving the discipline (Gregor & Hevner, 2013). As a partial artefact such as a use case narrative or diagram, the artefact specifies a singularity, which may be theorised in a design science context. An artefact plays a definitive role in both disciplines; both produce an artefact of significance during distinctive processes. In the former's case, it is during the requirements engineering process (Van Lamsweerde, 2000), and in the latter, it is during theory development (Peffers et al., 2006).

Requirements engineering concerns the specific activities of gathering, eliciting, analysing, specifying, documenting and evaluating requirements (Van Lamsweerde, 2000, p. 6). This review favours the fourth activity (specifying requirements) as the point of intersection with design science. The intersection between the processes can be explained by examining how the requirements specification relates to design science. Inherently, it contains both design and science: the specification uses scientific principles, techniques and methods to articulate or express requirements via language constructs and models to inform the design of later instantiations (the working software). In design science as a discipline, the artefacts are categorised as constructs, models, methods and instantiations (Langenfeld, Post, & Podelski, 2016; Sangupamba Mwilu, Comyn-Wattiau, & Prat, 2016). The intersection can be presented visually (below).
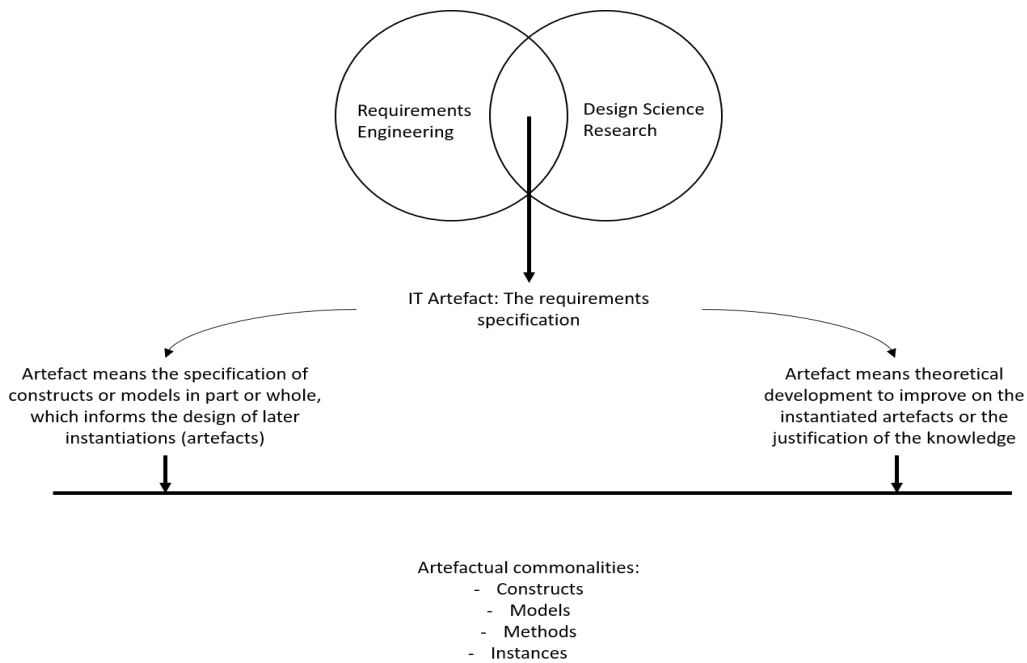
Figure 4: The artefact as the intersection between the engineering practice and research

The question raised in this review is whether an artefact means the same thing to both these disciplines. For example, does it refer to a whole document, or does it refer to parts of the document? These questions stem from a phrase prominent in the current literature that describes the artefact's quality. Since the artefact concerns both practice and research, "poor requirements" pre-empts a concerned interest. If indeed the artefact is poor, the presumption is that, in both disciplines, it means a degree of delimiting effect. These synonyms shall subsequently be used interchangeably. This review concerns itself with finding out to what degree the literature evidence delimits.

The artefact seems limited by definition, but one senses that other delimitations are possible from the expression: poor requirements specifications. The possibility is due to one's perspective, which surfaces via shifting the word "poor". One perspective is (poor) + (requirements specifications), which assigns "poor" as an attribute of the artefact as a whole product, i.e. the "specification" document. Another perspective is (poor requirements) + (specifications), which points to the constitutive parts that make up the document, i.e. the content. Finally, a third possibility of the word "poor" refers to something abstract, only determinable by extending the inquiry to an abstract context, e.g. a phenomenon or class of phenomenon.

The above sets the contextual boundary of this inquisitive systematic literature review in which this phrase is situated. The review's objective is to inquire into the phrase's possible meaning(s) to illustrate the intersection of the two disciplines and their significance to practice and research.

5.1.2 The systematic review protocol

The systematic literature review is an in-depth study into the prevalence of the phrase, which continues to dominate academia and practice. The purpose of the systematic literature review is to position a delimited question of interest to a research community within a literature selection for critical analysis (Dewey & Drahota, 2016).

5.1.3 Scope (selection of papers)

Since the phrase is exhaustively researched in information systems literature, the scope is delimited to the requirements specification as the intersection product, i.e. a whole artefact (e.g. a document). However, this review delimited explicitly to the components or partial artefacts used to produce the whole artefact, i.e. language constructs and models (Gregor & Hevner, 2013; Sangupamba Mwilu et al., 2016).

Therefore, the review inquires about using constructs and models (e.g. texts or notations or model fragments) as the requirements. Aligned with the phrase and the main question (below), the importance of answering the central question for academic and practical use (contribution) is to know why this issue remains, what the effect is on artefact production, and how it could impact the respective disciplines.

The database selected for the phrasal search was Google Scholar, as it accepts Boolean constructed search strings and extends to whole phrases. A funnelled application of the search string was applied because the 18 100 articles returned from the initial phrasal string "poor requirements specification in requirements engineering", covering the range of 2000–2020.

However, as mentioned in the preceding section, the paper's focus and main question alleviate some of the burdens of such a high number of articles by shifting the phrase as follows:

- ("poor requirements" and "specifications") – 1 530

- ("poor requirements" and "requirements engineering") – 1 110

- ("poor requirements" and "specifications" and "requirements engineering") – 768

5.1.4 Research gap and question

This inquiry intends to answer the following central question:

In what way does "poor" define requirements specifications?

Does the inquiry consider whether this question points to a preferred meaning or delineation? Does it refer to the use of partial artefacts? I.e., the constructs and models as defined in section 1 (from now on mutually referred to as "the language-of-use"). Subsequently, two related sub-questions can be asked:

What delimits the artefacts (partial and whole) for it to be considered poor?
How does the delimitation affect the two disciplines?

The meaning of the word poor must be answered by the artefacts used within the disciplines, which is the focal point in both cases. Thus, the use of the word "poor" points to whatever it references. Said otherwise: poor requirements specifications could mean poor artefacts, which in this review are the language-of-use; thus, one can say poor language-of-use or poor use of constructs or models.

The language-of-use in current literature focuses on the attributes, synonyms, or references used to define "poor". Delineation at first glance seems to denote the fixing of meaning via the use of particular constructs and models, such as taxonomies and ontologies, among others, which have their meaning informally, semi-formally or formally controlled. However, decades later, the same delimitations remain. Could it be that the reason for its diachronic prevalence is a gap in the approach to the problem? What if the delimitations are not constructive (natural language text) ambivalence or perceived modelling rigour? This review aims to inquire which it is.

The purpose of delineating the research question is to prove that it is essential to academia and valuable in practice. The question's importance could be proposed by merely considering an antonym of "poor", which would prove a too naïve interest to scholars. However, if some satisficing criteria could validate such a description, some credibility is established. The definition of satisficing criteria (Simon, 2019) is practical to both practice and research. In this regard, both disciplines have design, science and artefact in common; all have objective

criteria for their validation. Design is the abstract specification of requirements using the artefacts explained earlier; science implements the design specification (Van Lamsweerde, 2000) using principles, methodologies, and techniques, subject to either human adjudication and qualification or formal assessment by automated tooling. Academics are privileged to theorise about the outcomes of a systematic review, and practitioners are enabled with helpful knowledge.

Despite each specifying its particular acceptance criteria, the prevalence of the research question and initial search results forces the second requirement for this review, stating how the answer extends the body of knowledge and impacts current practice. Practitioners need to know why poorness prevails in specifications since project failure, and its consequential monetised impact is well documented. Academics are informed as to the theoretical underpinnings and gaps in the current research.

5.1.5 Search process

The search process is depicted as a two-way keyword-based search (Figure 5). The following sources were selected apart from the initial inquiry:

- EBSCOhost (https://www.ebsco.com/products/ebscohost-research-platform)
- IEEE Xplore (https://www.ieeexplore.ieee.org)
- Google Scholar (https://scholar.google.com/)
- Science Direct (https://www.sciencedirect.com/)
- Springer (https://link.springer.com/)

Contextual search is the *poor* notion in discipline "**Requirements Engineering**"

(Title, Keyword, and Abstract) has **poor requirements**

("poor requirements" AND "specifications" AND "requirements engineering")

N = 768

Excl. criteria (without the words "projects"

N = 178

Incl. criteria (> 50 citations, and exact words "defects", "errors", "smells,")

N = 9

Note: 6/11 has ambiguity focus, i.e., 60%

Contextual search is the *ambiguity* notion in "requirements specifications"

(Title, Keyword, and Abstract) has **ambiguity; linguistic or engineering**

("ambiguity" AND "requirements specifications" AND "requirements engineering")

N = 2980

Excl. criteria (without the words "tool, method"

N = 159

Incl. criteria (> 50 citations)

N = 46 (+ 15 deviations)

Add to data collection form

N = 70

Figure 5: Two-way search process

5.1.6 Inclusion and exclusion criteria

Due to the size of works retrieved from the phrasal strings "poor requirements specifications" and the two distinct search strings, the decision was made to include only works with more than 50 citations, which – although arbitrary – was selected as it indicates a level of seniority and use of the work. This stringent qualifier resulted in approximately 55 studies between the two searches suggesting the problem's popularity, if not the severity. Therefore, the selected works were all included with full text.

The first search string positioned the term "poor" within the process's context (requirements engineering). The second search string placed the term ambiguity within the context of the whole artefact as a requirements specification. The reason is two-fold: Ambiguity appeared around 4 420 times throughout the initial works retrieved, and ambiguity relates directly to the partial artefacts (constructs and models) within a specification (the document artefact). Although the delimitation of the search to title, keywords, abstract, and the number of citations bracketed the results, the severity of the problem necessitates scrutinising the full text of the remaining works.

The exclusion criteria are as follows: the term "projects" was marked for the first search, which disallowed works in which "poor" related to project outcomes. A similar exclusion was made for the second search, disallowing both the terms "tool" and "method" because the focus of the inquiry is on language use, i.e. linguistic constructs and models. In addition, papers appearing more than once due to different reference types or extensions of documents were excluded. In both search methods, references to books were excluded, despite the topic and research question being well documented in authoritative works, e.g. A Sutcliffe, K Wiegers and J Beatty, C Wohlin and J Dick, E Hull, and K Jackson. Finally, any literature not in the English language was excluded.

5.1.7 Quality assessment

As this review is a single researcher review, the following assessment criteria were used to ensure the quality of the study:

- A simple publication metric was used: the number of citations and the number of research articles versus review articles; author status, i.e., the first author and citations indicate seniority. The Scopus H-Index was also used, selecting those authors with the highest scores.
- The types of papers included in the search are mainly peer-reviewed articles, conference proceedings (e.g., FIT, EmpiRE, IRCE, RE, ACM, AIRE, ISSREW), lecture notes from mainstream journals, and published papers theses.
- The validation assessment was done according to the study's strength, i.e., the method used to confirm the study findings. A single-letter code indicates the validation of each selected study as follows: empirical evidence/experiential

demonstration [E]; case study/field study/participative study [S]; demonstration other than experiential [D]; illustration/exemplars [I]; and conceptual/theoretical [T].

5.1.8 Data collection

The selected works were collected using the following profile (adapted from Walia & Carver, 2009, p. 1092)

Table 12: Data collection form

Data items	Description
Theme	A contextual descriptor identifying the common interest of the researcher(s)
Citations	The number of citations retrieved by Google Scholar
Scopus H-index	A measure of the author's productivity and scholarly impact
Identifier	Complete reference of the authorship
Year of publication	Year in which the work was first published
Study origin or source	Data source from which the work was extracted
Concepts	What term is used to limit the theme
Study aim or goal	What the goal of the study was: improvement or detection
Validation	How the study was validated, e.g. case study, experiment
Objective interpretations[2]	The author's interpretations (including gaps or remaining issues)

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[2] Reference in section 3.2 as a guide for the synthesis of the data.

5.1.9   Data analysis

An inductive thematic analysis (Braun & Clarke, 2020) was employed for this review, guided by the two sub-questions. The analysis takes on a conceptual theme due to the associated concepts related to the central question. The corpus of works displays a high association of synonyms used for the idea of "poor" (taken into consideration in the search). The literature is reviewed using topic-related concepts to inquire about the delimitation of the term "poor". It associates the solution and artefact type with many possible reasons for such delimitation. The inclusion of gaps provides an additional resource for finding and analysing potential relationships between the concepts. The tabularized version of the thematic analysis provides a visual synthesis of the data collection (*Appendix B: A synthesis of the literature on poor requirements specifications*), different from current presentations such as taxonomies, frameworks, checklists, meta-models and ontologies; the list goes on. The thematisation of the data differentiates via contextualisation rather than description, categorisation or classification.

5.1.10 Results

The results and synthesis are done starting with a breakdown of the selected works across the data sources, followed by intentional deviations and a synthesis of the works, including which group of works answered which research question.

5.1.10.1   The search results

The first search string acted as a generalisation of the research question and was therefore used to search in Google Scholar to return the broadest studies on the topic of "poor". The string was refined using the advanced option in Google Scholar by employing "with the **exact phrase**", "with **at least** one of the words", and "**without** the words" as delimiters. The initial retrieval decreased from 1 310 to 178 candidates. From those, a total of 70 (see Appendix B) were selected for review and analysis. The second search string returns papers specifically associated with the most prevalent concept and its relation to requirements specification as a whole artefact: ambiguity. The string ("ambiguity" and "requirements specifications" and "requirements engineering" – tools, methods) was unrefined further, and the search returned 159 papers, of which 46 qualified for review.

Table 13: Sources of studies and distribution of selected studies

Source	Number of selected studies
Google Scholar	35
EBSCOhost	30
IEEE Xplore	10
Springer Link	8
Science Direct	4
Studies in compliance with the protocol	55
Studies deviating from the protocol	15
Total studies selected for review	**70**

After studying the works returned from the search, it was noticed that pertinent concepts appeared in the studies, which suggested a separation of concerns: poor requirements (Table A.1) and ambiguity in requirement specifications (Appendix B, Table A.2). A further but directly related separation concerns systematic literature reviews (specifically introduced), design science and human error theories (not to be confused with the concept of error found as a delimiter of poor). It connotes a cause of poor and is therefore included in the comprehensive studies presented in this review. These concerns may be strictly seen deviations (Appendix B, Table A.3, Table A.4 and Table A.5), but their relevance is apparent to the main question and the sub-questions.

5.1.10.2   Deviation from protocol

The intentional deviation from the standard protocol includes three themes (across 15 studies) based on relevance, which surfaced prominently as derivations from the second search string. Five systematic literature reviews related to the search string ("systematic literature review" and "requirements specifications" – error, challenge); four works related to human error theories (HET) were extracted using the search string ("human error theories" and "requirements specifications"). Seven works about design science were included using the search string ("design science" and "requirements specifications"). In these last cases, the citation count was ignored.

5.1.10.3   Data synthesis

The synthesis of the selected works is thematic, which points to the contextualisation of the central question and identified gap. The synthesis is structured thematically. The central theme remains language use. Van Lamsweerde and Letier (2000) ascribe linguistic ambiguity as a possible delimitation of "poor". The analysis of the gaps relates to the central theme by way of abstraction. One finds several references to "complexity" and "multiplicity". The rest refers indexically to the heuristic themes explicated as deviations, e.g., "human error" and "human intervention".

The inclusion of the four systematic literature reviews (studies 57–59, Table A.3) indicates a pronounced interest in the notion of "poor" and its delimitations. Taxonomy demonstrates delimitations as addressing defects of translating models into text (Nicolás & Toval, 2009) or aspects of human error (Anu, Hu, Carver, Walia, & Bradshaw, 2018; Walia & Carver, 2009) or multi-faceted challenges in scaled agile (Dikert, Paasivaara, & Lassenius, 2016). All four taxonomies found "poor" delimited by the constructs or models used; all found an improvement goal. From the gaps analysed, one can abstract (indexically) which points to complexity, whichever solution was proposed (in most cases a taxonomy).

Theme 1 (studies 1-9, Appendix B, Table A.1) concerns poor requirements, which delimits use to a "defect", "error", "fault", "smell" or "ambiguity". All the delimitations are found to have similar attributes ascribed to them. However, the list is not complete: inconsistent, incomplete, inaccurate, deficient, vague, imprecise and omitted. Simple statistics can illustrate the gravity of these delimitations. Defects account for 78% of the nine studies, with errors and faults making up the remainder in equal share. As previously mentioned, ambiguity, split between linguistics or engineering, is prominent in the findings included in this theme, except for three, which indicate cognitive factors as the delimitation (Castañeda, Ballejos, Caliusco, & Galli, 2010; Kamata & Tamai, 2007; van Lamsweerde, 2009). The common denotation ascribed across the studies is one of failure: unstructured use (Asghar & Umar, 2010; Van Lamsweerde, 2000), non-compliance (Katina, Keating, & Ra'ed, 2014; van Lamsweerde, 2009; Van Lamsweerde & Letier, 2002; Yang, Willis, De Roeck, & Nuseibeh, 2010) and imprecision (Castañeda et al., 2010; Kaiya & Saeki, 2006), except for human incompetence (Katina et al., 2014). Noticeably, the effect of these delimitations connotes the unquantifiability of the delimitation. The abstract meaning of the delimitations can be summed up in the notion

of multiplicity: of solutions required, of interpretations possible, of additional issues, of limitations both systemic and human.

Theme 2 (studies 10–55, Appendix B, Table A.2) concerns ambiguity specifically; the most prevalent delimiter of use and the only one directly associated with constructs and model artefacts. The outcomes are visualised, showing the percentage of association between delimiter and artefact type. The gaps analysed in the constructs (Figure 6) converge on the heuristic of **human error**. In addition, they take on the characteristics of interpretive issues that rank the highest from others, such as a certain level of expertise needed for interpretations, different views of the problem or solution, stakeholder diversity, and the gap between text and notation language-of-use, i.e. multiple expressions.
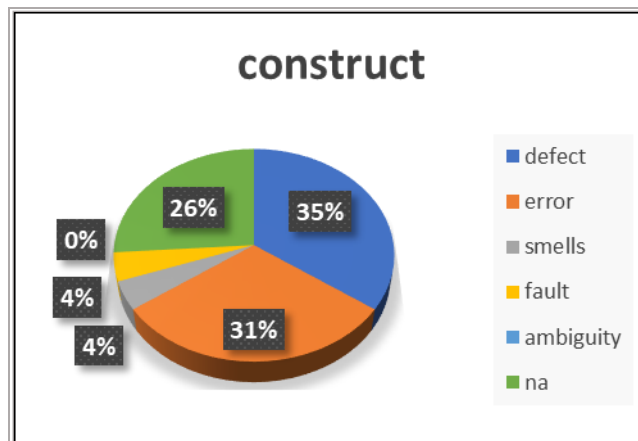
Figure 6: Synthesis of the construct's delimitations

According to the studies, the delimiters' distribution in the model appears similar if one accepts that the individual delimiters, according to the studies, seem to connote "ambiguity". Models refer to representations of the constructs, e.g. a use case narrative and a use case diagram. There is, therefore, an implicit link. This assumption is discharged considering that linguistic ambiguity is associated with 82% and engineering ambiguity with nearly 38% of the total
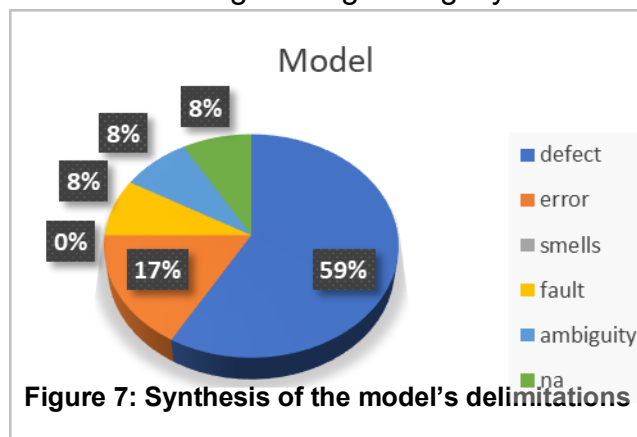
Figure 7: Synthesis of the model's delimitations

ambiguity cases (i.e. 35% in Figure 6). Thus, the percentile oddity is due to some instances in both categories of ambiguity as a delimiter.

The gaps analysed in the case of models (Figure 7) summarise the human intervention heuristic. This theme encapsulates characteristics such as understanding multiple models, correcting linguistic and engineering errors, multiple interpretations, and the expertise needed to interpret multiple interpretations (Te'Eni, 2001). An exception to this heuristic is a cognitive bias (Ralph, 2013) and an alternative approach to requirements representation as designs (Lawrence, Wiegers, & Ebert, 2001)

The third theme, human error theories (studies 60-63, Appendix B, Table A.4), derives from the primary studies, an observation that prompted its inclusion in this review, i.e., reference to theories of or about human error. Although only four papers are included, 75% found "error" (Figure 8) as the delimiter associated with the language-of-use. In contrast to the preceding themes, the association is not as expected, but here it is strongly associated with cognition, the **mental model** heuristic of the artefact.

The papers reviewed in this context found cognitive errors as the main delimiter. The gaps from these papers correlate with multiplicity and complexity in Theme 1 and the overbearing reference to human intervention in Theme 2.
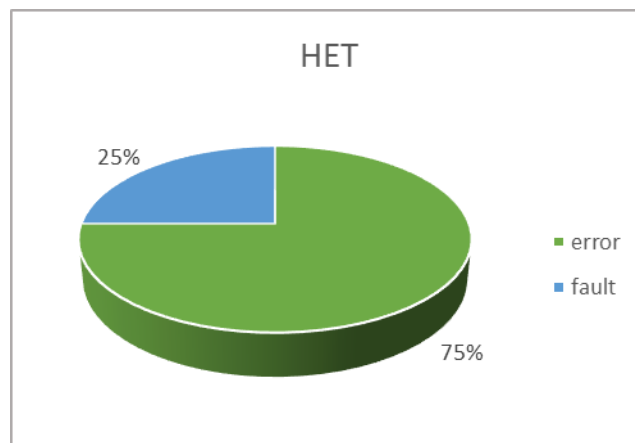
Figure 8: Synthesis of the Human Error Theories

This theory can be synthesised according to the gaps of human error in the context of failed attention to requirements as exceptional scenarios (Firesmith, 2004), failed attention to

users' misguided perceptions about requirements (Feather, 2008) and persistent analytical errors (Alspaugh & Antón, 2008).

The final theme is Design science research (studies 64–70, Appendix B, Table A.5). The main research question is illuminated in experiments, case studies, field studies and demonstrations. Most notably, the studies represent literature from requirements engineering practice. The final theme has at its core to do with theorising about aspects, concepts, problems or unresolved issues recorded in practice, so it seems from the seven studies reviewed under this theme. Table 14 tabularizes the associations, which appear to be closely related.

Table 14: Current design science research that relates to this review's themes

Citation number	Theory of use: topic	Studies associated with the theory topic
71	How to use ambiguity in design science	[6], [10], [13], [14], [20], [21], [29], [30], [33], [51] and [55]
72	The expressiveness of natural language does not improve visualisation or conceptualisation	[3], [31], [36], [46], [47], [48] and [49]
73	Improvement or detection method of semantic relations	[16], [27], [42] and [54]
74	Using indexicals to pair relations in sentences	[8], [43] and [45]
76	Multi-perspective approach to resolve interpretive gaps	[1], [2], [15], [19], [23], [24], [28], [37] and [53]
77	Ambiguity addressed by static forms; needs conversational dynamics	[4], [5], [8], [40] and [52]

5.1.11 Discussion

It becomes clear from the preceding analysis that a distinctive feature appears, which points to use; human use. In this review, 'use' is delimited to constructs and models; the language-

of-use associated with a delimiter, i.e. industry and academic reference ascribed to tokenise the term "poor". The analysis determines that delimiters such as a defect, error, fault, smell or ambiguity denote poor requirements. A general connotation of imprecision, inconsistency, incompleteness, inaccuracy and vagueness supplements the denotation. The centrality of these works revolves around two concepts – **complexity and multiplicity** – which, although they do not denote "poor", give rise to the inference that the language of use may cause the delimitations. It seems plausible that constructs or models over time have become complex, causing the human error to increase due to multiplicity. Multiplicity is a common denominator for ascribing the need for multiple solutions, the issue of multiple interpretations and stakeholder views (inclusive of beliefs and stakeholder opinions). Hidden in these works is an indexical, a token that relies on the works' context as a whole: the dominating world view, which is mainly positivist. This inference is plausible due to the static constructs or models recommended as solutions: ontologies, taxonomies, semi-formal and formal constructs, and the over-specification of quantifiable models.

Ambiguity, which is indicated as a delimiter in Theme 2 due to the explicit and extensive attention in the literature, explains the need for continued human intervention. The majority of the literature finds that constructs and models can only partially solve poor use. Additionally, they point out that the only comprehensive resolution is acquiring or re-acquiring the interpretation of the original interpreter, i.e. the user, author or requirements engineer. The common denominator in this compilation of works is not as expected between the multiple constructs or models but rather the interpretive gap between human user categories. Examples of the interpretive gap are the levels of expertise (Berry & Kamsties, 2005; Denger, Berry, & Kamsties, 2003), the elusive mutual understanding (Fabbrini, Fusani, Gnesi, & Lami, 2001b), multiple interpretations (Berry & Kamsties, 2005), and specific complex issues even in use case models (dos Santos Soares, Vrancken, & Verbraeck, 2011).

Some researchers offer refreshing alternatives regarding the relationship between the problem and theories, including human error and design science. They find the idea that requirements are discoverable a cognitive bias. Both user and developer misinterpretation occur due to the failed further exploration of possible meanings, which signals further theorising about the role played by human cognition in developing requirements. It is

conceivable that if thinking is compromised, so too will be the expression of requirements, irrespective of its language. Another view is to represent or specify requirements as designs, i.e., an immediate design focus or implication (Lawrence et al., 2001). One paper aligned with the literature on a theorising objective of design science claims that industry practice and theory are too far removed from one another to fully reciprocate the insights gained respectively (Firesmith, 2007). The cited studies on human error theories corroborate multiplicity and complexity, joined with the human cognitive factor. Although current design theories do not directly address poor requirements, it is encouraging that, among them, some consider how to intentionally use a delimiter such as ambiguity (Baskerville & Pries-Heje, 2001). Others think about better visual constructs (Lucassen, 2017), and some concertedly address the multiple stakeholder views and interpretive complexity issues (Bjarnason, Sharp, & Regnell, 2019). One exception to the studies mentioned here offers contextualisation as a counter to ambiguity (Bäumer & Geierhos, 2018). Unfortunately, contextualisation is undefined and merely suggests that a predefined process, contextualisation, has been executed. The context's role in this study is sentence-based, which serves as a linguistic trigger that identifies ambiguities at the sentence level only.

5.1.12 Conclusion

Theme 2 dealt mainly with the sub-questions arising from the problem statement illuminating the researcher's interest in the specific phenomenon in requirements specifications known as poor requirements specifications. The systematic review exposed an apparent problem, which shows up in various mainstream objectivist/computational approaches, without effectively dealing with the situation. The study illustrated a relationship between design and science. An artefact is a focal intersection, specifically delineating an artefact to the constitutive objects of language used in constructing a requirements specification: natural language text and graphical notation. The subsequent detailed review of the literature featured three main delineations of the notion of 'poor': linguistic and engineering ambiguity and human cognitive error, which illustrates the ineffective use of language's current form and function. The conclusion unequivocally pointed to increasing complexity and multiplicity, which seem unresolved. As illustrated in the preceding study, the systematic review initiated the sub-question of causation: the factors causing the overall effects. The following section elaborates on the theme of causation.

5.2   THE DILEMMA OF THE CURRENT 'USE': A DIALECTICAL INQUIRY

5.2.1 Introduction

This topic continues the initial evaluations on poor requirements specifications concluding 'poor' to be a *wicked* problem of **complexity** and **multiplicity**, centralized in the language of use. These evaluations postulate a series of dichotomies: approaches, oppositions of views, lack of assumptive mutuality, and interpretive conflicts (Denley, 1999, p. 60). Further, they are characterized by the failure of worldviews to recognize the current approaches' ineffectiveness, the dilemma of the remaining gaps in language use, and human failures: cognitive and otherwise. Simply put, these attributions will be considered the phenomenon of interest: wicked(ness).

The central theme attributes the current 'use' as wicked, i.e., in applying the constructs and models to express the human need to address the complexity and multiplicity of these attributions. Thus, the researcher raises a question about using language: '**what causes this *wicked(ness)*?**

Notably, from the above, one observes ascriptions to *wicked* such as conflict, opposition and dichotomous. Hence, it seems plausible that the process of inquiry into *wicked* should be characterised similarly. The Dialectical Inquiry, which synthesizes contradictions, ambiguities and paradoxes (Denley, 1999), pre-emptively fits the criteria. The dialectic (the essence of the process) ensures dialogue between opposing views and a resulting synthesis emerging from such dialogue. This aim collaborates directly with the primary notions put forth by Denley (1999).

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Roman Jakobson (Herbert, 2013) believes that concerning the central theme of 'use', the essential features are **referentiality, relatedness (cohesion) and context**. Together with poetic, passionate, conative, and meta-lingual (meaning), they ultimately affect communication. The essence of language use in communication is to make and transfer meaning, employing two continuously reciprocating operations: **dialogue** and **interpretation**. Respectively, the text and notation can be seen as a [text] dialogical operation. At the same time, users' understanding can be seen as the interpretative operation. This paper explains the contradictions apparent from the current 'use' of these features. It consolidates them into a novel synthesis with 'meaning' as the hypothetical product – a view with which the researcher affiliates.

The rest of the review is structured as follows. The following section explains the adoption of dialectical inquiry as a qualitative research method designed to extract and compare opposing theoretical views of wicked.

In the next section, the dialectic process is used to structure the dialectic as a triadic reflection, debate and post-reflection. Post-reflection refers to speculation of a sort; in this case, the researcher's hypothetical resolution (Holzapfel, 2017). The first process reflects the notion of '*wicked*' (complexity and multiplicity) as a dilemma and ascribes characteristics construed as a class phenomenon. The second details the underlying orientation, which aims to expose this class's causes in the typical dialectical form of critique (or thesis) and counter-argument (anti-thesis) and aims to reclassify it. The third details a postulate or hypothetical counter to the apparent dilemma.

The discussion concludes with inferences from the previous sections, a brief justification of the hypothesis' significance, and a final summary.

5.2.2 The alternative review: a dialectical inquiry

An appropriate alternative to the current methods for literature review is the Dialectical Inquiry. A qualitative research method deals directly with the essence of the problem introduced above: complexity and multiplicity of language use. It considers the review process discovery of ambiguity, contradiction and paradox via a process that entails the dialectic as a means of inquiry (Denley, 1999). The dialectic has been exhibited in the

following ways: as a thesis-antithesis-synthesis (Berniker & Mcnabb, 2006); and triadic reasoning based on reflection, debate and speculation (Denley, 1999, p. 69).

Denley's (1999) triadic reasoning is applied to the review as a pre-reflection, and after that, observations (reflection), orientations (the dialectic), and an emergent hypothesis (post-reflection). Following the dialectic move's aim, the paper consolidates the opposing views and underlying assumptions for their possible contribution to *wicked* using literature from a multidisciplinary corpus of secondary peer-reviewed articles and conference proceedings over 2000-2020. It focuses on four different disciplines: computer science, linguistics, semiotics and systems science. These serve as a basis for the inquiry and illustrate the extent of the problem.

Subsequently, the review above exposes several closely related concepts, which aim to identify and describe the phenomenon-of-interest characteristics. After this task, the ideas are redefined and labelled uniquely so that a specific reference for 'use' emerges as the thesis advances. It is expected from this section that the movement of dialectical reasoning will feature a pre-reflection of various views of the current problem, a reflection on the complexity featuring the current problem, a debate of the causes of the current problem ('the argument'). Then a counter adaptation of the emergent orientation (the counter-argument)), and a post-reflection or speculative resolution.

5.2.3 Pre-reflection

An initial set of papers discussed next is dated before 2000 and serves as a pre-reflection or context of the discussion. Christel and Kang (1992) find that language appears in various interpretations and referential inequality, which pose problems in an analytical review when confronted with the fragments or parts of a design instead of the whole. Contini-Morava (1995) illustrates the issue by giving a dialectical account of two distinct orientations in language, respectively the generative-grammatical and sign-theoretical. The first regards language in terms of formalisms, i.e., fixed patterns or a deterministic structure according to which interpretation proceeds from the syntax. In opposition, sign theory claims that language is due to its *use* – a natural occurrence in which the form is determined by the meanings intended. These two views represent the spectrum of thinking paradigms regarding the use of language and allude to the exposition of assumptions, according to

Dent and Umpleby (1998). Al-Rawas and Easterbrook (1996) claim the delimitations on notations' expressiveness link directly to communicative problems. The limitation of formalisms and linguistic ambiguity links to language's social aspect (Goguen, 1996). In his view, information is a social affair, which means that mere representational efforts miss the fact that information is constructed and used socially. He makes a couple of claims about this observation. Among others, he finds that the effectiveness of informal use depends on situatedness (context). Further, that specific applications which necessitate the use formalisms are at least context-sensitive.

These four exemplars serve to summarise and (pre) reflect on the categories of issues portrayed as the *wicked* problem: Christel and Kang (1992) point out the misunderstanding or difficulties of understanding between various stakeholders closely related to ambiguity, fragmented structural relationships in the artefact, and the differences in language use in stakeholder communities. Contini-Morava (1995) believes the systematisation of language causes it to fragment during decomposition. Fragmentation continues to a single lexeme or part, each containing only a partial meaning. Jakobson and Guillaume, the proponents of systematisation, are greatly opposed by those who maintain that the whole always explains the fragment (Wiczak-Plisiecka, 2013). A field study (Al-Rawas & Easterbrook, 1996) finds evidence of the paradoxical display of language use and understanding between the user community and the developer community; and claim that notations (a type of formalism) in general exhibit significant restrictions in establishing understanding among users. The limitation of formalisms and linguistic ambiguity links to language's social aspect (Goguen, 1996).

Between 2000-2020 the literature exhibits consistency in reporting ambiguity, fragmentation and context (linguistic, situated, and social) over the entire timeline, with specific outliers worth mentioning. The first is De Bruijn and Dekkers (2010) finding that poor requirements are only a tertiary contributor in the context of project failure (outside the scope of this thesis). The second work is of particular interest as it concerns a current methodology, a set of principles rather, known as Agile, in which Ehlers (2011, pp. 23,24) finds three issues related to this thesis: a one-sided view of the problem being solved; the increasing complexity with increasing detail; and a neglect of the context of the socio-cultural diversity. Bures et al. (2012), amongst others, reiterate this last point. Anu et al. (2018), the third

authorship of interest, find human error attributable to mental/cognitive errors made ahead of the expression recorded in whatever form. Their view is opposed by Kiyavitskaya, Zeni, Mich, and Berry (2007), stating that the human remains the best solver of ambiguity found in a natural language even in the context of automation.

Another insightful work deals with requirements specifications from an automation and integration perspective, i.e., it claims that the understanding and comprehension problem can be solved by integrating the text and notation to reduce the efforts traditionally made to resolve these issues (Nicolás & Toval, 2009). This extensive systematic literature review of 62 works underwrites the references to system solutions and warrants some of the discussion's arguments. Concerning the use of language, the study explains a pertinent focus on the structure or form of the language, i.e., text or notation and the transfer of its implied function, e.g., a use, an activity, a process, a relationship or a rule. Furthermore, there is a relationship between form and function, e.g., a use case narrative or diagrammatic form functions to describe or represent the intended behaviour of the form. Further, such a use of language illustrates two of its features: the referential and the relational. Unfortunately, the context is noticeably underdetermined.

Furthermore, the use of language (Nicolás & Toval, 2009) appears paradoxical: language misses the objective, i.e., the focus on multiple forms and functions fails to understand the particular 'use' content. The authors infer the use of various forms across the literature corpus, e.g., text only, a mix between text and notation and ultimately notation only, but more specifically, the classification scheme proposed by Kuhn (2014). The review further warrants the claim that a natural language's expressiveness is supposedly advantageous. The paradox is that such a statement contrastingly circles back to the problem of inherent ambiguity. Another example is the claim to simplicity assigned to a formal language, which circles back to the restrictions of expressiveness and usability, i.e., very few stakeholders have the training to interpret it.

Finally, there are few references to either context or meaning (the third theme) in the literature. The thesis refers to the totality of the linguistic and non-linguistic context. The well-known 'system context diagram' used by analysts falls outside of the scope of this thesis. Goguen (1996), Kamsties and Peach (2000), Wolter, Śmiałek, Bildhauer, and Kaindl (2008)

and Faily et al. (2012) all suggest considering context. Still, only two authors make a concerted effort to accentuate the context-meaning relationship in language use. Rapaport (2005) insists that context changes the meaning of an expression, linguistic or otherwise. Ehlers (2011) categorically states that the prevailing one-sided orientation in computer science prevents context from taking its rightful place in addressing the problem.

5.2.4 Reflection

The first characteristic of *wickedness* is, as earlier mentioned, the '**use**' of the language. The concept includes **ambiguity**, which is an inhibiting factor to understanding *and meaning*. Hence, the multiple forms in requirements specifications, i.e., syntax, semantics, pragmatics, and other forms. Second, it includes **fragmentation**, which refers to two related concepts, a) the sometimes-conflicting relations between the forms used, i.e., text and notation, and b) the heterogeneous composition of stakeholders and the confusion exhibited in the interpretation of these forms (Holzapfel, 2017).

The second characteristic is the **focus** from which the use springs. Most of the literature insists upon some means of precision (rigour) to text or notation to solve ambiguity and fragmentation. However, such insistence subsumes the overarching focus on form and function. The minority is characterized by the addition or inclusion of context to the form and function. Both these foci may be ascribed to the underlying assumptions discussed next.

The third characteristic, the underlying **causation,** posits the paradigms of human thinking about requirements and the expressions of her understanding of a requirement. Two such views are broadly defined as 'the computational view and the linguistic view. These views usually align with a particular orientation towards phenomena or how phenomena are observed: realist or objectivist (computational), which holds that knowledge of the object is caused factually and produces facts, while the other favours the constructivist orientation (linguistic), which states that facts are interpretable only under certain contextual conditions. The reference to linguistics is towards the disciplines outside of computer science (the field reported by most literature). However, except for Rapaport (2005), even the linguistic views in the literature bends towards the same causal factors of the computational view; Ehlers (2011) categorically uses the terminology of one-sided view. The thesis then refers to this idiosyncrasy as the **unilateral view**.

The fourth characteristic is **paradoxicality**, which emerges from the literature multiple times: illustrated by references to opposing theoretical approaches to using language as either pragmatic or syntactic-semantic patterns. For example, Hanks, Knight, and Strunk (2001) find the language use ideal for semantics but problematic for computation and *vice versa*; yet, others such as Levina and Vaast (2006), Bartis and Mitev (2007), Kiyavitskaya et al. (2007), Marsen (2008) and Tack (2002) in some way refer to this phenomenon of paradoxicality as an intended conceptual equivalence, which in practice emerges as confusion or **uncertainty** experienced due to multiple interpretations. Sometimes this characteristic is closely related to a dialectic: opposing stances or views on the same subject. It can also be understood what the discipline of information systems presupposes, i.e., different views working together to solve the same problem. However, from the literature, it seems the former definition wins over the latter.

In summary, the phenomenon of interest, i.e., the wickedness of language use, can, therefore, be characterized as exhibiting ambiguity and fragmentation caused by a unilateral view of the world.

The counter to the paradox proposes to focus on the characteristic of 'use' because it circumscribes ambiguity and fragmentation, primary influencers of the use of language resulting in the wickedness attributed to the content of the requirements specification. The literature restricts language to either natural or formal or some in-between use described as semi-formal/hybrid. Natural language is predominantly ascribed as ambiguous. Vimalraj and Seema (2016) discuss several types or levels of ambiguity at length; lexical (unit level), syntactic (structural level), semantic (assigned explanation level) and pragmatic (use level). The poor use of language is further defined as follows: incomplete (Hanks et al., 2001), inherently imprecise and incomprehensive (Firesmith, 2007), misused (Berry, 2000; Garnier & Saint-Dizier, 2016), error-prone (Anu et al., 2018), vague (Rapaport, 2005), poor incomprehensibility (Asghar & Umar, 2010), poor writing skills (Van Lamsweerde, 2014), and a confusing range of expressions (Kuhn, 2014).

Most authors suggest enhancement as a solution: technical training, specialized glossaries, vocabularies and precise natural language constructions, and formalisms in varying degrees. Although this orientation has been advocated for many years, the

literature's current exposition suggests that the information systems discipline seems incapable of overcoming the problem or content with the status quo. An exception is Mazzone (2015), who illustrates context as a factor in understanding information. It is naturally hierarchical and therefore subject to structuring as a form of both text and notation. Although his rendition is focused on verbal discourse, it applies to text and notation because the text can be seen as a discourse (read dialogue) in its own right (Halliday, 2014).

To summarize, the reflection on ambiguity points to the referential feature of the language. It means that ambiguity in the textual form will negatively affect the representational form or notation and *vice versa*. Consequently, this state of affairs can be labelled as a **loss of referential integrity**.

Fragmentation, in turn, is expounded in more detail as follows. The first concept that describes fragmentation is the failures of relatedness (cohesive relationships) between text and notation or, as some refer to as a failure to reciprocate: similar goals and responses (Ben-Menachem, 2001); equal use, i.e., what works for text does not work for the notation (Glinz, 2000) or translation (Lee & Bryant, 2002); separation of concerns such as between syntax and semantics (Harel & Rumpe, 2004) or between part and whole (Kiyavitskaya et al., 2007); processes that cater for both text and notation (Asghar & Umar, 2010); integration of text and notation using methods and tools (Ribiero, 2016); and the static nature of requirements as a part of the specifications as a whole (Faily et al., 2012; Glinz, 2000; Schwaber, 2006).

The second concept of fragmentation is a paradox that points to the human user community generally associated with a requirements specification, categorized as the business users, analysts, and developers. Levina and Vaast (2006) describe the paradoxical relationship as the interplay between the observer (user) and the objects of analysis or experience. They constitute and oppose one another because the user forms a meaningful relationship through symbolic expression in the social context. Still, on the contrary, the objects and relations once formed can change with a social context change. This fact applies to the requirements if no context is given, i.e., the overwhelming objectivist approach of formalism in information systems. In opposition are those few who insist that the part cannot be interpreted without the whole, which undoubtedly attracts contexts – the agent of change. They inevitably describe this paradox as a dilemma in the following ways: high language

variability in the forms causes multiple interpretations (Bartis & Mitev, 2007; Kiyavitskaya et al., 2007), the diversity of user's backgrounds cause the mutability of interpretations (Ibrahim, Wan Kadir, & Deris, 2014), and an imposing dilemma of interpretations exists between the trustworthiness of the expressions of the user and the analytical "absorptive" capacity of the analyst (Ferrari, Spoletini, & Gnesi, 2016, p. 33).

To reflect on fragmentation, it seems plausible to abstract two foci: the first is that the use of the multiple forms of text and notation as objects of understanding contrasts with their objective of transferring understanding because paradoxically, the means of constituting them as objects fails to reciprocate understanding. It means that the one translates to a different interpretation depending on the constructs used. The second paradox arises from the gap between the text and notations familiar to one and unfamiliar to another user category. Furthermore, the diverse potential meanings increase with every new form of use and user category. Consequently, the interpretability increases with each form of 'use'. These observations point to the relational feature of language being under-utilized, labelled as the **loss of relational integrity.**

5.2.5   The dialectic (debate)

In this section, the researcher debates the traditionalist's (orientations) and the emerging assumptions/orientations/worldviews in systems science and offers a counter-argument (in line with the method's dictates).

5.2.5.1   The disagreement

Dent and Umpleby (1998) were singled out because of the detailed explanation of the underlying assumptions of the six traditions in systems science. These traditions apply to cybernetics, general systems theory, system dynamics, analysis, total quality management, and organizational learning. Each of the traditions is discussed using eight assumptions. The eight assumptions are as follows: observation (the underlying ontology), causality (what causes an effect in the system), reflexivity (whether a thinking subject is involved), self-organization (how system elements interact), indeterminism (the predictability of change), environment (dependent or independent), relationships (how aspects are analysed), and the level of explanation (whole or part). This work clarifies nearly all of the concepts discussed so far and supports the inferred characteristics of the problem. The

authors view the combinations of tradition and assumptions as two worldviews: the traditional and the emergent. For reasons that will become clear later on, they were reconstructed respectively as a) the objectivist-unidirectional-reduction worldview, and in opposition, b) the constructivist-reciprocal-holistic anti-worldview. An adaptation of the authors' findings is displayed in Error! Reference source not found..

Another work in this dialectic inquiry concerns the assumption of dialogue as proposed by the Agile approach (Turk, Robert, & Rumpe, 2005). This assumption refers to the following (italics highlight contradictions):

- 'Use' means a dialogue causing visibility through working code (text and notation), surpassing static documentation via short iterations of dynamic dialogue. However, contrastingly the authors note also that *any misrepresentation or misunderstanding must emerge visibly in the code.* Short iterations do not work well for complex interdependent code or functions, *only showing misunderstandings during and after integrating functions*.

- 'Focus' means a dialogue between customers and developer teams, on-demand and collocated with the necessary tooling, and mutual agreement is always possible through frequent informal dialogue. The dilemma with this assumption is not theoretical but practical. The regular informal dialogue meant for evaluation is subject to assumptions 1, 2 and 3 being valid or achievable momentarily.

- 'Paradoxicality' means the dialogue is simple, agreeable, self-evolving, and parsimony is a practised norm. However, the paradoxicality appears in the authors' own words "*Unfortunately, not all development teams have these qualities… It is generally accepted that there is no single process that will be applicable to all projects*" (Turk et al., 2005, p. 73).

In summary, the Agile approach's contradiction is that it has freed itself theoretically but does not seem to have freed itself practically; presumably, it can do with more practice. The intended continuous dialogue between stakeholders presumes a result of shared understanding/interpretation, but at the same time, it gives the impression that of contradiction, perhaps unintentionally.

Table 15: Traditions and assumptions in systems thinking - adapted from Dent and Umpleby (1998)

Assumption	Traditions					
	Systems Theory	*Systems Analysis*	*Systems Dynamics*	*Total Quality Management*	*Cybernetics*	*Organizational Learning*
Level of explanation	Holism	Holism	Holism	Holism	Holism	Holism
	Reductionism	Reductionism	Reductionism	Reductionism	Reductionism	Reductionism
Unit of analysis	Relational	Relational	Relational	Relational	Relational	Relational
	Entity	Entity	Entity	Entity	Entity	Entity
Environment	Dependent	Dependent	Dependent	Dependent	Dependent	Dependent
	Independent	Independent	Independent	Independent	Independent	Independent
Causality	Linear	Linear	Linear	Linear	Linear	Linear
	Circular	Circular	Circular	Circular	Circular	Circular

Organization	Self	Self	Self	Self	Self	Self
	Causal	Causal	Causal	Causal	Causal	Causal
Observation	Realist	Realist	Realist	Realist	Realist	Realist
	Constructivist	Constructivist	Constructivist	Constructivist	Constructivist	Constructivist
Determinacy	Determinism	Determinism	Determinism	Determinism	Determinism	Determinism
	Indeterminism	Indeterminism	Indeterminism	Indeterminism	Indeterminism	Indeterminism
Reflexivity	Static	Static	Static	Static	Static	Static
	Dynamic	Dynamic	Dynamic	Dynamic	Dynamic	Dynamic

5.2.5.2 The counter-argument

The literature should clarify that context appears under-utilized and under-reported; nevertheless, the unilateral view includes context as a functional part of the language used in information systems. By emphasizing the use of context, it constitutes a 'use' in its own right, assuming it will exhibit counter-characteristics to the unilateral view. Additionally, it should emerge as a counter to both the effects of ambiguity and fragmentation as an indispensable feature of language use *for the sake of meaning*. It can be done if the counter-argument accounts for the constructivist-reciprocal-holistic worldview for its emergent attribute and countering of the unilateral view. Concerning context, not the theory, a renaming of the word emergent to dynamic is appropriate. Emergent relates more to theory in the sense of emergent or developing. The counter-argument hypothesis is not, but it does allude to dynamics in the meaning of the operations of dialogue and interpretation.

The definition of a context is historically an enigma for most disciplines. Still, it can be categorized as linguistic context and non-linguistic or situational contexts (Nouraldeen, 2015) or the immediate, situated and socio-cultural contexts (Shen, 2012). Notably, the cognitive aspect of language and how it relates to context is omitted by the first authors but pertinently argued for by Smith and Collins (2010), Schwartz (2010), and Clancey (2008). Thus, a dynamic counter-argument accounts for all the above categories of context. As a prelude to the hypothesis, a brief discussion of works illustrating the properties of context follows.

5.2.5.3 The referential and relational properties of the context

Not only in Computer Science but also Linguistics, orientations are bifurcated between functionalists and formalists. The formalists and functionalist tradition of a grammatical structure are as important/essential as the formalists claim to be. Still, the functionalists also take into consideration the entire situational context. Thus, formalists claim that language is merely a vehicle for rational thought and that form is independent of meaning and function (Newmeyer, 2000). Functionalists oppose this view favouring contextualisation.

This section exposes the conflict arising from the definition of the word formal. The functionalist tradition is towards a *use*; language 'use' develops its structures or (rephrased)

the governing structures emerge from the content. In opposition, the formalist defines it as a form of structure and arrangement (rules) of language, which formally integrates these elements (inclusive of grammar, semantics and pragmatics) into meaningful communication. An insightful functionalist position of context is taken by Brochhagen (2015), who argues for ambiguity reduction with or without context via a comparison method. He points out that success depends on "the meaning-form associations and their relation to the contexts they appear in" (Ibid., p.74). Brochagen (2015) concludes that an ambiguity referencing distinguishable meanings (via contextualisation) fare better than one referencing indistinguishable meanings.

5.2.5.4 The situatedness property of the context

Rapaport (2005) attempts a Contextual Vocabulary Acquisition method (CVA) as an exemplar of the immediate context, which entails the inference of correct meaning from a word in a text; caused by the context. However, his reference to context flows over into the situational, stating that 'correct' does not mean a word (sentence or text) has a correct meaning immediately but whether the text is understood. The proper meaning becomes more accurate as the interpreter gains experience and knowledge from the related contexts' cumulative effect. The author claims that a text's meaning is a joint function of the text and the interpretation. The interpreter jointly uses a nominal context (representing itself) and an adequate context (context-of-use).

"Context is all about the whole situation relevant to an application and its set of users. In contrast to traditional systems, we do not design for a single or limited set of contexts of use; instead, design for several contexts. The advantage of this approach is that we can provide optimised user interfaces for a range of contexts" (Dey, Kortuem, Morse, & Schmidt, 2001)

5.2.5.5 The social-cognitive property of the context

Two concepts that appear pretty subtly in the text: the social function or socio-cultural aspect of context (§p. 6; 93); and cognition or thinking paradigms (§p.89) illustrate without a doubt that context plays a significant role in societal discourse, which relates directly to cognitive discourse subsequently written up as a text. Fairclough (2003, p. 11) finds that we gain insight and meaning from the discursive negotiations in discourse within the social context. The advantage of dialogue and interpretation, "which at least gives us some

evidence of how things are being intended and interpreted," is lost during the transfer from discourse to the written form. Christel and Kang (1992) adamantly point out that because requirements elicitation (the precursor to a requirements specification) is a social process, it necessitates that special attention is given to context and the role it plays in this process. Carter and Goddard (2015, p. 198) take an even stronger stance about communication that involves various technologies, which "are highly shaped by the affordances and limitations of the technologies at any one time. The participants behave as they do because of what the system allows them to do". The relationship between context, language, cognition and human behaviour are interdependent. According to these two authors, they cannot be fragmented or separately proposed; how they infer meaning is illustrated as a function of reciprocation, according to these two authors, reiterated by Shen (2012), who concludes that any text is produced and interpreted within a context. Ogden and Richards (1923) discuss the relationship between form and reference and their propositional meaning in a theory of contextual referencing. They point out that a reference always includes the contexts, whether cognitive or external. The transfer of thought between humans via their linguistic and other behavioural expressions is contextually dependent.

From these insights, it seems plausible to infer that the reciprocal relationship of function is a transfer of meaning via and between contexts (Haregu, 2014). The relationship between language, cognition, context and meaning, is summarized via the concept of situated (contextual) cognition in the words of Clancey (2008):

"…The one essential theoretical move is contextualization…: We cannot locate meaning in the text, life in the cell, the person in the body, knowledge in the brain, a memory in a neutron. Rather, these are all active, dynamic processes, existing only in interactive behaviors of cultural, social, biological, and physical environment systems." (p. 28).

5.2.6 Post-reflection: a speculative resolution

Topic 4: A speculative or hypothesis 'use' of language

Sub-question 4: Why an alternative?
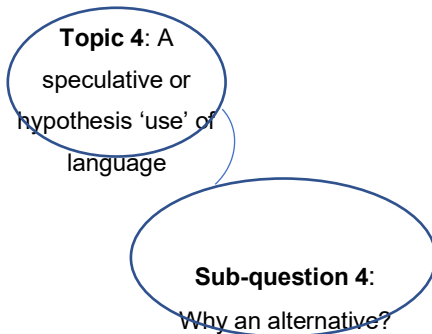
What has been discovered in the literature up to this point is that the tenacity of the wicked problem (Kroeze et al., 2014b) presents **ambiguity** and the two aspects of fragmentation as the main characteristics. To consolidate the two aspects of fragmentation, they shall henceforth collectively be referred to as the **interpretive sophistication** defined by Alpay et al. (2008) as the high variability and complexity in communication due to interpretations "that are significantly different from one individual to the other" (Ibid., p.86). This definition is adopted but redefined as the fragmentation of cohesion in the number of languages used (scale) and in the diversity and number of interpreters (scope) (Holzapfel, 2017, p. 10). The preceding sub-section adds to this definition by accentuating the prevalence of ambiguity and interpretive sophistication due to the unilateral view, construed as dilemmatic. The counter-argument given above offers a dialectical view, which appears better suited to counter the critique. The counter-argument focuses on *context*, which is posited as a lemma to the current unilateral view. Thus, it is the objective of contextualisation to counter ambiguity and interpretive sophistication levels. Said otherwise, contextualisation aims to counter the loss of referential and relational integrity. This counteraction includes constructing a context to produce meaning and transferability between contexts: Context 'A', between text and notation, e.g., a use case narrative or agile story and its usual graphical notation; and Context 'B', between the diverse interpretive audience.

The premise of construction is that a single contextual meaning emerges from the construction of 'A', which is transferable to the context of 'B'. The initial ground rule of the

premise is that the contexts used must be cohesively related, and both text and notation must reference the same contextual meaning. This premise requires the following elements or components: **semantic-contextual equivalence** and the **transferability** of ordinary contextual meaning discussed next.

5.2.6.1 A semantic-contextual equivalence

A type of contextual equivalence is synonymy, which creates a situation wherein two propositions are logically valid, if and only if they hold in the same conditions or contexts. According to Briscoe (2011), this rule extends beyond propositional logic as it "involves equivalence of meaning between words or words and phrases". Although this statement particularises only words and phrases, the researcher claims it holds for a set of sentences and their representatives or referents in principle. One would then infer that what holds for the text must hold for the notation within the requirements specifications. Resnik (1995, p. 4) argues that the similarity between two objects or concepts is the extent to which they share common information and meaning. He finds that words with several meanings that appear together take senses that "share elements of meaning". He concludes that "in measuring the similarity between words, it is the relationship among *senses* that matters"; the italicised word refers to *meaning*. Jing and Tzoukermann (2001) investigate the contextual equivalence between terms used in retrieval and their representation in a document. They find that equivalence holds if words correlate directly to their context rather than their form (Jing & Tzoukermann, 2001, p. 6). The context relevance is also calculated based on the "relatedness between words" (Jing & Tzoukermann, 2001, p. 8). They find that the semantic closeness of contexts is not reliant on the same words in the retrieval and the document but reliant on **contextual relatedness**.

Berzlánovich and Redeker (2012) reiterate the importance of contextual relatedness, which results from the expressions in and around the text. The cohesion exists between the referential, relational and linguistic components of the text. However, in the hypothesis, this cohesion property is a property of contextual equivalence. If context causes a semantic equivalence between text and notation, the reciprocal relationship must also hold; implying referential cohesion. The authors describe this relationship as "a cohesive item of the referential cohesion always points backwards or forward to another specific item with the identity of reference" (Berzlánovich & Redeker, 2012, p. 12). They point out how difficult it

is to derive meaning outside of context, even amidst precise word meanings, without context, which shrinks meaning to single propositions. Therefore, it seems plausible to infer that the cohesion property resolves both referential and relational integrity issues: a prerequisite for decreasing interpretative sophistication via sharing the contextual meaning.

5.2.6.2 Transferability of a contextual meaning

Does the inference of contextual equivalence further imply that context transfer is possible? The answer may be found in an article by Mousavi, Nadjar Araabi, and Nili Ahmadabadi (2014), defining context transfer as "the problem of knowledge transfer between agents in the same environment doing the same tasks even as their state-action spaces are different". Their findings indicate the following possible relations that cause the transfer. They conclude that a transferable context task is such that the environment (contextual) variables between the two agents are the same, although the state-action dynamics differ. Transferability between contexts is possible, even if there is a difference between the functional descriptions of text or notation. This finding correlates with previous findings by Tack (2002) that "the linguistic dialectics between sign structural relations and a meaningful referential conceptualisation" exists. Katz and Te'eni (2007) favour contextualisation and warrant its use in computer mediation to illustrate such collaborations. They find that contextualisation agrees with the nature of adaptive communication behaviour and the aim of knowledge sharing.
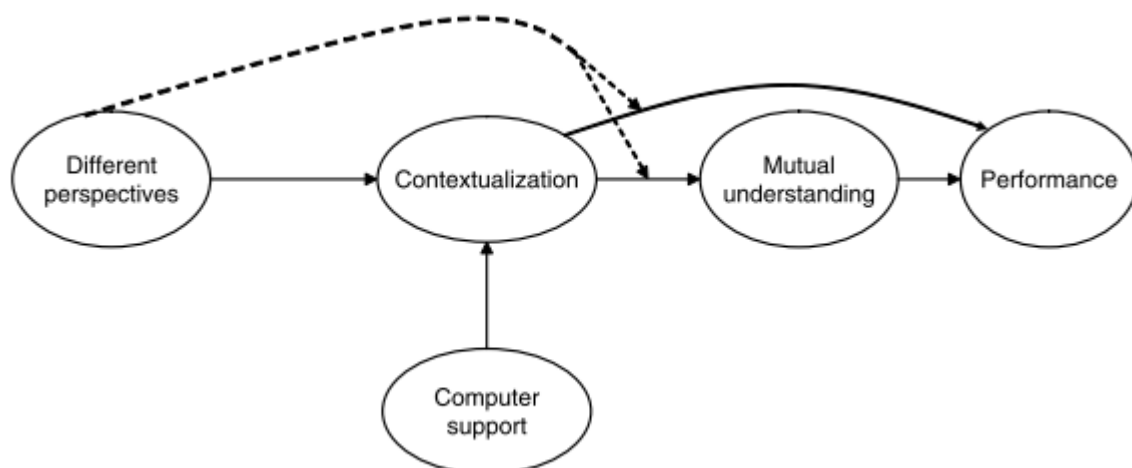
Figure 9: Contextualisation in collaborative computer mediation (Katz & Te'eni, 2007)

The discussion now turns to the researcher's hypothesis of contextualisation in which the constructed context causes a contextual equivalence transferable to a diverse audience (multiple interpreters/scope). The transfer causes a decrease in interpretative sophistication. Figure 10 visualizes the counter-argument (fully explained in Section 5.2.5.2).
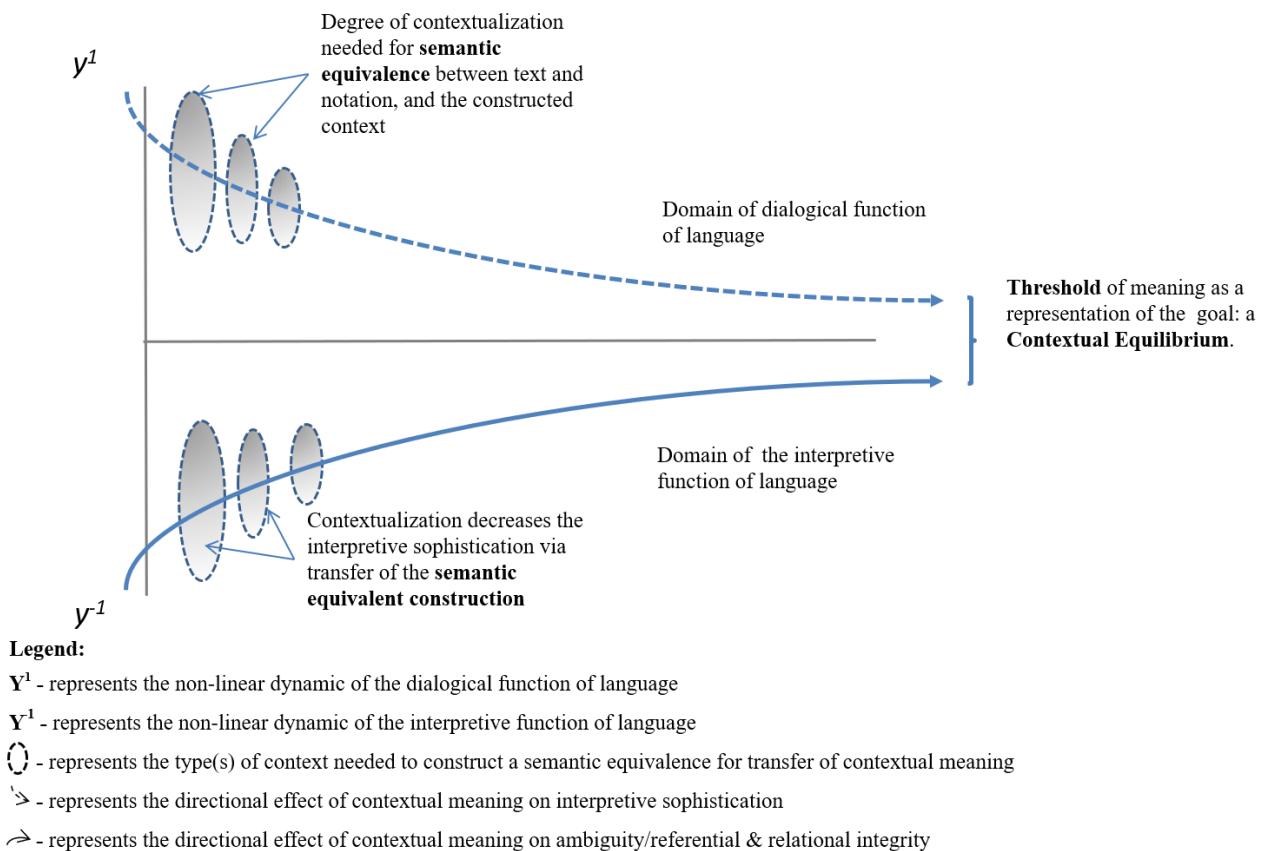
Figure 10: a hypothetical framework of contextualisation (Holzapfel, 2017)

The model is explained as follows. A vertical axis runs through the beginning of a horizontal axis. The top half of the *y*-axis represents the referential axis in the hypothetical argument, and the bottom half represents the relational axis. Let the top axis be labelled (y^1) and the bottom (y^{-1}). This figure shows that the x-axis represents the dialectical dilemma between text and notation (area above the horizontal line) and the dialectical dilemma in interpretation (area below the line).

The more significant the increase in ambiguity in the dialogical function, the higher the loss of referential integrity. The more significant the increase in scope and scale in the interpretative function, the higher the loss of relational integrity. The degrees of loss determine the degree of contextualisation needed to ensure a minor threshold. As

contextualisation takes effect, it positively affects both referential and relational integrity, causing a downward curvature in the (y^1) axis and the upward curve in the (y^{-1}) towards the point of maximum effect. The hypothesis model illustrates the dynamic characteristics of the language used in its entirety, which postulates the following: the more significant the increase in dialogue and interpretation and consequential continuous reciprocation, the better the potential for achieving the ideal of a contextual equilibrium, i.e., where ambiguity and interpretive sophistication is zero. Admittedly, that achievement is theoretical; in practice, a threshold is more realistically achievable. The degree of learning and application of the construction and transfer of contextual meaning will determine the movement in the threshold.

5.2.6.3 Validations of contextualisation

The equivalence relation is ideally suited to validate the hypothesis as defined in the last paragraph above. Therefore, the rule of equivalence posited by Gouws (2002) is reused to validate the semantic and contextual equivalence.

The test for equivalence relations is such that the contextual meaning *n* for a set *A* is at all times reflexive, symmetric and transitive. Respectively, this means that the source proposition's semantic meaning (the text) equates to a constructed context, and that the target proposition's semantic meaning (the notation) also correlates to the constructed context's meaning, and that the source proposition's meaning is/has a propositional referent in the target. Hence, this new process of dialogue and interpretation produces a contextualised meaning between text and context or notation and context (referential function); interpreters and interpretations (relational function) end in a threshold of contextual meaning.

The test for transferability is adapted from Mousavi et al. (2014). Transferability applies to reinforcement learning and homomorphic equivalence, but the principle applies to context transfer. Knowledge transfer, like contextual transfer, needs two participants sharing a commonality. In like fashion, the transfer of the constructed meaning is possible due to the contextual equivalence (the commonality). They define a context transfer as a situation where knowledge transfers between participants in the same environment and exhibit the same behaviour, although the environmental elements differ.

The hypothesis postulates that if the inferred meaning of the constructed context, i.e., the contextual meaning equals that of the semantic meaning of the text, irrespective of the use of forms and functions, then semantic equivalence exists, which makes the contextual meaning transferable to the representative notation the interpretive diversity of the audience.

Consequently, two rules inferences emerge a) if the relationships between the semantic meaning and contextual meaning are symmetrical, transitive and reflexive, it qualifies as equivalent. The measure of equivalence, in this case, is a threshold and not a binary value, and b) if the semantics of a text correlates to the contextual meaning, it invokes transferability to the notation and the diverse audience.

In summary of the counter-argument, it suffices to point out that computer science exhibits a limited understanding and potency of context in addressing the unilateral view. Nevertheless, in the exposition of context and precisely the social aspect, it is clear that context potentates language, whether verbal, text or notation. This possible potency is best described by a term used before, used going forward as **contextualisation**. The word implies two operations: to *construct* and to *transfer*. Thus, construction is a function of context that changes the properties of reference and relation, and transfer is a function of context that changes the social-cognitive property.

The rethink to follow posits these two operations as precursors or inner operations to dialogue and interpretation's primary (outer) operations.

5.3   CONCLUSION

An in-depth dialectical review of the current orientations driving thinking about the complexity and multiplicity issue showed that the mainstream computational/binary approach directly affects language use; hence, the summative reference to a unilateral view. The findings redefined the complexity and multiplicity as features of language use: ambiguity and fragmentation, respectively, responsible for the loss of referentiality and relation/cohesion. The study found an apparent paradoxical use of language, which refers to any form or function of uncertainty (e.g., ambiguity and confusing interpretations).

The review cast the orientations of two categories of theories of meaning from theme 1 in a dialectical debate, proposing firstly an alternative to the unilateral view, which appeared to be the underdetermined notion of context, and secondly to have a speculative solution emerge from the debate. In these objectives, the dialectical inquiry successfully explained a body of literature mainly from exogenous disciplines, i.e., other than information systems, yet relevant, and secondly by positing a hypothesis that visualises the inferable objectives for an emergent theory of meaning-making.

Poor requirements, limited as they are in this review, can be summed up using the following heuristics of "use": human error, human intervention and mental models, which in the context of the review accentuates the current complexity and multiplicity around the issue of poor requirements, indexically referring to "wicked" problems, i.e. featuring resistance to the current solutions due to the phenomena associated with them, which require a multi-disciplinary approach (Kroeze, Travica, & van Zyl, 2014a).

The two questions that underly the main research question are answered directly in this review. The first question - what constitutes poor requirements - concerned the delimitation of the artefact. From the analysis and discussion, it is plausible to conclude that the language used is the delimiter. The denotations and connotations associated with it merely attest to the complexity and multiplicity of the problem, which adversely impacts requirements engineering.

The second question – what causes poor use – was answered in the analysis and synthesis of the dilemma. One can conclude how particular world views fail to recognise that the complexity inherent in this question needs a different approach to the current static approach. It is not presumptive to conclude that, if the current world views remain in practice or are transferred to design theory development, both disciplines may remain in limbo

The dilemma pointed out the effects of the world views on the use of language: at one end, the restrictive effects of the unilateral view and the liberating effects of the interpretive view. The unilateral view restricts context to the objective factuality of form and function (the current 'use'). In contrast, the interpretive view opens up the possibilities of unique explanations emerging from on-demand constructions using the total capacity of the human

linguistic-cognitive prowess. The hypothesis put forward as a speculative solution holds promise through the contextualisation of the inhibitors of meaning: ambiguity and fragmentation. On the other hand, the proposal of continuous dialogue and interpretation necessitates context in its total capacity, which results in a practical compromise between the individual effects of contextualisation on the inhibitors – a contextual meaning. Contextual meaning is thus a common understanding that can be transferred among a diverse audience. This section concludes with an invitation to rethink the use of language. Such a rethink is proposed to develop within constructivist-reciprocal-holistic world view with which the researcher affiliated. This topic is investigated in the next chapter.

6 Chapter 6: THEME 3: 'USE' PARTICULARISED

6.1 THE ALTERNATIVE 'USE' (A RETHINK) TO THE CURRENT 'USE': A NARRATIVE REVIEW

> "… imagination is required to close the gap between meaning of an utterance and its relevance for a context" Doyle, 2007, p.44)

Topic 5: A rethink of language 'use'

Sub-question 5: What is the alternative?

6.1.1 Introduction

The rethink starts with the researcher's particular orientation: constructivist-reciprocal-holistic, which broadens the scope of the review, analysis and synthesis of 'context' in terms of 'use', i.e., an application of use. The use of context includes definitions, categories, dimensions, relations, and characteristics, which surfaced from the previous literature reviews.

The prevalence of poor requirements necessitates an intuitive/imaginative/inventive 'use', attracting technical and non-technical users. Intuitive in the context of the remainder of the thesis means what one would count as commonsense. Hence, this section investigates what is called **everyday use**, a form of commonsense. This 'use' runs counter to the current lexico-grammatical, semantic and pragmatic unilateral worldview, which causes poor requirements. Subsequentially, one expects to find an **inventive form-function relationship**. Based on the findings of the preceding post-reflection, context proffers to be the most likely candidate, notwithstanding its current delimited use in Information Systems. Due to this clear delimitation, it seems plausible to investigate the

potential of **context as a 'use'** outside of the information systems disciplinary boundary by including exogenous disciplines such as Linguistics, Psychology, Cognitive Science, and Philosophy.

The subsequent review is a narrative structured according to the central role of context in the language-meaning relationship, categorising context followed by its features. These features manifest as causal factors in meaning-making. After that, the language-meaning link is discussed, revealing the context's unique characteristics and dimensions from the centrality of 'use'. 'Use' has been repeatedly associated with a dynamic character, causative in this sense. This particular characteristic is explained comprehensively next. Causation relates directly to the characteristics and dimensions of context. Finally, the notion of meaning-making is investigated, concluding the discovery of definitions of the primary concepts. After that, the novelty or alternative 'use' is exposed as two particular mechanisms (forms) and their intuitive operations (function) in making meaning - the novel form-function synthesis. Finally, the review ends with conclusory remarks.

6.1.2   Related works as a narrative review

This review aims to narrate the notion of 'context' within the broader body of literature; hence, a narrative review. The review is narrow in scope because it is done from the perspective of the orientation/worldview the researcher is strongly associated with constructivist-reciprocal-holistic. The reasons are twofold: 1) to investigate the presumption that context causes meaning, and although underutilized in the majority of information systems literature, needs exploration for its potential to act as a catalyst or causal factor of meaning-making, and 2) link the essences of the preceding reviews (poor requirements specifications and the dilemma) with the speculation (hypothesis) on meaning-making and the forthcoming literature review of developing a Use Theory of Meaning-making. Therefore, this section will repeatedly refer to the underlying concepts of 'construct', 'reciprocate', and 'holistic' to keep the reader in context.

From the outset, it seems profitable to explain the tenets of the worldview taken herein. The **holistic** notion is an essential component of the rationale in searching for an alternative 'use'. It can be described as an inclusive approach to language, context, and meaning. If one delimits the description of context, one immediately, like the positivists, raise problems

and issues, whereas taken as a whole, one can better see the forest from the trees (Ogden & Richards, 1923). The fact is that in isolation, both a minor component in dialogue (a word) and the most prominent component (whole texts) are void of interpretation. Only when a human uses them in context is meaning obtained. This fact differentiates the **constructivist** (another essential component of the rationale) approach from the other approaches; language is an instrument used to reflect an individual's or group's thinking about the world – known as referencing the cognitive context (Kecskes, 2008; Mazzone, 2015). Therefore, the relationship between the cognitive context and the referent or object of possible meaning is profound. The act or process of thinking is actualized referencing because it is "… Thought … which is directed and organized, … recorded and communicated" (Ogden & Richards, 1923, p. 9). The relation alludes to a dependency, which can manifest during an interaction between the two, which is **reciprocal** (the final essential component of the rationale). The interaction for its part constitutes causation, i.e., a causal relation between one or more key concepts of 'use' - the language-context-meaning relationship.

Two seminal works clarify the centeredness of context. The first is on translation and translating (Bell & Candlin, 1991). A review of that work (Salzmann, 1993) is a metaphor for what is discussed in this section. The literature highlights the criteria for successful interpretation and reciprocation between interpreters and the problem of meaning production. The first work explains the premise of interchange between translation (the product or yield) and translating (the process) as a matter of **equivalence**. The causation of this premise lies in the linguistic-cognitive relation of meaning production (meaning-making). Meaning production is explicated as unequivocally context-enabled: the form (syntax and semantics), which is situated in a context becomes enabled due to a function of (pragmatic) 'use'.

The second work (Duranti & Goodwin, 1992) depicts it [context] as a **dynamic/continuous** triadic interaction between the conversation/text, context, and the social setting in which it occurs - the context-text interaction. Furthermore, the social framework/setting, the linguistic and non-linguistic contexts, and situational background parameterise a context. This work also accentuates the correlation between the dynamic nature of context and the common feature between interpreters letting "each other know just the information they need … achieving understanding through negotiation, through a

constant process of giving and processing information… and we need hints or cues to… infer real meaning" (Duranti & Goodwin, 1992, p. 151).

Causation takes prominence in the relationship between context and interpretation— the context as a construct and interpretation as its action. According to one of the context's definitions, context can be seen as the factor causing the interpretation. Another definition of context is recurring past experiences. If the experiences are to be viewed as correlates of interpretations, it seems plausible to conceive those past experiences are re-interpretations of sorts or recurrences of interpretations. The correlation between interpretation and context suggests that contexts are recurrences (Ogden & Richards, 1923, p. 55).

6.1.3   The language-meaning link

A holistic consideration needs to be given to 'context' in terms of 'use', which entails definitions, categories, dimensions, relations, and characteristics, which surfaced from the literature under review.

6.1.3.1 Linguistic context

The findings (Table 16) show a broad perspective across the various disciplines concerning a context definition.

Table 16: Definitions of context across various disciplines

Reference	Discipline	Definition
(Wilson & Sperber, 1985)	Linguistics	A set of premises used in the interpretation (preferring inference over a specification)
(Duranti & Goodwin, 1992)	Linguistics	A set of attributes. A 'frame' surrounding an event. A relationship between the focal event and context, mutually informing each other to construct the larger whole.
(Lindstrom, 1992)	Anthropology	Sets of discursive procedures and conditions.
(Abowd et al., 1999)	Computer Science	Any information, which characterizes a situation.

(Brézillon, 1999)	Cognition	What constrains a problem-solving or a kind of expert system able to predict.
(Denley, 1999)	Ergonomics	A set of properties; extended conditions.
(Dey et al., 2001)	Technology	A whole situation, which is relevant.
(Thibault, 2003)	Linguistics	A set of propositions is taken for granted.
(Bazire & Brézillon, 2005)	Cognition	A cognitive process of construction based on relevance or general processes that control the construction of knowledge or determine the conditions of knowledge acquisition. A concurring view is that construction refers to a dynamic between cognition and the contextual elements (Savolainen, 2006)
(Rapaport, 2005)	Computer Science	A context includes: (i) a personal interpretation of the surrounding text, (ii) a historical interpretation according to prior experience and meaning, and (iii) excludes external resources
(Brezillon, 2006)	Cognition	The sum of relevant knowledge and practices (contextual procedures) is constructed to yield meaning.
(Bamberger, 2008)	Technology	A driver of cognition; a sensitizing device. A set of relevant facts.
(Garnham & Oakhill, 2013)	Cognitive Science	An aspect of a situation.
(Kirsch-Pinheiro, Mazo, Souveyet, & Sprovieri, 2016)	Computer Science	The information that characterizes a situation.
(Davidoff, 2019)	Medicine	All things in a situation, which are relevant to meaning.

Suffice it to point out a particularity concerning the definition of a context as a set of some things. The apparent association with this descriptive term is logical in the current positivist vernacular, which points to a fixed/static form. Such forms intend a binary result (Putnam, 1975b). In this thesis, a binary notion cannot work because the thesis develops from a constructivist view. The constructivist theory obligates a holistic perspective, which cannot bear any resemblance to binary options. However, that is what makes this endeavour significant as "words in a natural language are rarely a matter of 'yes/no'" (Ibid., p.134). This thesis gives preference to the Bazire and Brézillon (2005) definition as the most holistic one: A cognitive process of construction based on relevance or general processes that control the construction of knowledge or determine the conditions of knowledge acquisition.

6.1.3.2 Non-linguistic context

Apart from the linguistic context defined above, one has to review another and probably more important context: the non-linguistic context. Although most authors refer to this type as a situational context, it seems to encompass a much broader definition. For example, positivists refer to situatedness as an environment in an empirical sense (Biadsy & Mengibar, 2017). Another logical form is assigning a value from the interpretation relative to the context, without considering it social, cultural or mental. The latter explanation of the form is evaluated via affordance, relevance, and quality (Stanley, 2000). The form is a type of loose semantics where the interpretation relies on expressions relative to a context. In contrast, the evaluation is according to benefit-orientated pragmatics where one input produces another but different output caused by the context.

Others turn to a more constructivist or use-orientation such that context is seen as a social construct due to the natural tendency of the human to recall resources from experience to act as a context in aid of the interpretation process (Akman, 2000). Where context is used in discourse, intonation, for example, enables enrichment of the context, setting up cues for interpretation: an ongoing process in constructing the text and the dialogue between interpreters. Context is defined as dialogical assumptions, which are updated during the dialogue by reciprocating interpretations and re-interpretations (House, 2006). There is a distinct correlation between the notion of reciprocation of interpretations in this last definition and a definition of *relevance*; something is only relevant to an interpretation if it is situated in the cognitive context, which is linked with other contexts by

that interpretation (Ogden & Richards, 1923, p. 76). The significance of this insight is twofold: contextual links are cognitive, and relevance includes relatedness (cohesion). If the subject's interpretation is directly related, information is relevant or tentatively conclusive unless redirected by relevance. This relation posits an inferentiality wherein A→(B→B) is logically relevant but invalid due to an unrelated conclusion; whereas, (A→B)→((B→C)→(A→C)) is relevant and the conclusions hold due to relatedness/logical cohesion (Ekbia & Maguitman, 2001).

The other aspect of the non-linguistic context includes situated cognition. The situatedness herein refers to a reciprocal relationship between part and whole. Cognition is perceived as being an internal (neural) and external (social) process. The interrelatedness and reciprocal workings exhibit characteristics of complex systems: emergence (non-linear patterns); reflexive interpretation and re-interpretation, mutability history; and cohesion/relatedness of the part-whole composition (Clancey, 2008). A usable summary of the types of context is objective/semantic (an object refers to something in space, time and speaker identity), subjective/cognitive-pragmatic (a point of view: cognitive in the sense of a theory), and discourse/conversational (discourse includes the text: a merger of subjective and objective contexts) (Bell & Candlin, 1991; Penco, 2008). Interpretation between these three contexts is semantic negotiation underlined by some cognitive theory (assumptions or constraints). The localised domain theory constrains the objective/normative context, i.e., location, time and discourse participants at the time of dialogue. The cognitive context is constrained by pragmatics (i.e., language, axioms and conventions). Both constrain the dialogue context in varying degrees (called conversational context (Penco, 2008)). An important question is raised whether an objective context must at all times exist for an interpretation to succeed? An evaluative dichotomy exists if a factual context must be present. Still, an interpretation is likely due to the cognitive context and dialogue. Penco's solution is precisely the cognitive context that permits differences of relevant interpretations for evaluation. Notably, the mechanism recommended for evaluation is a "plausible theory of communication" (Ibid. p. 193).

A second question arises concerning the definition of the dialogue context as 1) a prior agreement or shared assumptions or common ground (the semanticist view), and 2) a set of propositions constituting a common goal. Penco suggests a kind of shareability or

convergence between the subjective context or awareness of the common goal. The objective context of the structures and rules of the shareable facts and the social context illustrate the distributive or cooperative function. Another acceptable interpretation of the notion of shared assumptions is that interpreters are initially uncertain about what explanations the reference holds in terms of a possible commonality but rely on **plausibility** to recognize a commonality among the continued updating of assumptions (Arlo-Costa, 2008). Penco (2008), on this development, states that in real terms, a dialogue is a form of barter and exchange of interpretations, which is primarily cognitively constituted; hence, his insistence on the primary role of cognitive contexts. Only relevant propositions are retained during the reciprocation of interpretations as "… our *descriptions* … rely always on a background of practices and beliefs … on the background of the open discussion among different points of view …" (Ibid. p. 206). The importance of this insight finds its application to resolve ambiguity in general caused by indexicals "to disambiguate misunderstanding when propositions are the referents of indexicals …" (Ibid. p. 209)

The relation between language and cognition is necessary to explain, lest the perception that they are separate concepts in this thesis. In a holistic approach, language and cognition are jointly referred to as the human **linguistic-cognitive** capability, which as a whole concept is subsequently directly related to the context. The context for its part comes in two forms: linguistic and non-linguistic, each having sub-forms or references among the scholarly audience, e.g., subjective/objective, endophoric/exophoric, and the aspect of situated cognition as explained above. This aspect can be broadened to mean the entire "extralinguistic reality – mental and social" (Tsvetkova, 2017). From her linguistic perspective, language is a human construction that originates in the mind within the boundaries of a social context to purpose the conveying/sharing of life experiences. The construction includes "every system of belief, knowledge, understanding, **interpretation**, perception, etc." and some studies on non-linguistic context indicated that "non-linguistic patterns have a strong influence on linguistic constructs" (Tsvetkova, 2017, pp. 221,224).

6.1.3.3 The characteristics and dimensions of context

Attention turns to the characteristics and dimensions of context as a 'use' – an alternative form and function of language. The following list pairs the context characteristics

to the theoretical terms or components of the Use Theory of Meaning-making (references to the terms are italicised).

(i)   acquisition entails context as a point of *reference* (a) how to observe the context (an environment, situation, etc.), (b) how to nurture the observation, and (c) how to manage the changes in the context,

(ii)   *subject* – how to represent a context, i.e., the observations and the interrelations,

(iii)   *model* – the most appropriate representation of context, and

(iv)   Interpretation of corresponding data (Kirsch-Pinheiro et al., 2016). The focal point (Duranti & Goodwin, 1992) and the accompanying signs (Allwood & Ahlsén, 2019) typify the dimensions of the context of 'use'

(v)   production of information (*construction*),

(vi)   *interpreter*(s) – at least one,

(vii)   interaction between interpreters (*dialogue and interpretation*)

(viii)   interpretant (*meaning/explanation/interpretation*),

(ix)   syntactic context, i.e., what is being represented (*text or notation*),

(x)   semantic context, i.e., how the representation refers (*referentiality*)

(xi)   pragmatic context, i.e., a mode of use (e.g., *inference*), and

(xii)   a relationship between all of the above (*cohesion/relatedness*)

A dimension not in the above list enhances all of the others and accentuates the most prominent use: the dynamic dimension of context. "Without an explicit representation of this dynamic dimension, it is not possible to catch entirely context in an application" (Brezillon, 2006, p. 147). This statement probably can be considered aligned with the notion of 'updating assumptions' (House, 2006). Several authors reiterate the significance of the dynamic dimension, such that issues requiring context for interpretation and meaning cannot be statically solved. The elicitation and sharing of 'meaning' is a matter of movement (Brezillon, 2006). The mutability of the context is related to the choices made from momentary influences (history, immediate situation, and patterned practices) and shaped by socio-cultural worldviews. Mutability underlines the human capability to construct a context on-demand/dynamically using linguistic-cognitive expressions to move (*transfer)* an interpretation from both linguistic and non-linguistic contexts. If analysed together, these references point to the *emergence* of meaning from the use of linguistic and non-linguistic contexts.

6.1.4 Causation

Causation in this thesis takes several definitions: the production of an effect; the fact of causing; the agency of cause; and causality. Essentially, these meanings connote movement, which analogously points to the centrality of 'use'. One can then rightly ask what causes the 'use'? The term causation needs explanation before continuing. A working definition that characterizes the effects of context is "… the capacity of one variable to influence another. The first variable may bring the second into existence or may cause the incidence of the second variable to fluctuate." (Rouse, 2016). This explanation alludes to the explanations of context given, for example, by Mousavi et al. (2014) and Benerecetti, Bouquet, and Ghidini (2001) in the above summary.

Causation is also a pertinent feature of situated cognition in systems thinking. The relationship between part and whole is dynamic; the "ongoing product of a coupled causal relation, such that the entity … and its context … shape each other in a complex system" (Clancey, 2008, pp. 18-19). Thus 'situated' can be construed as contextualisation: the ongoing operation of the mind to construct and interpret (explain) changing contexts to produce, reproduce, transform and transfer cross-cutting knowledge across a diverse interpreting audience.

Historically, the view of situated cognition included a static model in which both construct and transfer are generated by computational abstraction, later replaced by the biological theory of storage function. Both views are objectivist. The constructivist view, to the contrary, posits a model of dynamic interdependencies. These are constructed behaviours from internal and external resources (contexts), explaining perceptions about observed phenomena. Such explanations are usually captured in artefacts, an extension of the cognitive process (computers count as an example of such extension). Language use is another extension, precisely a "shared socio-cultural resource" (Smith & Collins, 2010, p. 132). An exciting feature of this process is that socially humans do not rely on stored information *per se* but instead use the innate cognitive operations and relevant information from available contexts (environmental, socio-cultural, experience, and associative ones: other humans). This 'use' uses other's knowledge as pointers or tokens for establishing one's own during the dialogue and interpretation reciprocated between humans. The tokens

act as **indexicals** to produce meaning (explanation) due to the relevant contexts that frame them. It seems plausible that tokens may be distinct in dialogue or interpretation. A conclusory definition of the significance of dialogue for its part in the language-context-meaning relation is such that:

"… dialogue does not consist of individual speakers exchanging unilateral speech acts. Instead, it is based on cooperation and collaboration, which manifest in the collective categories of coherence, communicative project, collective WE-intention, coparticipant, dialogue act, co-supposition and dialogue common ground" (Fetzer, 2001, p. 449)

This explanation of 'use' infers that causation exhibits a reciprocal character in which context shapes the cognitive transactions. The shaping constitutes 'meaning' as the construction of patterns of the socio-cultural semiotic system. Meaning is a product of the constant dialogue and interpretation within contexts, which point to a process that purports some mechanism. The (Collins, 2020) Dictionary defines a mechanism in philosophy as (a) "the explanation of phenomena in causal terms …", (b) in general a "means of doing something, esp., a physical or mental process". Braun (2017) associates indexicality with a mechanism of referencing a context, mental or otherwise.

Furthermore, causation attracts or confirms the context principle (Lindstrom, 1992; Mesquita et al., 2010). It explicates the static and dynamic properties of context, i.e., the reference to causing the internal operations of constructing and transferring meaning and the dynamic operations of causing continuous dialogue and interpretation (Twiner, Littleton, Coffin, & Whitelock, 2014). The static property of context is the reductionist view of essentialism, i.e., cognition as the mere analyses and conclusions favouring static states and behaviours of delineated entities. Contrary to the reductionist view, the current thinking favours the improvisational character of dialogue and interpretation. This view aligns with the psychological theory that how we think about phenomena are not singular causalities but emergences from "multiple transactive processes", in which **emergence** is explained as "a behaviour … a function of the person and his or her momentary context" (Mesquita et al., 2010, pp. 5,6). To summarize, one has to look no further than the seminal work of Ogden and Richards (1923), which vests the need for a causal explanation in a theory of meaning (-making) between the cognitive process and the signs it constructs and interprets: "… the

symbolism … is partly caused by the reference we are making and partly by the social and psychological factors … for which we are making the reference" (Ibid., p.10).

6.1.5 Meaning(-making)

Neither context nor causation is in isolation; it pre-empts both their interrelation with their product: meaning, and the fact that a product/result pre-empts a process: meaning-making. Neuman (2006) defines meaning as the response to the interactive processing of variable inputs. The word response is synonymous with object/referent (Allwood & Ahlsén, 2019; Khaled & Noble, 2005), replaced by **contextual meaning** in this thesis. These terms also align with the first requirements of a theory: a product and a process (Baskerville & Pries-Heje, 2010). The definition of meaning-making in the thesis includes these requirements, as will be seen.

The semiotic perspective of meaning-making is critical, showing an apparent dependency on the linguistic-cognitive aspect of meaning (Ogden & Richards). The semiotic perspective highlights the role of cognition in the meaning-making process. Kecskes (2008) posits two meaning-making systems: one constructs, i.e., the dynamic inference of meaning from interpretation, and the other prompts for an interpretation. The vital aspect of this view is the continuous reciprocation between these two systems. The cognitive system relies on the regularities of the prompting system, i.e., the lexico-grammatical form and function. However, due to the finiteness of that system, humans need the construction system of the mind to have meaning emerge. Once the emergent meaning is patterned, the prompting reuses it; and so the cycle repeats. Together they can be seen as a linguistic-cognitive system. Such a system proposal inevitably alludes to a theory of sign (semiotics). Its most significant feature is that meaning-making is a dynamic of "continuities and discontinuities" (De Luca Picione & Francesca Freda, 2016); a movement of the sign (discontinuous form) between different worldviews, from which the meanings emerge (the continuity). The metaphor to illustrate the movement or reciprocation (as the term is repeatedly used throughout this thesis) is an ebb and flow. This explanation concludes that meaning-making is a process (dynamic feature) from which a constructed entity emerges (the product); hence, the reference to a fixed or static entity. In theme 1, the static problem was pointed out consistently, also its attribution to programmers. Jutant Gentes (2013) also points out that there is a tendency to fixate known patterns for problem-solving in conceptual

engineering design. However, the design is also a creative process, requiring an open-ended approach to present and explain patterns. This dichotomy remains both a challenge and an opportunity.

The researcher's challenge is to prevent "too premature commitments to a particular problem" or the over-commitment to creativeness, synonymous with the under specification-over-generalization problem (Jaszczolt, 2010). The hypothesis's notion of a threshold or contextual equilibrium of meaning seems plausible to solve this challenge.

A system suggests, apart from contextualisation, a process. In the context of meaning-making, contextualisation has three context-referencing aspects: a truth-conditional pointer, i.e., a presupposition entailed in the expression such as 'It wasn't me!'; the inferential pointer, i.e., referring to an implication or assumption; and lastly, an indexical pointer to a collection of assumptions (contexts) (Levinson, 2003). One crucial statement supporting the constructivist view in this thesis is that where meaning is concerned, context is mandatory. This statement invokes indexicality as the primer for indexing the relevant context-of-use. Indexicality is continuous and analogical in function, and therefore context-dependent, strongly opposing the static and fixed-form assignment of semantic value (e.g., an activity diagram).

6.1.6 Conclusion

It was shown that from a constructivist interpretive holistic worldview, the language-meaning relationship could not exist without a context. Also, it was discovered that context is an undervalued essence in that relationship. Whereas language use purposes meaning it depends on context. It was shown that such a dependency relies on the dynamic characteristics of the context. That dynamic showed that the context causes meaning, hence, the prominence given to causation. Furthermore, causation affects meaning, which results from the context acting as a 'use'.

Among the particular forms and functions of context as a 'use' (e.g., objective, social, cultural, and so on), indexicality is featured as the main attraction. A pointer/token indexes a context (Thibault, 2003), whether linguistic or non-linguistic. However, the resulting indexical-context relationship is tricky; how can it be explained? One explanation is linking

the **uncertainty** (a phenomenon (see the Introduction)) to relevant content. In this way, a context-specific relation is constructed. From thereon, the meaning that emerges is a matter of reciprocal dialogue and interpretation. Thibault (2003) labels the emergence (noun) and the process of its construction as the "contextually constrained meaning potential". Another explanation is the link between multiple abstracted meanings particular to a community, which interpreters use to construct and transfer non-linguistic context according to a shared practice. Thirdly, in all discourse (verbal or text), a communal context exists, allowing a kind of reflexive interpretation, i.e., interpreters of like knowledge are bound to make the same inferences to a large degree (Jaszczolt, 2006). Finally, the interpreters determine the continuity of the dialogue and interpretation (Lukianova & Fell, 2015).

It seems plausible that context as a 'use' metaphorically refers to a **mechanism** in the meaning-making process. From the preceding prominence to the linguistic-cognitive aspect, context as a 'use' also acts as a reasoning mechanism: the relevant facts in a dialogue are determined via construct and transfer as distinct reciprocations between three types of contexts, i.e., domain-specificity, delimitation/abstraction away from irrelevant information, and interpreter perspectives (Benerecetti et al., 2001). The notion of transfer is expounded in detail, differing only in the terminology used for the **reasoning mechanism** as a transfer mechanism to produce a goal (scope of a context), a reciprocation between explicit and implicit contexts, and the changing of worldviews/perspectives (Mousavi et al., 2014).

In conclusion, summatively, the above alluded to the equally essential notion of **explanation** and its direct relation with 'meaning' in the meaning-making process. The synthesis, to follow in the next section, is a precursor to the forthcoming Use Theory of Meaning-making's design and development, which intuitively points to an explanatory theory, which is expected to emerge from the insights gained and discoveries made in the preceding. Briefly, a meaning theory is a set of constructs or models of what is to be explained; thus, a Use Theory pre-empts a particularised use of constructs and models for the sake of explanation. Additionally, an explanatory theory attempts to explain a phenomenon or class of phenomenon, so things are as they seem. However, such an answer depends on the context of the questions (Young, 2001). The implication is that an explanatory theory can also be seen as a contextual theory (see also (Ogden & Richards, 1923)), which in turn comprises

contextualisation (Bamberger, 2008; Clancey, 2008). This conclusion abstracts to the topic of the thesis – Contextualisation: a Use Theory of Meaning-making. The novel theoretical terms are explained in detail in the next section as part of the particularisation of 'use'.

6.2   THE NOVEL FORM-FUNCTION SYNTHESIS: CONTEXTUALISATION

The reference disciplines define contextualisation as the adding of context to a conversation to cause effective communication; the human ability to resolve ambiguity, and to use it to construct meaning; as a strategy to design information for use between diverse groups (Katz & Te'eni, 2007; Miller, Oakhill, & Garnham, 1996; Neuman, 2006, p. 1443; Wyatt, 2014, p. 4). These definitions confirm the 'use' aspect of contextualisation, firstly as a framing/putting a concept into a context, resulting in meaning as the product of interpretation (context of production (Bianchi, 2001)). This product *simpliciter* refers to this aspect of contextualisation as the **context of use**. Secondly, as a process (Miller et al., 1996; Wyatt, 2014); as a construction (Zepke & Leach, 2002); as a justification of meaning-making (Bianchi, 2010; Bianchi & Vassallo, 2007); as a usability attribute in theory development (Bamberger, 2008); as related to a theory of understanding: the practising of communicative acts of meaning-making (Gumperz, 1992; Thibault, 2003). Finally, it exhibits the operations of construction and transfer (Ackermann, 1995; Cornish, 2008; Mousavi et al., 2014); as a shaper of meaning (Winters, Kirby, & Smith, 2015) or a form of comprehension (Alpay et al., 2008). These definitions confirm contextualisation as acting upon the context, resulting in meaning-making as the production of the meaning (context of interpretation (Bianchi, 2010)). One can henceforth refer to this aspect of contextualisation as the **context in use**. This component is what Neuman (2006, p. 1445) describes as "transgradience", which he suggests is the missing component to the notion of contextualisation. His description supports the thesis definition of the process component of contextualisation, stating that it entails "interpretation, inferences … applied to a *signal-in-context* … to achieve a global, … view of a situation".

In sum, the definition attributed to contextualisation is distinctly characterised as a collection of contexts, not a single thing. Such a collection constructs collective references, consisting of things that are subsequently tied together cohesively by relevance. Depending on the 'use' of the context, the collection may hold any of the following:

- attributes/aspects/properties of a situation or

- the interpretations of participants to a discourse (dialogue) or

- premises/propositions for an understanding of the practices of a community or

- facts or procedures and conditions (see *Contextualisation* definition).

Even though one can see that the concept of context holds promise in both form and function, its most important feature is to act as a causal agent/mechanism.

The following sub-sections are about context as a causal mechanism that enables an alternative form and function, respectively called **indexicals** and **literary devices** (collectively 'devices'). They are operationalised by what the researcher defined as the outer functions of dialogue and interpretation and the inner functions of construct and transfer. The terms can be described as causalities (relations) between them:

- The **dialogical** function operationalises an **indexical** via **construction**

- the **interpretive** function operationalises the **transfer** of the **device.**

The concepts highlighted above are closely related to the definition of 'use' as intended in this thesis. Therefore, the reader should retain this conceptualisation to appreciate their explanations and operationalisations fully. The theoretical framework (Figure 10) and meaning-making model (Figure 11) depict the above relations as visual aids to the synthesis.

6.2.1 The dialogical operationalisation of indexicality (context in use)

Concerning **dialogue**, a novel mechanism may be found in *indexicals*. Indexicals have everything to do with context. The views on context can be categorised as context-dependence (constructivist) or context-sensitive (positivist). For the constructivist, indexical expressions are an everyday occurrence. They depend on various linguistic and non-linguistic features as part of the dialogue in which they are used. Dependencies influence interpretation (Nordquist, 2018). This dynamic indicates a relationship between text, context and the dialogue: the referent and relation change with a change in the context (Cornish, 2008). Two views of context-dependency exist. The one view is that the value of the referent is provided by the context (context-sensitive). The other view is that the index depends on context for an interpretative value (MacFarlane, 2007). The mainstream (Kaplanian) view is that context and the expression pointing to it determine the expressional content/interpretation. In this view, the interpretive yield is seen as the content of the expression (Parsons, 2011). Thus, interpretation is not a matter of context-sensitive expression but comprehensively reliant on context (Davis, 2013). Positivists argue that

indexicals are structurally, semantically and pragmatically constrained by fixing the surrounding text. An example is a formalised domain-specificity (Benerecetti et al., 2001, p. 117).

One exposition favouring this thesis is the perceived distinction between indexicals and contextuals, both context-dependent notions (Rast, 2014). For example, the parameters of time, location and speaker, which act as a context of situational references, allude to a true or 'pure' indexical (Perry, 1997). In contrast, a context that represents the knowledge states of the participants is contextual. In a later work, Perry (2017, p. 9) assumes an extension of the default definition of indexicals; *undexicals* do not refer to context features but refer to prior knowledge such as everyday use or socio-cultural practice. Rast (2014) extracts three working definitions of which the third correlates well with the notion of undexicals: 1) context represents a situation that allows for the determination of meaning (semantic fixing) of an indexical or that which the indexical represents; 2) context acts as a semantic framework, which consists of the shared meanings of a particular group of interpreters; 3) context acts as a reference point. This third distinction is explained in the next paragraph and illustrated (*Figure 11: A synthesis of three different but related meaning-making models*).

The correlation between contextuals, indexicals and undexicals illustrate two types of context-dependencies that can be abstracted to a specified or unspecified context. One could also see context as a placeholder, which holds things observable or discoverable in this sense. The adaptation includes further refining the definitions to **indexical contexts** and **contextual indexes**, discussed next.

6.2.1.1 The indexical context

An indexical context alludes to the construction of a point of reference. This obligation and the index form a relationship: a context (Bouquet, Serafini, & Thomason, 2008). Firstly, the context is indexical if the point of reference and demonstrative are related (Etelämäki, 2005). Secondly, if the interaction (relations) and context point to each other. The principle illustrated by this adaption is that a causative relation occurs between the index and context through the act of pointing or insertion by necessity. An indexical context is analogical to a sentence of unary purport, i.e., intransitive. An example in everyday language illustrates: 'Product A is being marketed' implies an indexical via the common form '*someone* is marketing the product'. In the indexical form, the true meaning relies on constructing context

via shared knowledge about the product or marketed depending on a type of share, e.g., a group perspective, cultural influences, or operational domain (Baker, 2012). The meaning of the indexical context assumes that all interpreters share a common ground in the dialogue (Roberts, 2015). This truism is confirmed by the knowledge gained in the preceding that interpreters reciprocate individual knowledge to form new knowledge, and context itself is a collective of constructions of multiple potentially explanatory resources, cohesively related. The analogical reference aptly illustrates cohesion. This form of indexicality describes a **relational movement**.

6.2.1.2 The contextual indexical

A contextual indexical, on the other hand, constitutes the act of inference from multiple meanings. In this case, the index points to the most relevant referent caused by the context as a collection of interpretations. The index initially points to multiple uncertainties: textual or notational ambiguities or interpretive sophistications (Parsons, 2011). The initial multiplicity necessitates the construction of familiar interpretations using multiple devices inserted as a partially constructed context. (This mechanism illustrates the human preference for contextual indexing/inferencing (Ervin-Tripp, 1996)). A new inference can be drawn from this constructed context - the resulting explanatory referent (Recanati, 2005) again in the form of a device. This second illustration compliments the general principle of parsimony, i.e., given a choice, an interpreter will prefer an everyday explanation over a scientific one. The indexical depends on some commonality inferable from the context constructed by the interpreters. The inference is preferred because it aligns with a constructivist approach. This form of indexicality is primarily a **referential movement**.

A feasible explanation of the functioning of indexicals is drawn from the Reference Theory, i.e., the principle of directing/pointing or constructing. The theory suggests that one can construct the meaning of uncertainty/indexical via *definition* or *description*.

Description "typically consists of one or more markers together with a stereotype – a standardized description of features … generally are criteria … which in normal situations constitute ways of recognizing a thing…", e.g., "this (fruit) is a lemon". The concept in parenthesis marks the referent, which explicates the indexical (Putnam, 1975a). A description is primarily **relational** because of the requirement of cohesion. Cohesion is

defined as a plausible relation between the indexical, reference and referent. This view is commonsensical, at least. Without empirical testing, one knows that the referent (the object described as a 'lemon') of 'this', the indexical, must be a higher-order class description related directly to the lower-order description. How? If not from Biology at school, then at least from own observations of, experiences with, and uses of everyday things. The higher-order collective class suggests a direct relationship between some of its features and the lower-order thing and a contextual relationship due to its other features. E.g., attributes such as form (shapes being asymmetrical, dimension, location, etc.) and function (edible, nourishment, enjoyment) suggest a contextual frame. Within that frame, the specifics of the referent form and function must correlate. For example, from experience, the lemon, although acceptable only to a required palate, is still edible, and it indeed is locatable where one would suspect to find both referent and class, i.e., natively in an orchard or artificially on a shelf in the 'fruits' area of a market. After this long-winded rhetoric, the reference and referent can be seen as contextuals: one a collective, the other, a singular.

Definition pertains to **referentiality** due to the act of inference. Why? Because inference defines, narrowly or broadly, the referent via drawing upon the collective references. In interpretivism, the inference is a construction of the cognitive processing of the collective human interpretations. The researcher believes this is what (Putnam, 1974) meant by stating: "Traditional semantic theory leaves out two contributions to the determination of reference – the contribution of society and the contribution of the real world" (Ibid., p.711). Accordingly, the inference determines the referent, but indexically so because the inference depends on the context. Determination in this sense is non-static, and therefore one can accept it to mean definition instead. The referent is a definition by extending the inference from a collective interpretation "because extension is, in part, determined *indexically*." (Ibid., p.711).

6.2.1.3 Transfer of meaning via indexicality

Both cases of indexicality make use of devices such as metaphor or analogy. Therefore, a device as contextual can act as both reference and referent, respectively indexical context and contextual index. This claim raises how meaning can be transferred between contexts, a question similarly raised by Recanati (2015) in his article relating to the specific topic of mental indexicals or cognitive indexing. He questions whether one can only

observe or infer what several interpreters think if all are privy to the *same* context. What happens if interpreters do not share the same context; hence, the question. At the outset, assume that indexicality is a mutuality, not a duality. It is because indexicality is a distinct linguistic-cognitive feature. This premise constitutes the cohesion between thought and expression. In turn, it relates to indexicality because the expression gives rise to multiple explanations in the thoughts of interpreters given different contexts.

Recanati argues against the minimalist view of the indexical-contextual relations as having truth conditions. Those views are appreciated and essential in many other explanations. Still, the constraint is too narrow for use in the thesis, which at the outset presumed the less constrained holistic-interpretive stance towards context-dependent inferences. Therefore, none of the minimalist views is discussed further. Instead, the researcher adopts the idea of the "thought/truth-conditions pairing *being* relative to context" to stipulate that a cognitive certainty ('truth') arises from the constructed relation with a context, not empirical but **common sense reasoning**. This premise alludes to the notion of contextual meaning, i.e., an explanation inferred from the context. Based on this premise, one can argue two possible problems: 1) a dialectical between thought and expression, and 2) diversity in mental constructs. The first arises as a natural phenomenon experienced daily. The dialectical is caused by individual competence or lack thereof to articulate thoughts equivalent to the actualised signalling, i.e., verbal or non-verbal. The second arises from the natural phenomenon of subjectivity, i.e., interpretations are subject to individual experiences, past, present, and projected.

In answer to the question raised in Recanati about the difficulty of meaning-making and transfer between different contexts, one observes that it has less to do with the content, which is not transferable, and more with a means of coordination of thought with relational conditions constraining the means. The conditions or references have content; its shareable features (Recanati, 2015). In his view, as the researcher interprets it, the vehicle (mental file) associates with a reference (placeholder) such that it holds one or more "descriptive meanings" or attributes. Thus, each vehicle (mental file) "contains relevant information about the reference" (Recanati, 2015, p. 24) and points to the same referent. This view answers the question. Even if each mental file is constructed differently, the constraint enforces coordination/shareability, determining the equivalent inference (referent).

The researcher extends this singular solution to the question (Recanati deals with it only from a speaker position) of how meaning is transferred between contexts. During the dialogue in which the expressions of thought are reciprocated (interpreted and reinterpreted), users of the language must associate each expression with a cognitive construction and coordinate (test if you will) it against a shared description. The shared description is a collective of [higher-order class] features related to the cognitive construction – Recanati uses the word associate for relating (Ibid., p.12). Both the higher-order class and the lower-order are possibly contextuals (or indexicals). This relation constrains either or both reference or referent. In the preceding, indexicals and contextual as causal concepts also assume either causing a reference or referent. In the researcher's view, the content is constructed by the device, which forms the reference or referent. Because of the typical features of a device, it seems conceivable for the device to act as a context or placeholder of content or meaning, comprehensively explained in the next section.

6.2.2 The interpretive operationalisation of literary devices (context of use)

Concerning the **interpretation**, a novel interpretive mechanism may be found in language use in what is sometimes referred to as *literary devices* (a 'device' for short). The motivation for this novelty can be found in an excellent reference to a narrative being an "intervention device" (De Luca Picione & Francesca Freda, 2016). Based on that explanation, all of the devices in this section and the subsequent theory design and development should be understood to mean the same – an intervention device. However, a short description of each suffices for now. These devices are discussed in the following order: 'analogy' (cross-referenced with metaphor and mental models), 'anecdote', 'metaphor' (cross-referenced with the analogy), 'heuristics', 'narrative' (includes 'stories'), and 'mental models; all of which can be classified as 'contexts' in and of themselves.

At an atomic level of interpretation, inferred knowledge constructions become abstractions/generalizations at a higher level of categorisation of knowledge, a learned endeavour of patterning relevant inferences. This patterning is a familiar feat for kids but, unfortunately, not an easy process for adults. A more palatable process for adults is an analogical abstraction, i.e., the projection of knowledge from one context (Gentner & Hoyos, 2017). Abstractions, intrinsic to theoretical approaches, are extensions by analogy. The

analogy extends the form and meaning of the linguistic-cognitive constructions; a metaphorical association with the core meaning is formed and understood analogously (Ibbotson, 2013). **Analogy** serves to solve problems in an everyday fashion "by extending our reasoning from what we understand to what we don't" (Juthe, 2005). Analogy transfers complexities and sophisticated interpretive knowledge "strictly human-centred and natural fashion" (Lofi, 2013). The well-known method of idea-thinking is an exemplar of analogy (Dam Teo, 2017). A pertinent reason for using a device such as analogy is that it serves interpreters who can only make weak inferences and those who can make strong inferences, affording meaning-making to non-technical and technical users irrespective of the level of expertise. A critical aspect of analogy, specifically analogical reasoning, is its applicability to the thesis because of the 'discovery' role. Such a role aligns with using a device as a mechanism of meaning-making because meaning is discovered through constructing a context and the subsequent inferences; both manifest discovery characteristics. When used to support a conclusion, the role is extended to justification, which can be plausible (weak form) or predictive (strong form). The former is of pertinent concern in this thesis, which assumes common-sense reasoning as the basis for its arguments in the theory development. Such reasoning invokes interest in the cognitive processes involved; in particular the roles of discovery and construction in the inferential outcomes it purposes, and "… how do we combine them with other forms of inference, .., especially theoretical confirmation?" (Bartha, 2013).

Anecdote serves as a relational neutral construct of "recalled experience" (Schwartz, 2015). Positivists argue that it is "uncontrolled subjective observations". If one considers that the positivist orientation is justification rather than discovery, one can see the distinction. The former explains only via proven empirical patterns, while the latter invites a more open holistic approach. (Novella, 2010). In this manner of thinking, the anecdote acts as a brief momentary construction related to a real case intended to reveal the truth (Mutonyi, 2016). An anecdote relates to a story because of shared characteristics - flow or continuation, i.e., one fact following another, instead of a set of facts. This feature is pertinent to continuous dialogue because it can join fragments of facts holistically, to form a context or contextual meaning. Such a construct is much easier to understand, retain and re-apply to recurring cognitive and practical complexities (Devaney & Johnson, 2017).

The **metaphor** of all the devices is probably the most well-known and used, albeit underutilized due to its paradoxical nature. It connotes a sense of meaning (intent) while denoting a reference (extension). The construction of a metaphor includes a non-linguistic and non-conceptual thing as a referent, purposing to 'fix' the referent. Something in the metaphor relates to another meaning between the contexts (Hausman, 1983). Something else is an inventive cognitive substance whose interpretation requires both local and non-local contexts (Coulson & Oakley, 2005). A metaphor, a figurative expression, shifts a word or phrase from everyday use to a context in which a new meaning emerges (Harbus, 2008). An essential aspect of metaphor is that it focuses on the change aspect of the context in terms of complexity (dynamic systems theory). It means a relationship between social and cognitive systems as processes or movements rather than stagnant, fixed entities (Cameron, 2007); a dynamic conceptualisation device that binds the construct (metaphor) to the flow of experience (Müller & Schmitt, 2015). A relationship forms between the contexts and the semantic relations, between the metaphor and the active cognitive concept, i.e., two knowledge domains become related due to a shared property that both have (Shinjo, 2014). However, some interpretive difficulties arise between single meaning and multiple-meaning interpretations. An example of applying metaphor in an Information System's perspective can be found in the XP-agile environment (Khaled & Noble, 2005). Herein proposed that metaphor causes understanding between diverse interpreters because it does not require familiarity with the technical jargon. However, the use of metaphor is discovered to be underutilized in the XP domain. The study makes the salient point that "… it is a tried and true learning technique which people use very frequently … as a fundamental part of *everyday* communication" (Khaled & Noble, 2005, p. 4). A usable definition, which summarizes the discussion on metaphor, is that [it] "is the use of one reference to a group of things between which a given relation holds, for the purpose of facilitating the discrimination of an analogous relation in another group" (Ogden & Richards, 1923, p. 213).

Heuristics is another well-known device in decision-making circles. Still, this thesis extends to a cognitive operation of reasonable (not precise) matching of goals by using the surrounding information structures (contexts). Heuristics are context-dependent and **facilitate** inferences, operating as a function or mechanism for discovering inferences (Chow, 2011). This type of inference is argued especially from a positivist view as bias. Some biases invoke heuristics, which favours qualitative research over empirical research

because of the less stringent criteria of plausibility (Trinh & Le, 2018) or probabilistic reasoning (Mueller, 2014). Thus, heuristics appear as an everyday use at the intersection between two cognitive means of reasoning: probabilistic and intuition, which explain/judge uncertainty (Bottom, Gilovich, Griffin, & Kahneman, 2004; Gregor, 2002). Despite having multiple forms and constraints such as bias, heuristics (Gigerenzer, 2008; Kahneman, Slovic, Slovic, & Tversky, 1982) are valuable in everyday use because "… they can exploit evolved capacities naturally available to humans to find different solutions for a problem than a statistical calculus would" (Gigerenzer, 2008, p. 22). The three heuristics best suited for theoretical and practical use are availability, representativeness (Lempert, 2015; Todd & Gigerenzer, 2000), and anchoring (Parsons & Saunders, 2004; Rachlinski, 2008). The 'availability heuristic' is constructed from pre-existing experiences/contexts/mental models, while the 'representative heuristic' is constructed from a related prototypical similarity/stereotype. These two heuristics are well-documented as experiments *during* artefact construction (Parsons & Saunders, 2004). Still, it is assumed that these two heuristics are most suitable as an everyday means of explaining the 'wicked' problems *before* artefact construction, which to the researcher's knowledge, has not been attempted yet.

An exemplar of the **narrative** as a device of use can be found in case study research concerning failed information systems projects. The narrative of the case study is presented as a means to study human interactions. It highlights incorrect assumptions, such as creating a framework (context) of reference for a more profound understanding (Dalcher & Drevin, 2003). Stories aid in contextualising known and unknown situations to improve understanding; sorts of pre-packaged contexts enhance causal relationships (Devaney & Johnson, 2017).

The **mental model** is a final device for everyday use: constructing internal or individual representations of meaning with some causal mechanism linking the effects between input and output (Erlich, 1996). A mental model is a form of contextualisation: 1) the innate human capacity to construct a mental model and infer conclusions from several inputs (Garnham & Oakhill, 2013) or 2) as a shared meaning construction conceptually relevant contexts. It serves as a cognitive mechanism to construct descriptions, explanations (interpretations), and predictions of states and behaviours in a system context (Jonker, Van Riemsdijk, & Vermeulen, 2011). Mental models explain worldviews, helping to make sense

of the world via interpretation, providing default assumptions, and suggesting a course of action aligned with the context of use (White, 2015).

In sum, another demonstration of indexicality, the relation between indexicals and the device, is beneficial. It shows how context influences metaphor use (Shinjo, 2014). Metaphor facilitates the construction of meaning via the reciprocation of the unfamiliar component with constructed metaphorical references. This process continues until a stable meaning emerges (Krippendorff, 2005). The use of indexicals is embedded in dialogue. Indexicals have a special relationship with the user's perspective (interpreter) of the indexical expression. Subsequently, perspectives are socio-culturally and linguistic-cognitively bound; said otherwise, contextually bound. Perspectival binding suggests the potential for a change in the meaning because they act as contextual constraints. It is common knowledge that a person's perspective can change due to social or cultural influences, which inevitably "shifts" the indexical reference. Therefore, an account of fixed reference is hardly acceptable considering the possibility of perspectival change (Roberts, 2015).

Another distinctive feature of indexicality is the continuous dynamics of human cognitive functioning, suggesting mutability. This operation contrasted with the traditional position and fixed reference account of the context's semantic value, the first being static, the latter dynamic. In a relational theory of meaning, the context is viewed as an indexical form and function. This statement echoes the basic tenet of indexicals being context-dependent or having mutable referents caused by contextual changes (Braun, 2017)). The form of the indexical device is contained in the context, a function of construction within a dialogue (Ginzburg, 2019). A unique characteristic of the indexical-context relationship is that interpretation (including subsequent re-interpretation) causes the transfer of meaning (Mousavi et al., 2014), putting to use the device (itself a (sub) context).

Finally, several concepts are strikingly apparent throughout this section: construct, transfer, dialogue, interpretation, context-dependence, referentiality, relatedness/cohesion, and the dynamics of the devices, context and indexicals. Furthermore, the interrelatedness between context, device and indexicals compose the essence of the subsequent discussion.

6.2.3 The merger between the novel form and function

In this section, the hypothesis frame (Holzapfel, 2017) is reintroduced together with a novel system of semiosis, which emerged from the preceding, to explain the relations between context, device, and indexicals. Similar constructs from the seminal works of Ogden and Richards (1923) and Peirce (Jutant Gentes, 2013) are referenced to support the novel synthesis that explains the framework (Figure 11). The novelty is construed by abstracting away from the Ogden & Richards diagram, which explains the relational aspect of meaning-making from the non-symbolic or cognitive perspective and the cyclical semiosis between sign, mental formation, and object in the Peircean model.
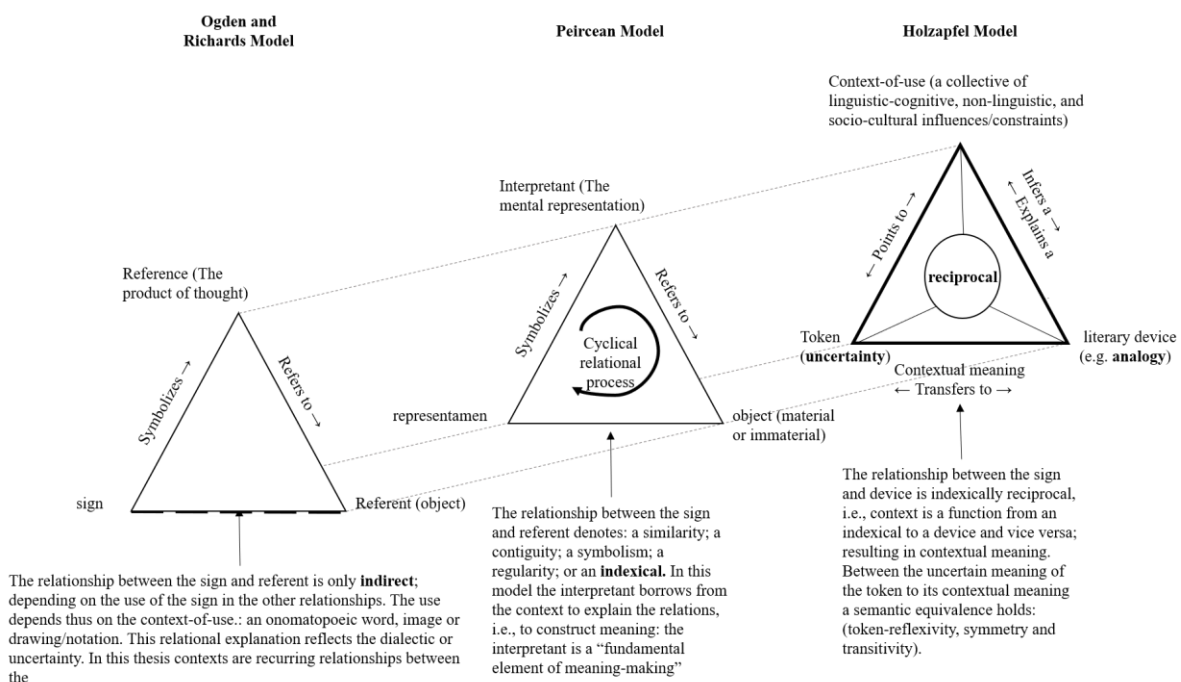
Figure 11: A synthesis of three different but related meaning-making models

The third model is the researcher's semiotic synthesis which explains the inner form and function of contextualisation: context-of-use and context-in-use. It is understood that the context of use is the placeholder that holds interpretations constructed from the use of any number of literary devices. The context-in-use is implicitly illustrated in what follows as the relations between the components and their causations. A collective agreement is reached (Lukianova & Fell, 2015), encouraging the interpreters to select the most appropriate (plausible) inference as the object of explanation: the contextual meaning. A helpful definition is "The character of an expression is its meaning — it is what two semantically

equivalent expressions have in common" (Parsons, 2011). The internal process is one of construct and transfer, which operationalises the context-of-use. Abduction, *"when a researcher seeks to choose the 'best' explanation among many alternatives to explain 'surprising facts' or 'puzzles' identified at the start of the research process"*, sufficiently defines the context-of-use process. In the third model, the semiotic process is akin to an open-ended process of reciprocation where the contextual meaning becomes a device for reuse. This view is in agreement with the approach that meaning is the translation of signs from one system to another (Lukianova & Fell, 2015, p. 616).

Analogy (one example of a device) serves to illustrate the model. The principle accommodated herein, which relates to contextual meaning as the output of an abstracted commonality, produces an inference from the specific context-of-use. The process is an abstraction mapping aligned to both referential (object) and relational structures. It validates a match between the analogue (the literary device) and the token (the uncertainty) according to constraints such as "causality and symmetry… This reflects a tacit preference for coherence and inferential power" (Gentner & Hoyos, 2017). The analogy is constructed from known/familiar knowledge/experiences (context) compared to the unknown knowledge via inference; to "…transfer a system of relationships from a familiar domain to one that is less familiar" (Naseriazar, Özmen, & Badrian, 2011, p. 526). If the comparison holds, it satisfies the transfer rule: semantic equivalence. It seems plausible to point out the effective use of analogy in science instruction, which supports the current reference in the thesis and the theory's possible use in education (***Error! Reference source not found.***).

Suffice it to summarise aspects of the framework to simplify the association between the insights gained from the preceding sections and what follows in developing the emergent theory. Everyday use of linguistic and non-linguistic devices suggests a possible means to construct and transfer meaning via dialogue and interpretation. Context plays the leading role in meaning-making, causing contextual meaning: the novel object of inference/referent. Contextual meaning offers an explanatory dualism, drawn from Kecskes (2008) such that 1) the construction of a context by inserting any number of meanings alludes to an **indexical context**; 2) an inference is drawn from a constructed context, which constitutes the representation of the explanation of the uncertainty, a **contextual index**. It is this simplified representation that becomes a transferable entity of explanation: the **contextual meaning**

(the insertion or inference of a transferable meaning (object) explains the uncertainty (the term used to refer to either ambiguity or interpretive sophistication). This definition synthesizes (MacFarlane, 2007) and Kaplan (1989) (*see The dialogical operationalisation of indexicality (context in use)*). A token/uncertainty (MacFarlane's index) depends on the context to determine an interpretation. Alternatively, the context together with the indexical causes the meaning (Kaplanian inference).

An illustration by way of analogy will do. The following sentence, courtesy of (Putnam, 1975a) provides the analogous components: "this (fruit) is a lemon". The components are *this* (*parenthesis*) and *lemon*. The word "*this*" is indexical. The () marks the reference/point of reference/placeholder or context. *Lemon* represents the referent or object that explains the indexical. The indexical expects a context, which will explain it. Putnam (1975) explains the two possibilities of explaining an indexical as *definition* and *description*. Let a simple case be such that:

a)   The () is filled with multiple kinds of fruits. One then applies templates or prototypes of *lemon*. The fit between the template and the kind of fruit allows the inference **that** [this] fruit is a *lemon*. This method is known as "*definition*" - the meaning of the referent is *inferential*. One can say the meaning is contextually indexed – hence the thesis' concept of a **contextual index**. The analogy applied is such that the meaning of a user story is uncertain (indexical). A dialogue causes the construction of a context (placeholder), i.e., whatever surrounds the story, from which an agreement is reached about the meaning. Finally, an index (a literary device, e.g., metaphor) is inferred to represent the meaning. That inference becomes the referent or contextual meaning.

b) The () is filled with multiple fruits. One then inserts/constructs possible meanings by characterising their dimensions, forms and functions. Whatever relates the best with the referent of *lemon* qualifies [this] fruit is a *lemon.* This method is known as "*description*" – the meaning is constructed through *relation* or cohesion. One can say the meaning is indexically contextualised. Hence the thesis' concept of an **indexical context**. Using the same example of a user story, interpreters go round during the dialogue and assign several explanatory devices, which form the reference/placeholder/context. After interpretation and agreement, a representative device is selected, which becomes the referent … (ellipses intended). In this case, an indexical context is constructed as a descriptive reference. Thus, the second

criterium of referentiality is constituted. The indexical context is attributed to being a 'description'.

The reader should note *this* is a true indexical, which necessitates an existing referent [lemon]. The mechanisms definition and description apply to determining the context, complementing McFarlane (2007) and Kaplan (1989). However, in the thesis, anything with an uncertain meaning or multiple meanings is replaced or represented by an indexical. The principle of indexicality is noteworthy. The significance of the illustration is the backing it receives from the theory of reference eloquently articulated by Putnam (1975a) in his seminal work, which implicitly entails both cohesion and relevance, the two other necessary constraints for a theory of meaning. Further, it clarifies the pertinent differences between the third model and the others:

- It explains both the novel form and function, i.e., a context-of-use and a context-in-use,

- It illustrates the dual reciprocation process. The token acts as an indexical (uncertain meaning); it can get meaning either by referencing a constructed context or being transferred to a literary device inserted into a collection of devices (also a constructed context). Such a process conforms to the principle or premise of holism. However, pure holism is constrained by the referentiality condition, the relational condition, and the most significant relevance condition. The first mandates the existence of a referent (Bjorkman, 2014), whether current or constructed (Stahl, 2007). The second mandates that cohesion holds at all sides of the triadic to make it holistically related. The third refines both via the relevance condition, i.e., inferential appropriateness (Carston, 2002), or a relation between cognitive effect and efficiency (Carston & Powell, 2006). These constraints explain the use of 'holistic' as a component of the emergent theory.

A more succinct and fitting summation of the above can hardly be found other than the following, providing the best definition of a metaphor.

"… a really good metaphor can create a new context… a strong or vital metaphor… requires active interpretation. More importantly, it must 'fit' the situation, in the sense that it must be relevant and lead to important results relative to the interests and needs of the

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persons involved… Further, whoever makes the metaphor is suggesting a new context in which to adequately handle a particular theme. By putting a theme into a new context, the speaker creates an opportunity for the dialogue participants to take a new stance to the theme" (Doyle, 2007, p. 93).

From this, one can construe some of the components for theory development: a device (represented by the metaphor), context (represented by situation/theme), indexicality (represented by 'take a new stance'; pointing to), a constraint (represented by 'relevance'), construct (represented by 'makes/create'), transfer (represented by 'putting'), and dialogue and interpretation.

6.3 CONCLUSION

Theme 3 started with the hypothesis proposed at the end of theme 2. This review's literature dealt explicitly with the context concerning the two negatively impacted features of 'use': referential and relational (cohesive) integrity. The literature shows that the notion of context provides a mechanism to counter the loss of integrity. The idea of contextualisation is pronounced as representing context as a form [thing of] use and a function of use; hence, the concept of movement surfaced, aligning with the alternative or dynamic feature of 'use'. The literature showed hypothetical proof of the potential of contextualisation to construct a transferable contextual meaning, which purports an idiosyncratic semantic equivalence as potentially correcting the current 'use' problem.

The main feature of the rethink consisted of highlighting the unequivocal link, the relationship between language, context and meaning and the causative effect of context in making meaning. From the preceding, it should be clear that context's definition, characteristics, and dimensions in this study override the restrictive use of "factual" context in the positivist tradition. As a matter of fact, using context in the rethink opens up numerous potential meanings via construction and interpretation within a continuous dialogue. The rethink further embodied a dynamic model of cognitive processing over the current static model, highlighting that humans operate naturally by using each other's interpretations as contexts to infer the most appropriate meaning. This process emerged as contextualisation, a novel form-function synthesis that posits the construction of a context and the functioning to make meaning. Thus, from this study, two theoretical concepts emerged, namely the context-of-use and the context-in-use. These concepts are operationalised by dialogue and

interpretation, in which a context is constructed using literary devices. Literary devices are posited as meaning-making mechanisms every day, conclusively denoting the researchers claim to solve everyday problems. The next chapter develops these concepts and mechanisms in a Use Theory of Meaning-making.

7   CHAPTER 7: THE USE THEORY OF MEANING-MAKING

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Topic 6: The
emerging 'use'
theory

Sub-question 6:
Why a 'use' theory
based on design
theory?
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7.1   INTRODUCTION TO THE BUILDING OF THE THEORY

> "Homo significans – meaning-makers, reflects human beings' desire to create meanings" (Lukianova & Fell, 2015)

In this chapter, the researcher completes the preceding theorising activities by building the Use Theory of Meaning-making theory. As a starting point to the theory-building process, one should perhaps define what a theory is. In doing so, the reader can compare the essences of these definitions with the aims/claims of the theory. Many definitions are available, but the researcher considers the following definitions a usable coverage of some of the prominent theoretical terms:

"theory is a model. It is an illustration describing how something works by showing its elements in relationship to one another" (Friedman, 2003).

"a plausible … acceptable general principle or body of principles offered to explain phenomena"; "abstract thought: speculation"; "a hypothesis assumed for the sake of argument or investigation" (Merriam-Webster, 2015).

"the word theory will be used here rather broadly to encompass what might be termed elsewhere conjectures, models, frameworks, or body of knowledge" (Gregor, 2006).

"abstract entities that aim to describe, explain, and enhance understanding …and to give a basis for intervention and action" (Gregor, 2006, p. 616)

All of the definitions contain elements of the theory being built in this chapter. Still, the following definition positions the Use Theory of Meaning-making within the interpretive perspective where "the goal is not to develop theory that is testable in a narrow sense…but 'for understanding meaning, grasping the actor's definition of a situation…and the situation-specific meanings that constitute the general object of investigation…constructed by social actors'" (Schwandt 1994, p.118 in (Gregor, 2006, p. 615)). Against this backdrop of definitions and the many references to understanding and meaning, they seem to suggest an explanatory theory because it seeks insight into the phenomenon and relies "on varying views of causality and methods for argumentation." (Gregor, 2006). In the researcher's opinion, the last quote suggests 'use' in the sense of function.

At a high level of abstraction, the phenomenon of interest is synonymous with 'wickedness', which refers to its two components, complexity and multiplicity. In the real world, complexity means ambiguity in the dialogical realm. Accordingly, multiplicity means fragmentation in the interpretative domain. However, these terms collectively point to uncertainty. Uncertainty becomes an indexical, which can take any form or function associated with the phenomenon. Its meaning depends on the context.

Uncertainty is rooted in an explicit and implicit form. The explicit form is the overdetermination of patterned/algorithmic form (text and notation) and function (the multitude of languages currently in use) without understanding (Schwartz, 2015). The consequence is a gap in the translation of form-to-function (and *vice versa*) or between the textual-notation artefacts (requirements specifications) used in problem-solving in requirements engineering. As is evident throughout the preceding chapters, users in the context of information systems (more specifically requirements engineering and requirements specification) have not been spared the consequence of this gap, which exhibit a linguistic-cognitive state and behaviour as follows:

- Uncertainty of understanding the multiple particularities of notations (various arbitrary semantics; inexpressiveness of form) (Al-Rawas & Easterbrook, 1996; Bures et al., 2012; Ibrahim et al., 2014)
- The inability to recompose fragments of knowledge because of deeply decomposed functionality; losing track due to a lack of cohesion and referentiality) (Denger et al., 2003; Hanks et al., 2001).

The implicit form of uncertainty is subtly evidenced in the initial systematic literature review as human error and delimiting or prefixed mental models. These forms of uncertainty only become explicit once the delimited interpretation or lack thereof is expressed and fixed in an artefact. The linguistic-cognitive state and behaviour associated herewith are known as Imposter syndrome (a form of social anxiety): the fear of being singled out as 'inept' or 'unaware' (Kozyrkov, 2018). Imposter syndrome is further associated with psychological safety, which refers to a belief about the group context, generally associated with the projection that the context is positive. If the context is positive, individuals should feel encouraged to participate freely in the group discourse (Kakar, 2018). Still, if the context is perceived negatively due to imposter syndrome, it adversely affects individuals and groups. Because participation in dialogue is essentially cognitive, the researcher posits that the current lack of participation can be positively affected by the Use Theory of Meaning-making.

The behaviours above, essentially cognitive, prevent the complete and comprehensive understanding and meaning-making of form and function. The language used and supposed to express understanding is unfamiliar and increases the interpretive sophistication. To prevent the reader's potential confusion, the phrase 'interpretive sophistication' refers to fragmentation as previously defined and explained (Section 5.2.6) The unfamiliarity triggers the states and behaviours above, explaining current mental models as part of the poor requirements problem definition (the phenomenon of interest). The linguistic-cognitive link to meaning-making is again herewith made clear. The claim above highlights the ill effects of the linguistic-cognitive function, which is **not** used for its meaning-making purpose and potential. The result is an extension to an artefact in multiple forms of text and notation. Additionally, the neglect of the non-linguistic form and function, mainly attributable to the omission of context, was explained.

The researcher assumed that the human linguistic-cognitive function is holistic (i.e., physical, psychological and intellectual). Subsequently, through the discussion, it became clear that meaning is not reducible to binary semantics because it is innately dependent on [an] interpretation. Interpretation unequivocally implies a dynamic of more than binary possibilities. It implies human intervention and invention; hence, the postulate that 1) language use must be inventive and 2) intervening. How? A 'use', which potentially qualifies as a new invention that can be used as an intervention, is developed central to the theory; an everyday use.

From the extensive discussions on poor requirements specifications and the apparent cause, one may get the impression that this thesis attempts some semantic or pragmatic theory, but that would at best be presumptive. Two concepts directly related to the use theory's development and design science emerged from those discussions: invention and intervention. These two concepts support the purpose or type of the theory, which hopefully emerges during the discussions to follow. In aid of clarity and explanation, they are defined as follows:

- Invention: is strongly associated with the machine, device, mechanism, and artefact in design science. It is also associated with synonyms such as innovation, construction, development, design, and conception. These allude to the two intended theoretical outcomes/contributions of the Use Theory of Meaning-making: primarily to improve the human linguistic-cognitive process and secondary to improve the artefact.

- Intervention: the action of becoming involved in a problematic situation by improving it or preventing it from worsening. This definition describes the interaction envisaged for the human interpreters during the operationalisation of the theory's mechanisms. This fundamental notion is distinct from 'interaction', a communicative act or direct involvement with someone or something necessary but supplementary to intervention. The importance of the two concepts highlighted will become succinctly clear as the development ensues.

From the insights gained during the investigations throughout Chapters four and five and the discoveries made throughout Chapter 6, the requirement of stating the objectives of the theory follows.

7.2 OBJECTIVES OF THE THEORY
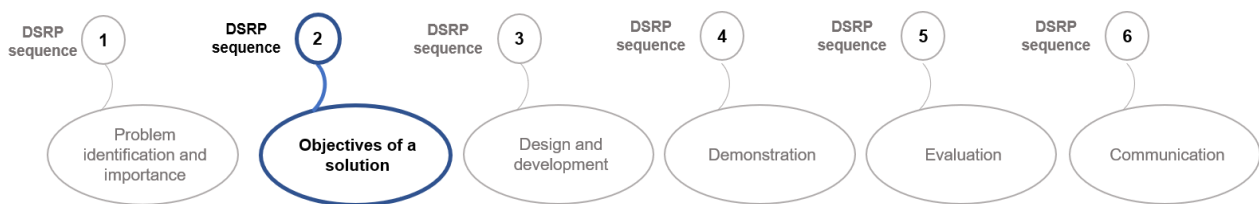
7.2.1 Theoretical objectives

The theoretical objectives are depicted in Figure 13: Synthesis of the outer and inner functions

1. Illuminate the specific phenomenon of the form-function problem, and make the theory generalisable to a class of phenomena, i.e., the phenomenon of the 'wicked' problem of complexity and multiplicity. *Requires a functional common-sense explanation of the use and for the use.*

2. Counter the delimiting effects of the prevailing 'unilateral' worldview in information systems. *Requires a holistic worldview*

3. Prove the positive movement (efficiency) to reach a threshold (contextual equilibrium) of ordinary meaning (effectiveness) of contextualisation *Requires an emergent (dynamic) mechanism and process of the use and for the use.*

7.2.2 Practical objectives

The practical objectives can be inferred from Figure 15: The 'movement' between context-of-use and context-in-use

1. Facilitate the continuous reciprocation of everyday dialogue and interpretation among information system users. It r*equires everyday use high in affordance, free of domain-specificity, and agnostic to current information systems methodologies.*

2. Improve the current and future use of constructs (text) and models (notations) in requirements specifications, i.e., the domain-specificity objective. It r*equires a simple mechanism and process, usable for the requirements specification through the requirements engineering process.* Furthermore, this objective alludes to the restoration of the loss of referential and relational integrity.

3. Improve the effectiveness and efficiency of the current language use in IS. It r*equires high usability, i.e., affordance, low training, and freedom from a particular socio-cultural use.*

7.3 RELATED WORKS: A THEORETICAL REVIEW

7.3.1 The theoretical terms within reference theories of meaning

Here follows a reference to the constructs or theoretical terms used in developing the emergent theory and their explanation within theories. An attempt at developing an emergent theory includes selective theories that form the basis of the emergent theory. The emergent theory being a 'Use Theory of Meaning-making', necessitates at its boundary a review of one or more theories of meaning. The difference between Chapter 3 and the current review is that the former accounted for a broader generalised scope. The current scope is relevant to the emergent theory's development because it explains the basic terms internally related to it. These terms will be italicised for clarity during this review.

In general, a theory of meaning includes or depends on a theory of signs; sign theory, in turn, attracts theories of meaning; thus, semiotics play a constitutive role (Herbert, 2013).

Semiotics is defined as the theory of signs and symbols, wherein representation and *transfer* of meaning play a constitutive role (Mingers & Willcocks, 2014). While authorities of semiotics concentrate on its influence and operations in three contexts; personal, social and objective (Ibid., p.1), the emergent theory's concern is for the signs' use in the context of use and the context in use. The reason why is the focus on linguistic-cognitive reciprocation in the process of meaning-making.

Semiotics make an appearance in design from the innovations of Krippendorff, who, in contrast to its traditional use in linguistic and non-linguistic signs, advocates an extended dynamic. He suggests that the sign is an aid to the coming to an understanding, having properties of explanation "other than themselves" (Krippendorff cited in (Jutant Gentes, 2013)). Semiotics in this article relates to how it contributes to design in general. One notable finding which supports the emergent theory is that signs are "part of a [sign] system with which users construct meaning". This finding wholly supports the tenets of the emergent

theory of the *construction* of meaning. Another critical finding is that signs point to things, i.e., *indexically* defining "things, situations, feelings and therefore are not fixed in a solid definition of what this thing is" (Ibid., p.2). Semiotics also points unequivocally to a theory of *context*. Furthermore, semiotics uses *dialogue* and *interpretation* in conversational implicatures and metaphor – "relevance-driven inference" devices. The Theory of Relevance backs such inference (Carston & Powell, 2006; Wedgwood, 2007), a theory of interpretive processing – apt for use in the emergent theory due to its indexical-context-inferential relations.

The preceding referred to theories that demonstrate a dynamic character to meaning; subsequently, every term will be characterised. As mentioned before, the use of a sign in the emergent theory negates a fixed meaning. The reason is its use in dialogue, which is never a static event. A fixed sign cannot explain the "correlation between purposes and means, and the rational use and selection … of different possibilities …" (Weigand, 2016, p. 230). The significance in Weigand's (2016) thesis is that the use of language purposes something (the product) via an inherent means (the process), both governed by 'rule'. Most prominent researchers concur with this assessment. Some researchers refer to conditions (Ogden & Richards, 1923; Putnam, 1975a) or constraints (Neuman, 2006). There is some debate on whatever constitutes the constraint, e.g., institutional, social, cultural or cognitive boundaries.

The emergent theory encompasses a product and a process, i.e., *contextualisation* – **meaning** (purpose) **and meaning-making** (means). In the theory's case, language contextualised affords two uses:

1. A dialogue activates the construction of context via interpretation. This dynamic relationship causes an inference (contextual meaning): *means*
2. The inference by design, i.e., everyday meaning, is transferable between many users (interpreters): *purpose*

Finally, where the supportive theories discussed in the preceding are concerned with the theoretical terms of the emergent theory, the question is, how do they relate to design science? The preceding theoretical literature review studies only a delimited focus of the last reference to theory, i.e., 'a functional explanatory theory' (Baskerville & Pries-Heje, 2010) as follows:

7.3.2 The theory's design science link

The 'use' aspect or feature of the Use Theory of Meaning-making (also called the emergent theory) can be interpreted as constructive. Then the theory can be called a constructive functional theory that explains or attempts to solve a problem. The design aspect in design science focuses on the expected output of an artefact. Fortunately, an artefact includes a theory (Gregor, 2006). In a further development, the theory-artefact symbiosis is directly derived from Purao's (2012) ostensive reflection on the theory-phenomena link/relation and its relation to design science. Phenomena are explained by supplementary theories, which each focus on a particularity of the phenomenon of interest. Thus, the collective foci produce the emergent theory about the phenomenon of interest. It is within this perspective that the researcher attempts an emergent theory.

Design Science envelops the so-called supplementary theories and prescribes the requirement for artefactual output to them. The thesis theory attempts to define itself as a 'use theory of meaning-making', a theory in the ambit of design science definitions (Gregor, 2006, p. 616; Offermann, Blom, Schönherr, & Bub, 2010; Purao, 2002, p. 23). The notion of 'use' in the thesis is defined as a patterned process followed and an instrument for linguistic-cognitive shaping. 'Use' does not directly relate to an explanatory theory's 'usability' requirement (Baskerville & Pries-Heje, 2010, p. 278). Still, that definition points indexically to the design of the emergent theory, which uses everyday devices. The use(es) output is a *contextual meaning* and a mental abstraction shared as a commonality. It is also artificially represented as an object within an existing requirements specification artefact. The latter could probably count as an instantiation of the 'use'. If the derived components in the emergent theory design are accepted as a novelty, it further complies with the two requirements of invention and intervention. Construction is posited as the invention (Offermann et al., 2010) within the context of the artefact's output as a symbolic articulation of the "behaviour of the phenomenon" (Purao, 2002), and intervention posited as 'use' and mechanism: of meaning-making (Lemke, 2000); of contextual reasoning (Benerecetti, Bouquet, & Ghidini, 2000); and abstraction, e.g., metaphor, analogy, narrative, etc. or 'recurring contexts' in Ogden and Richards (1923). Recanati (2004) proposes a dual-level approach to the indexical-context mechanism as a 'perspectival'. In his later work (Recanati, 2015), he describes the mechanism of indexical thought as constrained by the reference as the effect of interpreters having shared their thoughts within a condition (read context),

"despite being different thoughts with different contents" (Ibid., p.20). The theory appeals to devices and indexicals as mechanisms to leverage the potential of meaning-making via *contexts*, i.e., 'context-of-use and 'context-in-use'.

Two theoretical terms, *construction* and *explanation*, are further expounded. The first term is closely related to the inventive requirement of a theory, and the second is related to the theory's intervention requirement. The relation is where the reference theories above intersect with the design science theory because "design science applies as both constructive and explanatory theory. It serves roles before, during, and after artifact construction" (Baskerville & Pries-Heje, 2010, p. 275). Figure 12 is an attempt to visually construct the theoretically derived path to the best explanatory theory.

Contextualization: meaning-making as a 'commonsensical' certainty - A novel 'use' theory

(The development from theories within theories)

Theory of meaning (Ogden & Richards, 1923); (Putnam, 1975); (Neuman, 2006); (Levinson, Stephen, & Levinson, 2000)

Theory of use (Horwich, 2004); (Whiting, 2008); (Rauti, 2010); (Corazza, 2016)

Theory of sign (Ogden & Richards, 1923)

Semiotics (Zlatev, 2009); (Zlatev, 2012); (Mingers & Willcocks, 2014)

Context Theory (Ogden & Richards, 1923); (Bauer & Leake, 2001); (Bamberger, 2008)

Legend:

·····▶	'points to'
──▶	'includes'
└┬┘	'appears in'
---▶	'component of'

Theory of Relevance
(Gentner & Kurtz, 2006)

(Systemic) Theory of Communication (Baecker, 2013); (Recanati, 2015) + **Dialogue Theory of Language use** (Jaszczolt, 2010); (Weigand, 2016)

Design Science (Baskerville & Pries-Heje, 2010)

Invention – construction
(Offermann, Blom, Schönherr, & Bub, 2010); (Gibbs Jr, 2006)

Intervention – 'use' objective (Lemke, 2000);
mechanism (Ogden & Richards, 1923); (Weigand, 2016); (Benerecetti, Bouquet, & Ghidini, 2002);

Figure 12: A summation of the underlying theories of the Use Theory of Meaning-making

It seems necessary to accentuate how the intended 'use' theory aligns with the mainstream characteristics of design science without going into the detailed expositions of established proponents (Gregor, 2006; Gregor & Jones, 2007; Hjalmarsson & Rudmark, 2012a; Hjalmarsson & Rudmark, 2012b; Kuechler & Vaishnavi, 2012; Walls, Widmeyer, & El Sawy, 1992). It seems more plausible to list the theory's characteristics as they have emerged. These characteristics can be headlined as a '**usable (functional) explanatory theory**' because it exhibits a practical and explanatory component according to (Baskerville & Pries-Heje, 2010):

- **Practical**: it can be applied in all three roles ascribed, preferably *before* the construction of the requirements specification artefact (or any of the constructs (text) or models (notations) that make up the artefact). The power of the theory lies in establishing what different interpreters mean before capturing/fixing it in text or notation; hence, the following characteristic.

- **Explanatory** explains why a continuous dialogue and interpretation outputs a contextual meaning (a cooperative result) and decreased ambiguity or interpretive sophistication. Explanation, in design science, has advanced from a view upon a phenomenon of interest to the construction of artefacts.

An explanation is where theorising (development of theory) and theory-in-use (application) merge – the contribution. However, there is a debate over what constitutes a theoretical contribution in design science. The proposals regarding the structure and content of a theory border on complexity and multiplicity. Hence, the position of parsimony taken by Baskerville and Pries-Heje (2010) is favoured in the theory's development because it employs theories within theories, which can otherwise become entangled in complex reasoning mechanisms. This favouritism extends to include two views of theory: 1) a prescriptive view, meaning that the theory is about principles that relate "requirements to incomplete descriptions" of something for the sake of improvement, and 2) a consequential explanatory view, which intrinsically explains the incompleteness. The incompleteness refers to the improvement purpose of the artefact, not to any instantiation. Incompleteness further correlates with a class of phenomena, not a specific problem. An explanatory theory generalizes requirements that satisfy the generalised scope of problems. A crucial qualifier for an

explanatory theory is its credibility, which depends on the "evidence, arguments, and background theories used to develop them" (Baskerville & Pries-Heje, 2010, p. 275).

In sum, the emergent theory gives an explanatory functional account of the reason for the component-requirement relationship. In this section, some exemplars are given to illustrate the possible design patterns, one of which is usable as a metaphorical reference for the theory development (design) to follow: the "faking a rational design process" (Ibid., p.277) seems to fit that description. This pattern is the personification of the phenomenon of interest: the 'wicked' problem. Moreover, the pattern offers a counter-solution by accepting that the problem will not resolve; hence, the notion to 'fake' the ideal process, a version of 'satisficing' (Simon, 2019). This view concurs with the Baskerville and Pries-Heje (2010) argument that a constructive functional explanatory theory is not about optimisation but about solving a problem – the mission of the Use Theory of Meaning-making. Thus, the Use Theory of Meaning-making can be defined as a constructive functional explanatory theory.

7.3.3   The theory compared to like theories of meaning

In an article (Kecskes, 2008), several of the primary concepts explained in the thesis are repeated and confirmed as pertinent to meaning-making: 1) meaning is an immediate and continuous linguistic-cognitive construction and transfer function; 2) however, not in opposition to the patterned rule-based mechanics of computers but the aid of it; 3) the process is holistic and attracts different perspectives/interpretations; 4) reciprocity is a primary principle in meaning-making because the language and context construct one another; 5) due to the relations between language's static forms and the mind's dynamic, constructive capabilities, several meanings can emerge from an innate inferential ability; 6) confirms the principles of cooperativeness and contextual boundedness, and 7) context is the enabling mechanism between the language system and cognitive system. The Dynamic Meaning Model resulted from these findings. The model merges two conceptual functions of cognition: a construction function "because each lexical item is a repository of context (context) itself …" and an indicator (indexing) function, which "is always implicitly indexed to a prior recurring context(s) of reference" (Kecskes, 2008, p. 388). He too, like other scholars, differentiate between individual [private] and cooperative [public] knowledge but advocates the success of his model to the blending of these via the reciprocity of static and dynamic meaning, i.e., construct and infer (a "dialectical relationship" (Ibid., p. 396). The Use Theory

of Meaning-making fills the gap that extends this model by abstracting the labouring lexico-grammatical and semantic levels of communication to everyday practical use without losing their apparent value.

Rago, Marcos, and Diaz-Pace (2016) confirm the analysis and findings in theme 1 of the phenomenon of 'poor requirements' due to smells, defects, increased complexity, and multiple uses of forms and functions; the list goes on. However, they assume that these are caused by duplication; hence, their contribution is a duplication analysing instantiation. They fail to explain how duplicates from use cases bridge the interpretive sophistication caused by those same forms. The Use Theory of Meaning-making fills this gap by removing forms of ambiguity in text and notation and removing the obligation to use sophisticated interpretive forms.

Stories improve understanding: " – they can bundle together information, knowledge, context, and … use metaphors and analogies to make complex concepts easier to understand" (Devaney & Johnson, 2017, p. 894). A comparison is made between the human phenomenon of telling stories with the user story concept found in requirements specifications. However, Devaney & Johnson (2017) define storytelling as a naturally occurring function, and the article supplies evidence that stories are helpful to both requirements specification and the design process. The stories, however, seem contradictory because they refer to post-learned applications such as a pilot who learns by observing, copying, and practising the instructor's actions, but earlier claimed that stories provide the enrichment of the building of the aircraft being designed for the learning. Still, the reference to 'anecdote' is apt in confirming its relation to stories and a mechanism (on page 124). The gap they leave is that there is no application, no form or process of operationalising a story – the Use Theory of Meaning-making fills the gap.

Davidson, Chiasson, and Ruikar (2006) exemplifies an incorrect metaphor (Ibid., p.324). The incorrect use is as follows: the Swiss Army Knife features reference the factual situation of equipment leasing via open markets. In terms of the relevance constraint, the cognitive context and relevance criterium is ignored. It fails to relate to the context of upgrading from a cumbersome manual system to an automated one supported by web servicing architecture. Instead, the same context is reused with a different metaphor. This time apt,

comparing the old systems to a "Potemkin village in czarist Russia" (Ibid., p. 328), which was known to have been created as a dubious front to impress the Czar (owner of the systems) but which did nothing to resolve the damaged villages (systems).

7.4   THE METHOD OF 'CONSTRUCTIVIST GROUNDED THEORY'

The method of choice for developing and designing the emergent theory (Use Theory of Meaning-making) is a derivative of the classic grounded theory method - the relatively new method, Constructivist Grounded Theory (Charmaz, 2008b), which aligns with the thesis' paradigmatic orientation (worldview). Much like the overall thesis method discussed in Chapter 3, the method allows for the emergence of concepts, features, and characteristics. The rationale for selecting an emergent method for the development and evaluation of the emergent theory is explained eloquently:

> *"The logic of grounded theory provides a major contribution to emergent methods because grounded theory involves creative problem solving and imaginative interpretation."* (Ibid., p.156)

One of the benefits of this method to theory building is that it characterises the attribute of emergent as "inductive, indeterminate, and open-ended" (Ibid., p.155). These attributes attest to what has been done thus far in the thesis throughout Chapters four, five and six using inductive reasoning:

- something of interest is observed in the real world – poor requirements, evidenced by the preceding literature reviews, analyses, and discussions,
- an understanding of the phenomenon and the extant gaps is built up, and
- a possible solution is discovered – the hypothetical framework/model supported by a plausible alternative.

The method is further suited to studying "uncharted, contingent, or dynamic phenomena" (Ibid., p.155). The researcher believes the phenomenon of interest is definable in part as uncharted where it relates to the cognitive property of poor requirements – human error. It is contingent because poorness relies entirely on language use in terms of the linguistic-cognitive link. Finally, one can find cause to believe it is dynamic because of the many historically 'failing' solutions evident from the preceding literature. Emergence is about

discovering gaps in the data and the emergent theory, which allows for finding backing/evidence to support it. Further, the method pre-empts that the emergent theory, which starts in a narrow context (requirements specifications), may hold the promise of application in a broader context (wherever the text-notation relationship surfaces ambiguities and interpretive sophistication).

After the inductive analysis, the method prompted the researcher to move into abductive reasoning. Abductive reasoning is discovery via iterating the analytical process through the collected data, imaginative and innovative in interpreting the researcher observations. The process is complete when the researcher arrives "at the most plausible explanation of the observed data." (Charmaz, 2008b, p. 157). The freedom that comes with the method of choice comes with a responsibility to interpret intuitively. That responsibility inherently signifies a great deal of subjectivity, which contrasts an objectivist empirical responsibility. However, subjectivity in the constructivist grounded theory aids in the method's essence as emergence. Emergence is tightly coupled with theoretical codes or terms, the essence of theory-building – its building blocks. Abduction and emergence go hand in hand in this regard. The researcher's analysis produced the theoretical terms during the iterations through the secondary data. The theoretical codes include the discoveries made in the secondary data and during the focus group study.

The responsibility of interpretation is revolutionary to the characteristic of emergence in the sense of data collection and analysis and the construction of the Use Theory of Meaning-making as theory; the method becomes part of the interpretive process of "questions, choices, and specific strategies." (Ibid., p.161). Furthermore, the researcher examines his philosophical stance in an openness to the real world, studies and analyses the data to conceptualise the initial theoretical framework (Ibid., p.163). The Constructivist Grounded method is applied in contrast to the traditional Grounded Theory method. The traditional method focuses on coding procedure, philosophical stance, and literature, which is discussed next to explain the subjective responsibility.

The coding procedure in the Charmaz context advocates in-depth interviewing to collect data focusing on participants' experiences. Kenny and Fourie (2015) criticises this narrow focus and points out that the result is rarely a prognosis of the problem or a predictive theory as a conclusion (Ibid., p.1279). Whether the authors intended to limit the theoretical

scope to predictive theory is not inferable from the article; therefore, the researcher suggests that the Use Theory of Meaning-making falls outside this narrow definition. Instead, the researcher considers the next point inside the scope of the theory – "a constructivist GT study typically concludes with the researcher's interpretive understanding (rather than explanation)" (Ibid., p.1279). The researcher believes that the emergent theory attracts understandings via an explanatory aim because the interpretive understanding results from abstraction. Abstraction herein means discovering theoretical terms, which through abduction elevates the levels of analysis and "extends its reach" (Charmaz, 2008a). Such a high-level conceptualisation is grounded by iterative theoretical sampling until theoretical saturation. Once saturation is reached, the presentation (writing up) of the theory starts.

The method seems a good fit for a small participative study for demonstrating and evaluating the theory. While "intensive interviewing" is recommended, the theory diverts to a more lightweight focus group study application. It should also be clear that this approach follows Charmaz's explanation of the interpretive and constructivist paradigms, which supports the **'constructivist-reciprocal-holistic'** worldview. Charmaz's (2008) view can be interpreted to emphasise that the **language-context-meaning** relationship is a matter of multiple realities governed by individual and group interpretations within a delineated social setting. The operationalisation of the theory envisages, in particular, the cooperative co-construction of meaning to arrive at a single contextual representation of the commonality shared between interpreters.

A methodical structure becomes apparent from the preceding, which the researcher will follow to fulfil the theory-building aim. The structure highlights the interpretive responsibilities and the explanatory content – to be discussed next:

- A subjective responsibility consisting of the constructivist interpretive lens, the researcher's philosophical stance and the alignment of the literature with the method
- An empirical responsibility consists of the standard pattern of the constructive grounded theory: open coding, refocused coding, theoretical sampling, theoretical integration, and theoretical saturation.

7.4.1 The subjective responsibility of theory building

7.4.1.1 The constructivist interpretive lens

The preceding paragraph accentuates the assumptions that will guide the theory's building or construction process. The interpretive goal of the theory is to describe, illuminate and explain. Therefore, the theory must consist of systematic construction of "interpretations and meanings" (Gioia & Pitre, 1990) and conceptual structures and related processes. The reason why is clarified in the following declaration, which is in direct support of the theory's assumptions and the researcher's philosophical stance:

"The study of phenomena such as sensemaking, meaning construction … becomes very awkward to handle using any immutable objectivist framework." (Ibid., p.587).

7.4.1.2 Philosophical stance

In the constructivist tradition (Charmaz, 2008b), the researcher considered various theories and positioned the theoretical premises and practices according to his philosophical stance. The researcher's stance has been accentuated throughout as constructivist-reciprocal-holistic. This philosophical stance is clearly 'use' oriented; hence the initial contextual review of theories of meaning compares and squares the mainstream philosophies in this category of theories. One can derive the researcher's stance from the extensive exposition of interpretive theories. After that, the problematic philosophy was analysed and discussed in the systematic literature review (Section 5.1), but increasingly so in the subsequent alternative review (Section 5.2). The detailed explanation of the consequences of the underlying assumptions gave way to two opposite stances or worldviews, the second attracting the researcher's affinity. The researcher's affinity directed the interpretive study thence. The final study consisted of a critical review of theories that specifically addressed the main components of a Use Theory: language, context, and meaning. This review was purposed to position the emergent use theory within theories (a requirement of Design Science).

7.4.1.3 Literature

Concerning the literature, Charmaz was followed by compiling a preliminary review, which was extended into several pinpointed reviews "interspersed throughout the entire thesis". The writing of the selective reviews ensued after analysis, which should have explicated the thesis rationale throughout (Kenny & Fourie, 2015, p. 1285). Under this

method, memo writing was used to comment initial analysis to understand the literature. That was followed by a type of theoretical sampling, i.e., primary and derived theoretical categories which emerged from thematic analysis. The categorisation that emerged from the analysis can be seen in theme 2. It also explains the movement in the direction that emerged from theme 2, culminating in theory development in theme 3. At this point, suffice to mention that the reader should be aware that themes 1 and 2 show inductive reasoning, which developed into the theoretical framework. After that, the development gives way to abductive reasoning. Abductive reasoning allowed many inventions and subjective interpretations of the phenomenon of interest and the 'imagined' solution until a satisfactory or plausible solution appeared.

7.4.2 The empirical responsibility of theory building

The preceding adhered to the subjective-interpretive requirement of the Constructive Grounded Theory method. Following is an exposition of the objective-interpretive requirement of the same method, which requires a formality acceptable to the research community. The basic structures and goals of the method are derived from the ground-breaking work of Glaser and Strauss (1967). However, they are aligned to the interpretive characteristics that suit the discovery of an emergent theory proposed by Charmaz (2006) is as follows: the comprehensive scrutiny and investigation of data during the collection and analysis phases – possible meanings are noted and thematised for secondary and primary data; selective coding follows to categorise and synthesize categories and evaluate which offer the best explanations for the phenomenon of interest; memo writing supports the two coding activities; theoretical sampling follows to keep the study "grounded" (Ibid., p. 166), which for interpretive work means that sampling directs the flow of the study and integration, which is concluded in theoretical saturation – when no additional categories or explanations can be found.

7.4.2.1 Open coding

The process of open coding represents the *conceptualisation* phase. Open coding was applied to Chapter 7, Sections 4, 5.1, and 5.2 using constant comparison as the analytical frame to conduct open coding. The analysis was performed on an extensive body of secondary data. The analysis leads to the thematisation of initial meanings. The open coding process outputs basic descriptions of the conceptual constructs identified from the

initial analysis of the secondary data. Descriptions from the analysis of the collection of the kernel and reference theories and the problem analysis were categorised into fundamental concepts, e.g., use, meaning, language, context, and so on. The categorisation extended to describe the phenomenon under investigation resulting in concepts, e.g., ambiguity, fragmentation, referential, relatedness (cohesion), unilateral view, dialogue, interpretation, etc.

7.4.2.2 Refocused coding

Refocused coding is an iterative refinement applied to themes 1 and 2 through Theme 3 Chapter 6, using theoretical sampling as the analytical frame to conduct refocused coding. The sampling process needs further clarification. The theoretical sampling process received its direction in the spirit of emergence or discovery - the notion of using the previous analysis to guide the selection decision for the following data collection and subsequent analysis. The process mimics the iterative feature of the method. This coding procedure drives the analysis from a focus on deeper meaning; theoretical sampling, using the researcher's memos (*Appendix C: An introduction to education as a potential area of* application of the theory

The wicked problem described in the thesis seems to appear in other disciplines too, or at least the problem seems analogously defined. This can be seen from the following insights from the analogous phenomenon observed in Education. The researcher posits that it can be used as an argument for the generalisability of the emergent theory. The phenomenon pertains to the human ability to abstract away from particularities to generalities. This is a particular cognitive trait of conceptualising or individual competence to form an immaterial representation of a material occurrence (Baskerville & Pries-Heje, 2010). However, the trait depends on conceptualising, which is where STEM education fails in many cases. The minority of students find abstraction easy while the majority struggle. Take the case of the translation of word problems to notational representation in either algebra or geometry, which manifests two distinct phenomena: 1) the failure to move between two vastly different interpretive means, and 2) the mental model of resistance, ineptness and fear that forms due to the failure. The problem is aptly summarized in the following finding regarding the phenomenon: " 'We got the solutions. But I'm not sure how to explain how we got to the solutions, although it makes perfect sense to me'… points to a fundamental problem in

mathematics education. Students are trained to compute solutions, but they have difficulty articulating explanations" (Stahl, 2007, p. 10).

In the natural sciences, mathematics, in particular, is observed amongst school pupils as poor at expressing the textual equivalence of a mathematical notation using natural language. They know too well how to solve the expression but do not know its meaning, hence being unable to express it in words. The inverse is equally true as it appears that students struggle most at interpreting and solving 'word problems'. There is more emphasis or reliance on the function of solving the notation (the formal construct as a model or sign) rather than understanding its intent; its meaning (Engelbrecht, 2008). In this article, on page 56, the authors confirm this phenomenon in the dilemma of sense-making or meaning of surroundings (contexts) to navigate between mathematical (notational) expression and word problems. Another article concerning mathematics describes the necessity for learners to be skilled in finding ways to represent functions and recognise and articulate algebraic relationships that require "reasoning and sense-making" by connecting the two mathematical elements of knowledge; words and model (Nebesniak, 2012). The authors conclude that poor performance can be explained as:

- "inadequate language skills set in solving 'word' problems" (Engelbrecht, 2008:p68), and

- interpretation "since the text is not explicit about the format of the table, students must draw on their algebra skills and a correct interpretation" (Miller, 2009:p72). The main issue is a lack of sense-making irrespective of whether function or procedure is correctly applied. Lack of language and interpretative skills is evident.

Following the preceding Twiner et al. (2014) draw on sociocultural theory in an exploratory study of meaning-making as a "dynamic and situated facet of classroom interaction … The findings indicate dialogue as a means of initiating and evolving the construction of meaning. This is evidenced in this article by analysing a discourse between individuals and the collective. In this article, the potential of shared meaning is argued as a moment of convergence between intention and instantiation; the dialogical process makes convergence possible to decrease meaning potentials. This position supports the thesis threshold hypothesis of contextual meaning (Ibid., p. 99). Another is the essence of dialogue: the reciprocity requirement (Ibid., p.98).

In the context of adult learning, the translation of experience is considered the main source of learning, i.e., the meaning-making from all experiential sources. This includes past experiences of success and failure. The latter accentuates the presumption of related emotional experiences, which in some cases may be horrifying. "Adults can reflect on past experiences to make and re-make meanings." (Zepke & Leach, 2002, p. 206). This alludes to the possibility that 'bad experiences' can be remade too because "… adult's unique life situations form contexts … These influence the meaning they will draw from experience" (Ibid., p.206). In light of the findings from the demonstration, it seems plausible that the theory also holds in the contexts of education and law; the application thereof being a deliberate recommendation to researchers in those disciplines because "contextualized meaning-making – constructing knowledge in distinctive settings … is central to experiential learning" (Ibid., p.209).

Mutonyi (2016) study of meaning-making includes the influence that cultural context plays in the teaching of African children in predominantly Western Scientific culture. The author finds that literary devices like "stories, proverbs, and anecdotes drawn from the student's cultural context helps them understand science concepts" (Ibid., p.943).

In sum, the gap that contextualisation in this theory fills is the potential to teach students to construct contexts via their interpretations and, through the collective dialogue, hone the interpretations down to an ordinary meaning, shareable across cultures. Such a skill adds value to the already capability to draw inferences from a given context.

Appendix D: Examples of The theoretical categories from the researcher's memos*)* to accentuate the gaps and potential of the theoretical solution as a precursor to the active building of the theory. During this process, the concepts were refined through further data collection and analysis. They included an investigation into the gaps discovered during open coding. The aim herewith was to discover relationships between categories and to deepen the explanation of the phenomenon. The output of this process resulted in the refinement of the concepts such as indexical context, contextual index, semantic (contextual) equivalence, contextual equilibrium, threshold, etc.

7.4.2.3 Theoretical sampling

Theoretical sampling can be seen to have been applied in two contexts in the theory's development. The first context contains data from secondary sources about the concept of meaning and the academic scholarship defining it and its phenomena (Chapter 4). The data findings and analysis describe a relationship between language use and meaning and the role played by context. These results prompted the researcher to collect data around the use of language within the identified area of interest – requirements specifications artefact (Chapter 5.1). The artefact meant two things; the document and the components that create a document – the language constructs in text and notation (form). The language used in the latter sense directed the selection of data for an in-depth systematic review. On the strength of the gaps found, the researcher investigated the possible cause and possible alternatives. The discoveries made of the effects of a specific philosophical stance and the neglect of context as an objectionable feature of language use prompted the researcher to direct data sampling into these features (Chapter 5.2). The findings lead to the creation of a hypothetical framework for making meaning.

After that, the theory development process took a decisive direction, subsequently based on the previous findings. Still, at this time, the researcher's philosophical stance predicted where the following collection of data would be focused – context. From this investigation, the innovative characteristics of a theory started to emerge (Chapter 6). After that, the discovery of theoretical components gave way to a sampling of data directed at the construction of the theory according to a method that would ensure rigour, credibility, and reliability; hence, the Constructive Grounded Theory. This method, as mentioned before,

allows freedom of sampling that other methods don't yet ensure. That freedom extends to the second sampling, discussed next.

The second context contains a data collection extended to primary sources in a focus group study of nine participants and one observer. The group was presented with problem cases of language use. The cases included a pre-test wherein the participants were presented with a use case. The one instance had no context. It represented the current situation, and the other had an example context. The data from the focus group is centred around a carefully designed survey. The survey structure entails three themes. Between the second and third theme, an intervention occurs during which the group is briefly acquainted with the theoretical terms, associations and boundary conditions; to familiarise the participant with the everyday use.

Before the three themes commenced, a section was included to categorise the participants in their operational capacities, functions and roles, the degree of experience they have in this capacity, and their confidence level with the current language use. After that, the thematic questions resume. The first collection of data was inspired by the origin of the phenomenon of interest experienced by the researcher and observed in the industry among peers, hence the first theme: the participant's historical association with the form-function problem in the secondary and tertiary education context, and the participants.

The previous data collection progresses to testing participants' experiences directly related to the phenomenon as it manifests in industry. It tests their understanding and meaning of the current textual and notational representations; hence, the second theme: the participant's current knowledge and experience with the form-function problem in their work context. Mindful of the theory development, the previous questions prompted questions directly related to testing the knowledge of the novel mechanisms for making meaning. The participant's experiences using these mechanisms to effect meaning were tested with specific questions. A final survey contains a debriefing; hence, the third theme: the participant's revised experience after encountering contextualisation as proffered by the theory.

7.4.2.4 Theoretical integration

A most critical requirement in theory building is to demonstrate the emergent theory's situatedness within related theories. One definition is that it is "relating the theory to other theories in the same or similar field." (Urquhart, Lehmann, & Myers, 2009, p. 369) The definition which is more attractive and explanatory of the emergent theory is found in the reference disciplines. In Psychology, the word 'relating' is replaced with 'combining' concepts between different approaches to produce something that explains something about the problem in the discipline (https://dictionary.apa.org/theoretical-integration) or, better still, the synthesis of propositions in the hope of a result better than the constituents alone (https://www.sciencedirect.com/topics/computer-science/theoretical-integration). The latter word underlines the objectives set out in a preceding section – a synthesis of principles applied to related concepts, which improves the solution to the problem and associated theories.

To demonstrate the integration, the researcher highlights again the language-context-meaning relationship, which justifies the theories associated with the emergent theory. The mental model best suited to explain the integration is a celestial body centred inside a few surrounding celestial bodies. The concept to grasp here is dynamics. A proper integration would suggest that changes in the associative theories impact or influence the emergent theory and vice versa. The degree of influence affected by the emergent theory upscales it (Urquhart et al., 2009) relative to the other theories and reciprocally. The integration discussion starts with theories related to language and continues through context theory to theories of meaning. It is reiterated here that context theory is a primary focus (as it is throughout the thesis).

7.4.2.4.1 Communication theory

Communication theory and the dialogue theory of language use play a significant role in addressing the emergent theory's outer and inner boundaries – communication and reciprocation. The purpose of communication is the transfer of meaning resulting from a reciprocated conversation (dialogue). A communication theory that stands out among the many communication theories (e.g., engineering theory of sender-message-receiver; the reproduction-observer-correction system) is systemic communication theory. In the exemplar theories, the crux of communication is based on transmission, whereas an early

systemic theory posits selection (Benerecetti et al., 2001; Weigand, 2016). The notion of selection is closely related to the emergent theory's notions of construct and transfer. Whereas transmission is a matter of rule repetition, the systemic communication theory and the emergent theory are based on causation. The focus on relations formed upon which a communicative act selects possible interpretations from a single message was promising but failed to explain how a rigid repetition selects the correct meaning. The more promising development is the notion that communication emerges from the relations formed between multiple interpreters and the communicative functions of the human in a holistic fashion. This model posits that interpreters intend to communicate a continuous reciprocation of individual and collective referencing to reified, abstracted or potential meanings. A reference is defined as indexicality and contextuality, two mechanisms from which meaning emerges. A most attractive declaration to the emergent theory is that the concept of emergence in the sense of meaning production "is an explanatory principle, …, which helps *frame* and order observations … that declare … perspective on some complex reality" (Baecker, 2013). The systemic communication theory projects reciprocation language use as a continuous dialogical invention and intervention. In particular, the view of the dialogue, defined as Weigand (2016, p. 209) does "coming to an understanding in dialogue", is most promising to the emergent theory. Suppose dialogue is seen as a mere mechanism of communication. In that case, one ends with the static transmission model, whereas a dynamic model view dialogue as using language to express thought in a reflexive dialogue. Language use is an intentional act that implies purpose and means. Therefore, one can infer that dialogue is a purposeful means, i.e., a mechanism. The mechanism is a function of language, context, and thought. The mechanism operates interdependently and coherently towards a common goal: meaning-making.

7.4.2.4.2 Context theory

Next follows an argument for the close association of the emergent Use Theory of Meaning-making with context theory. A ground rule of a context theory states that experiences form a context, some simple, some more complex. Interestingly, indexicals, for their multiple meaning potential due to abstractions, do not need more complex contexts but different contexts or recurring ones (Ogden & Richards, 1923). The reference to which [it] the indexical subsequent signs or points cannot be constructed by contexts inferred by commonality. The metaphor describes this working adequately as " one reference borrows

part of the context of another in an abstract form … the use of one reference to a group of things between which a given relation holds", hence, facilitating the recognition of the commonality (Ogden & Richards, 1923). This explanation of the indexical-context relationship and its causation of inference is demonstrated in the preceding examples (cases a & b).

As has been pointed out in Chapters 5 and 6, the context has been overtly ignored in Information Systems, yet its development and focus in disciplines such as Management Science should be taken into "greater consideration … to prevent further fracturing of the field …" (Bamberger, 2008, p. 839). The article expressly broadens the definition of context to whatever surrounds the factors immediately associated with the phenomenon of interest, such as cognition and situational factors and their relations. This last reference spotlights context as a cognitive function that alerts the individual to the subsequent function of contextualisation.

Contextualisation is the cognitive process that links observations to relevant facts, events or perspectives to enhance the accuracy of our interpretations. In the management sciences, contextualisation is called 'situational linking', a facet of situated cognition, a primary notion in psychology, artificial intelligence and robotics (Smith & Collins, 2010). Thus, contextualisation extends to 'use'. An individual uses others' interpretation as indexicals for strengthening their experiences and knowledge. Within this statement lies the premise of normative evaluation of group thinking and the construction of meaning. However, the article also expresses a caveat to contextualisation in its present delimited form and functioning theory development. Albeit confined to the management sciences, the warning extends to this thesis. The caveat is that normative evaluation is weak due to insufficient information gathering, primarily qualitative, and the indeterminacy of contextual parameters. If contextualisation were a descriptive theory, the absence of parameters would reduce to a reductionist view (pp.89 & 113). An explanatory theory, in contrast, requires abandoning the confines of current theoretical boundaries. It does so by including firstly associative phenomena (phenomena analogous to the one being studied) and only those paradigms in other disciplines that explain the analogous phenomena. This process is called Context Theorising (Bamberger, 2008, p. 841). Secondly, it includes the integration of context theory within other theories "… to go beyond simply accepting the natural

heterogeneity and variability in the phenomena they explore … and beyond simply illuminating the possible … boundaries of proposed or just-tested hypothesis" (Ibid., p.841). Integration requires building into an emergent theory, the conditions under which contextualisation forms and functions, and the mechanisms which link the conditions and phenomena or their relational governance.

Finally, theories of meaning, use, and sign have one concept centralized throughout the literature, central to this thesis and the emergent theory: context. Thus, a context theory seems a likely candidate to be included as a reference theory. The detailed explanation in Chapter 6 is sufficient evidence of its role in the emergent theory. The importance of context theory being focal to the emergent theory is that it is directly related to other theories that explain its constructs, objectives, or assumptions. These related theories are associated as follows:

- Reference theory explains the problem of ambiguity or its abstract form: loss of referential integrity;
- Relevance theory explains the problem of fragmentation (aka interpretive sophistication) or its abstract form: loss of relational integrity.

7.4.2.4.2.1 Reference theory

Reference theory acts like a constraint or, in the case of the emergent theory, as a rule of causality, i.e., the relationship between a cognitive notion and what it is. This constraint is a necessary explanation of how inference works in the emergent theory (explained above). A significant view of reference supporting a constructivist theory is the metaphorical reference (Gibbs Jr, 2006). The traditionalists advocate reference as something from one context that is somehow analogous to another or refers reciprocally to some pretence or set up at one side (Parsons, 2011). Metaphorical_reference, in contrast, promotes the essentiality of the human cognitive processes as an essential component in the theoretical attempt. What is essential is that metaphorical reference is considered a process, a constructive cognitive operation, which is an act of presumption, if you will, of how another conversationalist would interpret something; an active mental stimulation of mental dialogue between interpreters. It is this definition which the theory affiliates. The relevance of metaphorical reference is the hypothesis that an inferential activity occurs, which results in detailed meanings; the metaphorical reference in the context of use. The abstraction

(contextual meaning) from the simulation process (context in use) results in a mental concept semantically equal to the objective world referent (Gibbs Jr, 2006); hence, the concept of contextual meaning.

The human ability of inference relates to indexicality, a prominent feature in emergent and context theories. The use of indexicality is supported by relevance theory. It opposes the semanticist's claim to truth-conditions, meaning encoded in a proposition. Indexicals, to the contrary, are dependent on inferences. In turn, they depend on the cooperatively constructed linguistic-cognitive context. This stance does not discount the existence of propositional expressions, which can be formalised to comply with some truth conditions. It is merely too restrictive for a theory of 'meaning' of the sort developed in the thesis. Therefore, in agreement with radical contextualists, context is to be grasped as inescapable. Hence, any expression is potentially indexical, depending on its use. Due to this explanation, the researcher posited earlier that whatever expression is put forward as uncertain potentially qualifies as an indexical.

7.4.2.4.2.2 Relevance theory

Relevance Theory is appropriate because it generalises the principles of inference and shows how these operate during the construction of ostensive interpretations. It has specific importance in supporting the emergent theory. The direction in Wedgwood (2007, p. 5) is attractive and promising. It supports the principle of social cooperation according to the two early statements:

1) that interpreters instinctively form their expressions with an acute awareness of the context of use, and

2) the communicative process is NOT merely the encoding-decoding of messages but an intent to explain the interpreters' cognitive processing and cognitive content.

The latter statement explains form and function in the way that the emergent theory posits. Wedgewood further states that the communicative act presumes particular human abilities such as inference and referencing. These abilities manifest as phenomena of language use like implicature, disambiguation, metaphor, and analogy. The human ability to infer and reference support the principle of individual competence via context-dependency. The reliability of use supports the principle of commonsensical boundedness.

7.4.2.4.3 Meaning theories

The theories that apply to the emergent theory is specifically those purporting to be 'use' theories. 'Use' alludes to every mention of the words activity, interpretation, simulation, process, *function* and so on. Thus, it seems plausible that a theory of use should be thrown into the fray (intentionally meaning 'together in a context'). Although there is some debate about what is meant by use, e.g., use constitutes the meaning, the meaning is not 'use' but only equitable to *a* use (Whiting, 2008). Most authorities, however, agree that nothing has *a* meaning in and of itself. Only, through cognitive production and linguistic articulation, does something have meaning—the constructivist view (Gray, 2013). The use defined in this way attracts two important sub-theories: acceptance theory (Horwich, 2004) and affordance theory (Woodward). Both apply to the Use Theory of Meaning-making development. A short description puts them into context. More importantly, use theory and the two sub-theories provide two principles (italicised) adopted by the emergent theory:

- An acceptance theory indirectly supports the principle of social cooperation. The assumption is that the meaning is neither given nor a given. Instead, it is a movement constituted by the dialogic-interpretive act. This movement happens because, occasionally, the sign is void of individual meanings. Suppose, in such cases, zero indicators exist to constitute its meaning. In that case, it is accepted that a "*collection* of symmetrically-used terms possesses a certain meaning that is *distributed over them*." (Horwich, 2004, p. 371). This claim alludes to the thesis' notion of contextual meaning: a constructed meaning using a literary device (e.g., a metaphor) symmetrical to an initial uncertain meaning. The symmetry makes the constructed meaning distributable over the uncertain meaning—a kind of semantic deference (Rauti, 2010). In the theory's terminology, distribution refers to transfer/transferability.

- An affordance theory holds that meaning-making and human experience are intertwined. This fact changes the meaning of affordance from the traditional 'situatedness' to 'enactment'. Situatedness views meaning-making as experienced by the use of or dependence on an environment outside of the subject. Enactment views the experience as the subject within the environment. The second defines affordance as being constructed as an explanation/purpose/significance (DeLanda, 2017). This view concurs with one in which the sign alone cannot account for the correlation between an interpreter's means or purposes and her rational selection of strategies during the dialogical act (Weigand, 2016). These views explain meaning-

making as purposed, which features bounded rationality between expectation and convention/rule. This last statement can be construed as one other principle adopted by the emergent theory: contextual boundedness or indexicality (Jaffe, 2009). The principle is most promising for the emergent theory. Indexicality is a movement, an interpretive construction in the dialogical environment for the individual or group purpose.

7.4.2.5 Theoretical saturation

An important caveat about saturation in theory building is that it has little to do with the exhaustion of resources and the validation of recurring themes unless it supports theoretical terms or categories (Charmaz, 2008b). Theoretical terms are the backbone of theory. Only when the theoretical terms are defined, boundaries and relationships established are saturation conceivable. Iterative conceptualisation was used as the analytical tool to ensure saturation. The theory is formulated during this process (Chapter 7). The process of theory building using an interpretive lens in the context of the goal direction cannot be anything other than "iterative, [cyclical] *reciprocal* and nonlinear." (Gioia & Pitre, 1990, p. 588) – italics added. The process prescribes data collection, analysis, and pattern recognition as a first phase, abstracting interpretive meaning schemes, and final analysis and theory construction. Charmaz (2008) advocates conceptualisation as a precursor to theory construction. (Urquhart et al., 2009) categorise it as conceptualisation and theoretical scoping. After conceptualisation, the second coding phase includes iterative coding via theoretical sampling. Theoretical sampling ends when saturation is achieved.

At the end of paragraph four of the preceding, it was mentioned that after saturation, the writing up of the theory commences. The writing up phase parallels the Swanson (2013) inclusion of operationalisation, confirmation, and refinement, aligning with demonstration and evaluation in the Peffers *et al.* (2006) method. The alignment extends the constructivist grounded theory method thus:

- **Theory Building: Section 7.5**: the theoretical terms are written in theoretical form and function as the Use Theory of Meaning-making.
- **Demonstration: Section 7.6**: the real-world assessment (measurement) or operationalisation of the Use Theory of Meaning-making and confirmation using a focus group study.

- **Evaluation: Section 7.7**: comparing the findings and results of the previous section with the evaluative criteria for theory found in the literature, motivating the Use Theory of Meaning-making against these criteria.

7.5   THEORY BUILDING
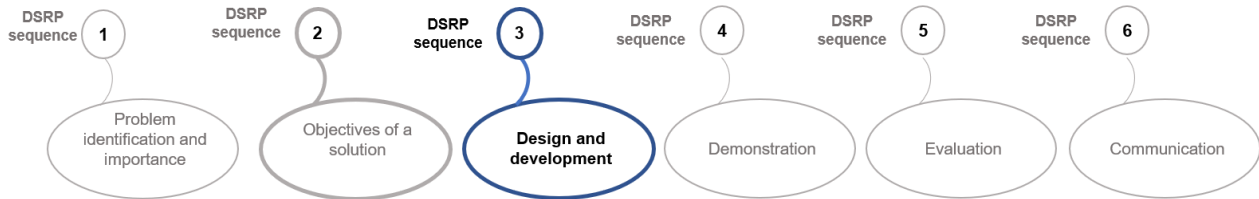
> "Meaning making proceeds through the weaving of different forms of referencing" Stahl, (2007)
>
> "The point of modeling-and of theory construction-is showing how things work" (Friedman, 2003)

7.5.1   The underlying assumptions (principles) of the theory

The drivers, the 'why' or explanatory part of the theory, lies entrenched in the following communicative (meaning-making) principles:

- The principle of *interpretive (social) cooperation* (Kjellman, 2003; Levinson et al., 2000; Putnam, 1975a) is defined as the innate ability of humans to instead draw upon the interpretations, i.e., the cognitive contexts of others as well as other contexts.
- The principle of *individual competence* (Jaszczolt, 2010; Penco, 2001; Sein Henfridsson, 2011)
- The principle of *commonsensical boundedness*: commonsensical certainty (Predelli, 2005) or plausibility
- The principle of *linguistic-cognitive interdependence* (Stahl, 2007)

7.5.2 The requirements for the theory

The following requirements were derived from both themes 1 & 2 and directly relate to the design components. They motivate the use of the components, which are plausibly acceptable for the design. The outcome of this relationship is defined as a functional explanatory theory. If, as is the case herein, the requirements include conditions, the theory is said to be a "conditional functional explanation" (Baskerville & Pries-Heje, 2010, p. 274). Apart from the apparent relationship between requirement and component, they also relate to the theory's premises (grounds, assumptions). These form a symbiosis with theory development and design.

- A functional common-sense explanation: 'use.'
- an emergent (holistic) worldview,
- an emergent (dynamic) mechanism and process which improves referential and relational integrity.
- Everyday use is high in affordance, free of domain-specificity, and agnostic to current information systems methodologies.
- A simple mechanism and process applicable to the requirements specification throughout the requirements engineering process (high usability, i.e., affordance, low training, and freedom from a particular socio-cultural use).

The common-sense requirement will become clear throughout the following sub-section, whereas holistic and dynamic requirements in their respective contextual uses have been explained. One that needs further explanation is usability. Its definition is entrenched in the requirements of design in design science such that it aligns with most of the assumptions for an explanatory theory: *dualistic* as it produces meaning and supplies a process for producing meaning; *principled* as it exhibits the tenets of established reference theories; *actionable* as it promotes a means of achieving the meaning-constructive goal (contextual meaning) and its subsequent transfer; *prescriptive* as it intends to improve the conversation among technical and non-technical users during the requirements engineering process (Baskerville & Pries-Heje, 2010).

Affordance is a feature of the design, based on a sign, after a user's experience-interpreted meaning construction. The resulting products are proof of the meaning of construction (the product). Meaning-making is the process of why users understand the meaning via interaction with the material and social worlds they experience and within the constraints of culture, domain knowledge and communication skills. However, meaning-making as a distinct part of the design process is not apparent since the dynamics of signs disallows determined interpretations; the current stalemate in sign-analysis, while affordance requires the inclusion of the user's perception and acceptance of a design, which invites the dynamics of thought and articulation (Jutant Gentes, 2013).

To test the usability of a design, one must first consider the context of use. This is backed in an article by Maguire (2001). He offers a procedure for ensuring that the measuring of the context-of-use is validated and reproducible. Usability is defined in terms of efficiency, effectiveness and satisfaction, all directly related to the use within a context - a placeholder for interpreters, behaviours, tools, and socio-cultural discourse. This definition is relevant for the usability requirement of a theory of meaning because it refers directly to everyday use, aligns with the objectives, and resonates with the ISO definition, referring to "the outcome of interaction in a context" (Maguire, 2001, p. 457). The importance of usability is driven home in the finding that humans rely on a standard agreement, a loose coupling of descriptions, i.e., not for precision but efficiency (Penco, 2018).

7.5.3 Components of the theory

A theory has three main components: "its constructs, its associations and its boundary." (Weber, 2012, p. 4). Equally important is for a theory to have a representation or model of the phenomenon's explanation. These requirements are elaborated on next.

7.5.3.1 A representative form(s)

The outer operations of language, **dialogue** and **interpretation**, are primarily depicted in Figure 13. It relates the operation of dialogue to ambiguity (the collective feature of the current 'use') because ambiguity is primarily a linguistic expression issue. The bottom depiction relates interpretation to 'interpretive sophistication', which is primarily a cognitive expression issue. The relationship between the two can be summed as follows: the dialogue

between text and notation expresses whatever interpretation surfaces from the cognitive process.

The inner operations of language, **construct** and **transfer**, are depicted in Figure 11. It relates the operations of thought and expression within the boundary of a context. Simply stated, an abstraction (Figure 13) of these two explanatory frameworks depicts this relationship best.
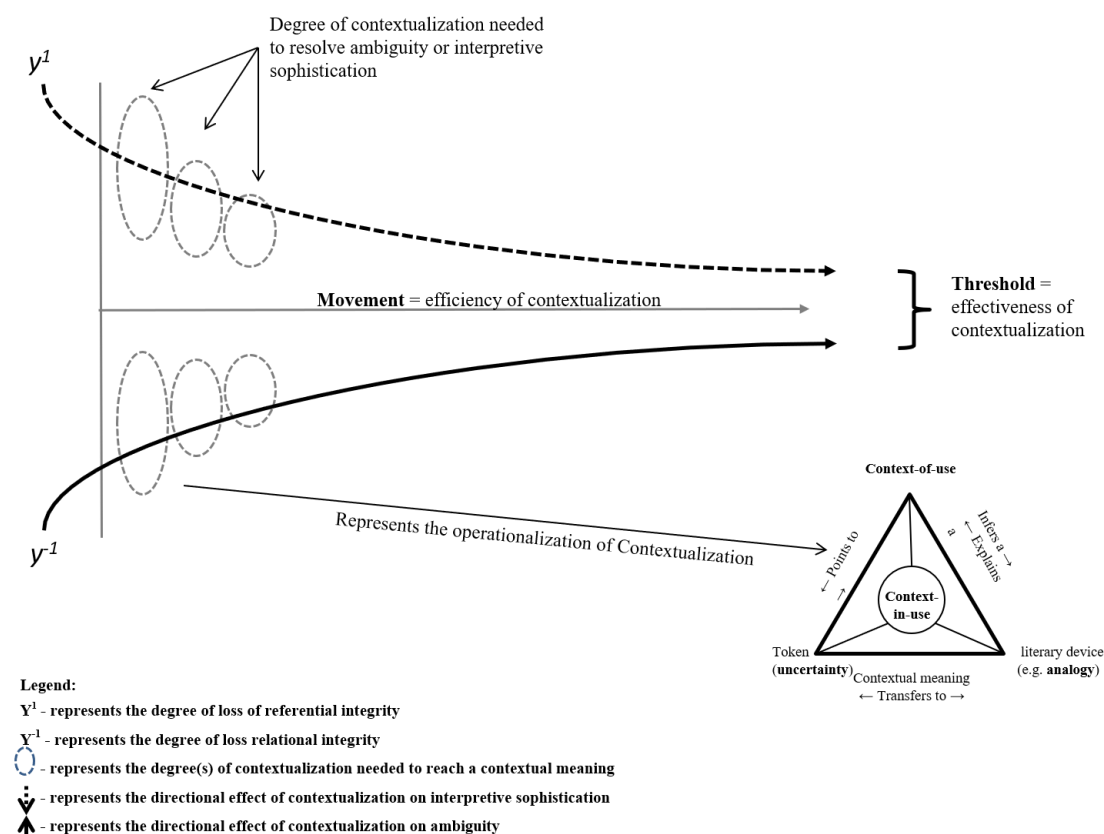
Figure 13: Synthesis of the outer and inner functions

7.5.3.2 Constructs of the theory: addressing the 'what.'

7.5.3.2.1 Novel form: context-of-use

The theory proposes to address two forms of the phenomenon of interest: one static and one dynamic. It does so via constructing a unique reference (placeholder), called a

context of use. The context of use holds interpretations. Interpretations are constructed via the operations discussed in the next section using one or more literary devices.

The **static** form relates to the current forms and functions (the artefacts as parts/constituents) fixed in the requirements specification document (the artefact as a whole). These fixed (static) forms and functions are respectively the textual constructs (e.g., use case narrative, user story) or graphical models (e.g., an entity-relationship diagram), which represent the partial artefacts. Their combinations in sets of constructs allude to the eventual document or whole artefact. In terms of the phenomenon of interest, the static form appears in practice as 'wicked' (i.e., in complexity and multiplicity detailed in theme 1). It points to the cognitive ability or inability that constructed these static forms and functions in the first place. The principle of complexity management in design is supposed to alleviate this apparent problem. It attempts to bridge the difficulty and the complexity by semantically equating text and notation. The equivalence dichotomy caused is between the "number of elements (symbol instances or tokens) on the diagram" and the effectiveness of the cognitive ability to consume a certain amount of elements, which is limited by a single diagram (Moody, 2010, p. 766); adding diagrams has the opposite effect of course. Complexity resolution necessitates more than symbolic representation to enlist cognitive effectiveness, hence the failure of the language to communicate constructs and models to novices and laypeople. Text and notational constructs between novice and expert divert completely in cognitive effectiveness because experts develop processing patterns, much like mathematicians, which comes down to heuristics, an expert heuristic, so to speak, which enables faster processing than novices.

To explain the improvement envisaged, the researcher draws upon Maguire's definition, classification and analysis of use context. His analysis is of specific interest as it is proposed for non-technical users. The basis from which the context of use serves the current static form and function is constrained by indexicality in its most primitive form: Maguire adds interpreters, time, location, and domain-specific situatedness (refer to Section 6.2.1 above) to the ISO 9241 standard of "tasks and equipment (hardware, software and materials), and the physical and social environments in which the product is used" (Maguire, 2001, p. 457). The list of contextual parameters (Ibid. p. 459) alludes to using a literary device.

In this way, the use of the device is a form of displacement of uncertainty, e.g., the category 'Personal attributes' like 'Personas' in the agile practice may present a plethora of possible meanings. By abstracting away from this interpretive sophistication, one uses a parsimonious representation in the form of a device to represent the list of attributes (age, gender, physical and cognitive capabilities and limitations, attitude and motivation). An exemplar suffices to illustrate. The following phrase, '*he* is the *typical* absentminded academic or professor (more specific metaphor), is a more *palatable* linguistic and *digestible* cognitive form than a list of attributes. The result is *bloated* with contextual meaning (word-play intended). This displacement becomes more effective when confronted with technical terminology in a list of tasks/requirements. In sum, the novel use relates directly to the device and what it represents, e.g., a property of the context of use, which could also be 'exemplars' or 'background short narrative' or 'analogy of experience'.

Secondly, the **dynamic form** is the more difficult of the two due to its higher abstraction/cognitive situatedness. For this explanation, insights are drawn from Smith and Collins (2010) and Recanati (2015). In this case, the difficulty is twofold:

1) the phenomenon-of-interest is at the cognitive level where constraints on interpretation such as an ineptness of translating a graphical form (e.g., a complex entity relation or activity diagram) or the fear associated with this ineptness prevail, and

2) the literary device itself being a sub-context necessitates combining other sub-contexts to propagate the context-of-use. In this case, each user constructs or uses a device to interpret the uncertainty (i.e., any ambiguity or interpretive sophistication that the user cannot understand without context). The content of such an interpretation carries by definition the individual's background, beliefs, culture, social and professional experiences, which are articulated in the literary device (note: the literary device is what makes sense to the specific individual). Once the context-of-use is saturated, it provides the content from which the inference, i.e., the contextual meaning, can be drawn. The context-of-use, in this case, provides several potential inferences; however, as the meaning emerges, participants come to a mutual understanding, which enables them to draw a single inference (the contextual meaning). This inference is again itself a device. In short, multiple devices together construct content from which an ordinary meaning can be inferred.

But the inference is formed from devices, which pre-empts that the single representation derived from there must be a device itself, albeit probably a different one or one selected from the context of use. This inference becomes the referent of the uncertainty; thus, satisfying one of the requirements and achieving the objective of referential integrity. The key to successfully constructing a context of use is for the sub-contexts to be cohesively related. Their relatedness is not reliant on the synonymy of wording or sentence semantics but contextual relatedness (Jing & Tzoukermann, 2001). The importance of the human ability to construct introduces the next section's focus on the functions of these constructions and relations. Smith and Collins (2010, p. 134) put the importance of the cognitive function of the context-of-use into perspective. Its construction is not merely the result of translation of pre-existing inputs to outputs but "involves online construction of cognition … in response to all elements of the situation [*contexts*]" (insert italicised).

Additionally, the device is an expression of thought concerning a context, posited explicitly in the thesis as the novelty of indexicals. Indexicals are a distinct element of thought and the cognitive process (explained above). It acts as a contextual parameter/attribute when a given expression affects multiple explanations in the thoughts of interpreters. Thus, using the device acts as an attribute of the context of use and as a sub-context. Although these devices by themselves "express different thoughts in different contexts" (Recanati, 2015, p. 2), their convergence on a context of use (placeholder or container) conditionally relates them. Thus, this exposition satisfies another requirement of mechanism and process and the objective of relational integrity.

7.5.3.2.2 Novel function: context-in-use via construct and transfer; dialogue and interpretation

Therefore, the context in use points to both the inner and outer operations respectively for its coming into being and continual functioning, i.e., causing the relations (explained in Figure 13). The outer operation(s) of dialogue and interpretation causes the reciprocation, i.e., the cognitive processing and articulation of re-interpretations or recurring contexts, to take shape or come into being. The outer operations should be understood to mean what they do in everyday use (not elaborated further). However, the inner operations do not propose to have such an ordinary meaning; therefore, further elaboration is in order. Much has been said about construct and transfer but less so about how they function. The construction here involves an indexical and one or more devices; the devices being a

cognitive construction, expressed during dialogue, form the reference (context-of-use). The form is unique because it contains several potential explanatory properties. The function is unique because it can take its meaning from the subsequent inference drawn from any single or collection of the constructed properties (Sherman, 2015). The inference drawn results from repeated interpretation, more so "the ability of those interpreting the indexical – the conversational participants – to coordinate their interpretations" (Ibid., p. 595). The interpretation causes an inference to be drawn over the indexical's referencing ability. The repeated interpretations or re-interpretations update the reference (House, 2006) or context in this case. The device, a transfer mechanism, is analogically comparable to implicit knowledge transfer via mentoring and storytelling. Both are core social capabilities in organisations (Swap, Leonard, Shields, & Abrams, 2001).

To illustrate the two interdependent operations, the researcher draws considerably upon Recanati (2015, p30) to back the hypothesis of this thesis. In this sub-section, the notion of context-in-use explains the phenomenon-of-interest in terms of a non-static function or terms of a dynamic operation only constrained by the individual and group thinking, wherefrom the subsequent linguistic expression originates. Therefore, the direction taken in this discussion is reiterated by paraphrasing Neuman: it is the interpretation of and inferences from a context-of-use that results in a perspective of that situation [*context*] (Neuman, 2006). As the context-of-use is primarily a referential matter, the context-in-use is primarily a relational matter. Indexicality is the function in which the indexical "is a property of the expression relation between sentences and thoughts" (Recanati, 2015, p. 3). Briefly, these definitions allude to that the context-of-use is more about the cognitive transactions that are in a sense formed by the use of indexicals and devices as prescribed by the theory; hence, a functional condition is placed upon the innate cognitive abilities of the human user/interpreter.

The improvement associated with this functional condition follows. When a non-technical user (not excluding technical users who may have their own experiences of 'uncertainty') experiences an uncertainty, which cannot be resolved due to the surfacing of the phenomenon of interest (explicit or implicit), the user leverages off familiar devices to solve the uncertainty. The uncertainty is positioned as an indexical in the mind of the user. The user constructs an explanation/interpretation of the uncertainty, which points to an existing reference (a context-of-use) or one constructed from multiple interpretations

(individual or group)—the relations formed between the indexical and the context-of-use surfaces one or more plausible explanations. The interpreter is now in a favourable position to infer an explanation in a familiar form, a metaphor, analogy or any suitable device in the moment of "coming to an understanding" (Weigand, 2016). This improvement satisfies another requirement and the primary objective on page139.

7.5.3.3 Associations of the theory: addressing the 'how.'

This section explains the causality between the components: novel form or context *of* use and function or context *in* use. To comprehend these causal relations, the reader must cognitively or otherwise keep the two model depictions close. As an introduction to the explanation, it suffices to reify the particular relations before attending to how they come to be.

Figure 14 depicts the relationship between the distinct operations indicated by the arrows. The movement herein explained is the inner operation of construct and transfer, which happens during the outer operations of dialogue and interpretation. An explanation of this simple movement follows:

1. A dialogue that ensues between individuals initiates the first of the outer operations. During dialoguing, interpreters construct a collective reference, i.e., an **indexical-context** or **contextual index** depending on the direction.

2. The cooperative (the collection of interpreters) interprets the constructed reference (context of use).

3. The collective interpretation is an inference drawn from the interpretations held inside the context of use. The collective interpretation is associated with a single device, which acts as the referent. The referent is the contextual meaning. The contextual meaning is transferred either as the final usable referent t^1 or as a partial explanation/interpretation to construct a context of use t^2 or reinterpretation t^3. The claim is that the final referent (contextual meaning) semantically equates to the initial token or uncertainty.
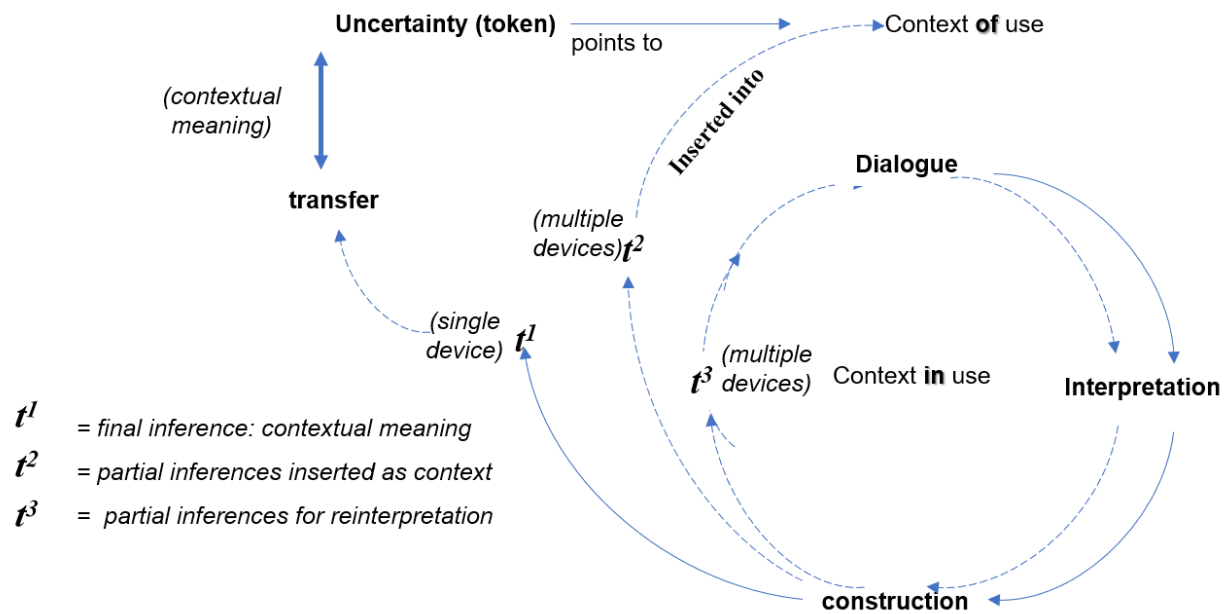
Figure 14: A depiction of the 'movement' between the inner and outer operations

The purpose of contextual meaning is to explain the uncertainty, but only if the contextual meaning of the uncertainty is semantically equal. The obligation of semantic equality sounds impossible, but the problem is solved if the projection principle is applied. The projection principle allows for a familiar pattern to be projected onto an unfamiliarity because of similarity (Doyle, 2007). The similarity constraint is akin to the preceding rules of relevancy and uniformity. Projection is possible if a familiar context shares a commonality or pattern with the unfamiliarity. The causality between the components, i.e., the indexical, context of use and inference, manifest a common explanation. This invention counters the "gap exists between a *form* of a representation and any particular *function* of this form and specific usage." (Ibid., p.87).

Doyle's (2007) explanation of projection can be interpreted as contextualisation. The article, which expressly uses the metaphor of 'language games' in the Wittgensteinian sense, makes a crucial point regarding the relevance of metaphor in Artificial Intelligence by highlighting the difference of inferential powers between man and machine. E.g., a machine could find commonalities among expression levels, i.e., word, phrase, sentence and whole texts. It could even relate parts of the same constituents together in both form and function (use), assign variables to use patterns, and ultimately raise probability outcomes based on rule checking. However, the machine would still not *make* meaning because it cannot

determine the relevance of unrelated use, as evident in literary devices. After all, coherency in human invention is not a predetermined relation.

Finally, once semantic equivalence is determined, the contextual meaning is transferable. Transferability is constituted at two levels. Firstly, the contextual meaning may not be in its final form. It may be reintroduced into the dialogue for reconstruction and reinterpretation at the operational level. The repetition could be due to a change in context or interpretation. The researcher believes that this behaviour also satisfies the requirement of iteration in theory-building at the abstract level.

Figure 15 explains the relationships between the mechanisms in use:
- between the indexical and the context of use (the reference) and
- between the context of use and the contextual meaning (the referent or referential object).
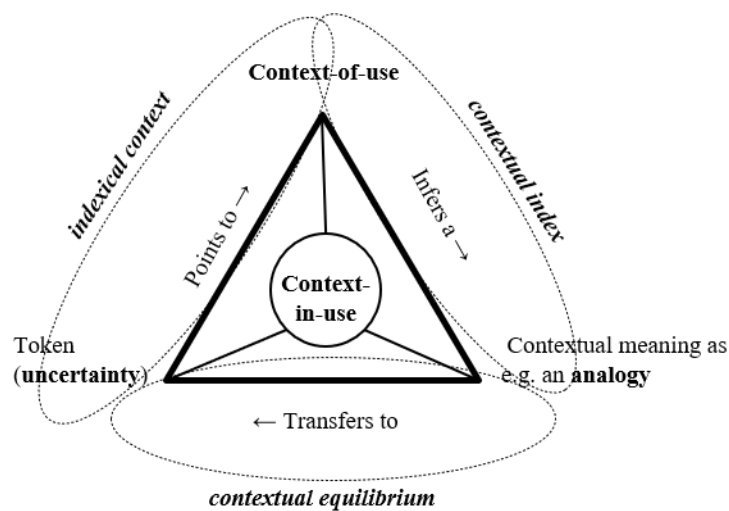
Figure 15: The 'movement' between context-of-use and context-in-use

The context of use as a placeholder or container can be seen as an "indexical frame" (Stahl, 2007, p. 13). Suffice to make a definitive reference to context as the direct link with cognition: context affects language and language affects contextualisation; "extra-linguistic realities – mental and social", which includes "every system of belief, knowledge, understanding, interpretation, perception, etc." (Tsvetkova, 2017). The relation between the indexical or uncertainty and the context of use is valid or relevant if a causal link exists between its

relation and the inferred referent. It is said to be contextually relevant. Contextual relevance is constituted if the indexical points to the reference because of a causal relation. The relation formed is defined as the **indexical context**. A relational part in one always points backwards and forwards to another relational part in the other which acts as a reference (Berzlánovich & Redeker, 2008). This causality associates with contextual uniformity or "contextual relevancies" (Ibid., p.13). Contexts are uniform if and only if the indexical which constructed the context is determined, i.e., it reoccurs in another context or is closely related to the referent. This position is confirmed by Benerecetti et al. (2000) in their explanation of contextual reasoning as a function of movement where the causal link or relation is determined by uniformity or dependency between contexts. Meaning entails 'sign' (referent), which necessitates context that ensures the reference; tied together by relevance. This relationship necessitates both referential and relational integrity.

Additionally, the context acts as a dual mechanism: 1) abstraction from recurring experiences/interpretations, and 2) referencing recurring experiences/interpretations (Ogden & Richards, 1923). Thus, being a mechanism of inferential reciprocation, it satisfies the third premise. The definition of a mechanism backs this explanation of context (being a mechanism itself): the first (1) is heuristically equal to 'discovery', and the second (2) to 'description').

A counterfactual test is whether a particular assumption is the only relevant one (Bianchi, 2001). An inference is drawn from the context of use. The inference itself is in the form of a literary device. An inference is only possible if the relationship between the reference and the inference is sufficient or plausible. The relation formed is defined as the **contextual index**. The governing rule is an adaptation of the rules of analogical processing ((Gentner & Hoyos, 2017; Gentner & Kurtz, 2006; Mueller, 2014). Finally, inference is the representation of the object of explanation or **contextual meaning**.

The preceding can be seen as two directions or moves (active interventions) in which meaning is made using context-of-use and context-in-use. These directions can be explained best by separating the two and superimposing the relational model (Figure 15).

7.5.3.3.1 The single-referential-inferential move

The single-referential-inferential move (Figure 16) is explained as follows: [**a1**] depicts an **indexical context** (see the full explanation on page 120) in which the uncertainty, any form of ambiguity or interpretive sophistication, points or references a context of use (the reference). The context may be preconstructed and or static. In this case, based on pretesting, the researcher believes that the more appropriate devices would be narrative/long story or exemplar due to the characteristics of this move. The context of use thus constructed may hold any or all types of contexts. However, in the simplest case, the need may be satisfied by an objective context only.

Context-of-use (a reference/placeholder)

a1   a2

Token (**uncertainty**)   literary device (e.g. **analogy**); the contextual meaning

a3
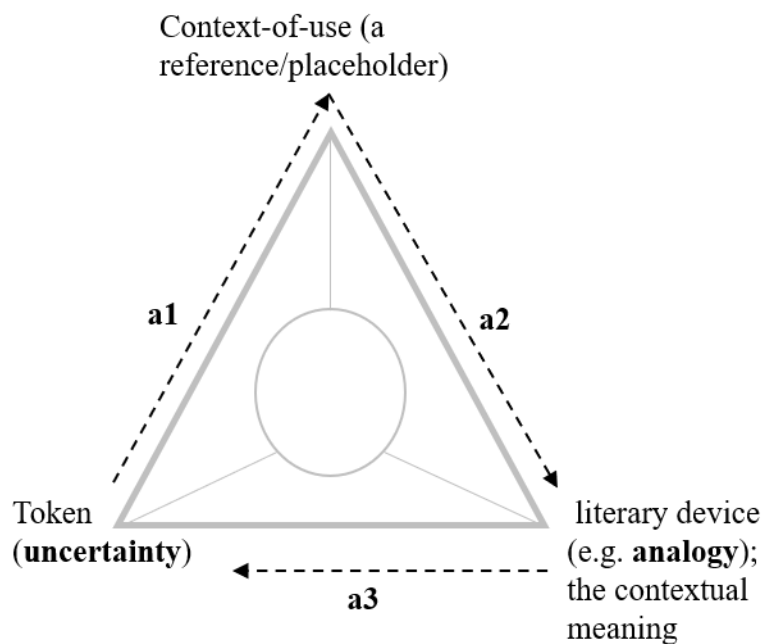
Figure 16: the single-referential-inferential movement

The content of the context of use is interpreted when the collective of interpreters agree to it being sufficient. If not, the process repeats until such time. A contextual **index** [**a2**] depicts the inferential move: the cooperative infers the most plausible explanation in the form of a literary device. The resultant device is the contextual meaning, a transferable object. The object is transferable if and only if the contexts are uniform. Contexts are uniform if any of the devices that constructed the context reoccurs in another related context. [**a3**] If the contexts of the uncertainty and object are uniform, the resultant contextual meaning is said to be semantically equivalent to the uncertainty/token. The move must satisfy the rule of projection, i.e., a construction from familiar contexts is projected onto the unfamiliar thing

due to a plausible commonality or pattern (Doyle, 2007). The contextual meaning can thus be transferred onto the token to explain it in everyday use (terms) (Naseriazar et al., 2011).

7.5.3.3.2 The double-referential-inferential move
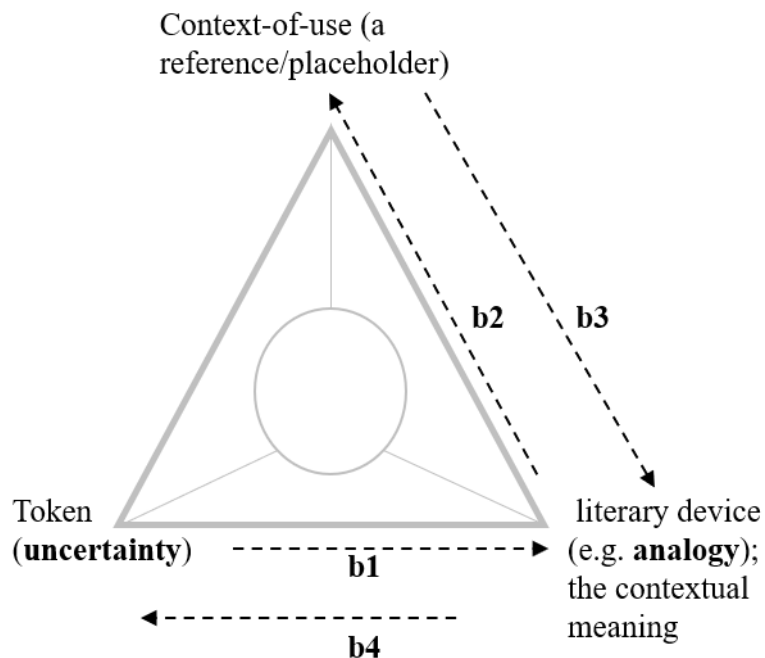
Figure 17: the double-referential-inferential movement

The double-referential-inferential move (Figure 17) is explained as follows: In this case, a relation must hold between multiple insertions. The insertions must be contextually bounded. i.e., any two or more contexts must be referentially related. [**b1**] also depicts an **indexical context** (see the full explanation on page 120). In this case, however, uncertainty, any form of ambiguity or interpretive sophistication, is *assigned* an initial literary device explaining it.

[**b2**] Multiple explanations are inserted iteratively as cognitive references or sub-contexts. Each sub-context is inserted as a probable explanation only if relevant, i.e., a causal relationship satisfies analogically.

Supposedly, the more probable devices would be metaphor/short story/heuristics/mental models due to the characteristics of *this* move. The multiple devices held in the context of use are interpreted when the collective of interpreters agree to it being sufficient. If not, the process repeats until such time. The [**b2**] process adheres to the constraints of reciprocity and relevance. [**b3**] again, the inferential move depicts the **contextual index**: the cooperative infers the most plausible explanation or contextual meaning in the form of a literary device. The resultant device is the contextual meaning, a transferable object. The object is transferable if and only if the contexts are uniform. Contexts are uniform if any of the devices that constructed the context reoccurs in another related context. [**b4**] If the contexts of the uncertainty and object are uniform, the resultant contextual meaning is said to be semantically equivalent to the uncertainty/token.

Notably, the critical difference between the two directions is the second process of insertion, which causes "the updating of the context"; a move supported in some of the literature (Arlo-Costa, 2008; House, 2006). Also, special mention must be made to the use of the word *assigned* in case b. It should not be misconstrued for the positivist use of the word as a determinant or parameter. Most context theories refrain from doing so because of the dynamic character of the context and the innate human capability of parsimony and individual competence to accept and appropriately use the inevitable changes in context during the construction of the context. These dynamics are balanced via the relevance constraint. The matter of multiple changing contexts (sub-contexts) raises the question of how stable they can be in producing a uniform meaning. The question alludes to the notion of contextual equilibrium, which is aptly explained in considering the potential of all the cooperating interpreters having the same interpretations of the uncertainty. Such a possibility would render the use of context negatable, which is impossible since all interpretation is in context. That leaves only the typical case, so to speak, of differing and deferring contexts, which presumably converges upon an equilibrium "where the process of adjusting towards the equilibrium position … can be accomplished via non-persistent updates" (Stalnaker in (Arlo-Costa, 2008)).

The notion of the 'threshold' or **contextual equilibrium** needs to be highlighted in concluding how the theory works. The above movements correlate with the earlier framework because the contextual meaning determines how much ambiguity or interpretive sophistication is resolved. A contextual equilibrium is reached if all is resolved, either by significantly decreasing ambiguity or interpretive sophistication or both in equal proportions. However, in practice, for any number of events, it is hardly conceivable that ambiguity and interpretive sophistication would increase in an equal degree, and even less conceivable that after contextualisation, they both will decrease in equal measure to reach the null level of resolution. A threshold that also moves according to the success of such contextualisation explains both dimensions. Some of the possible movements are illustrated by the following three exhibits.
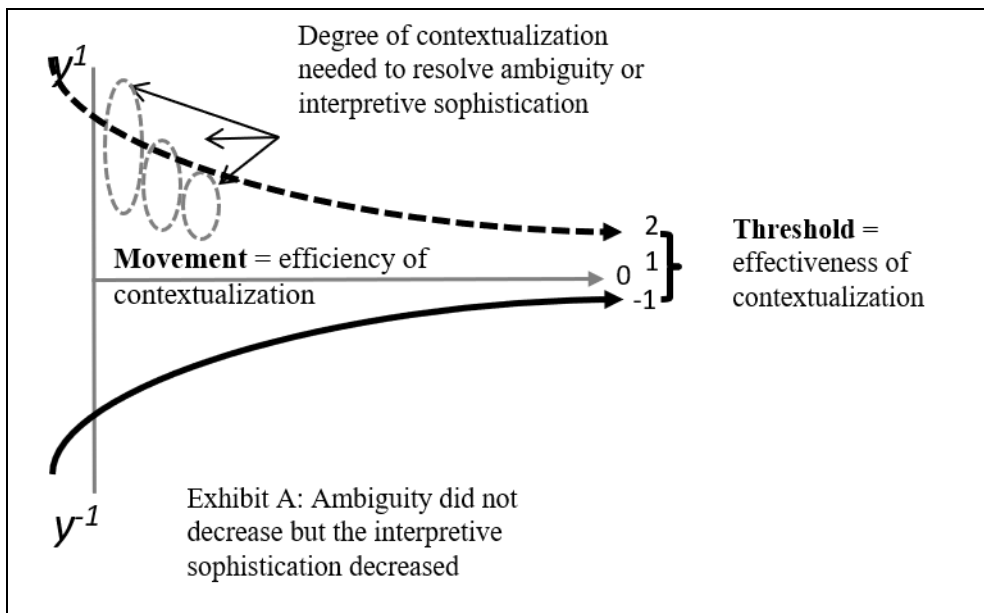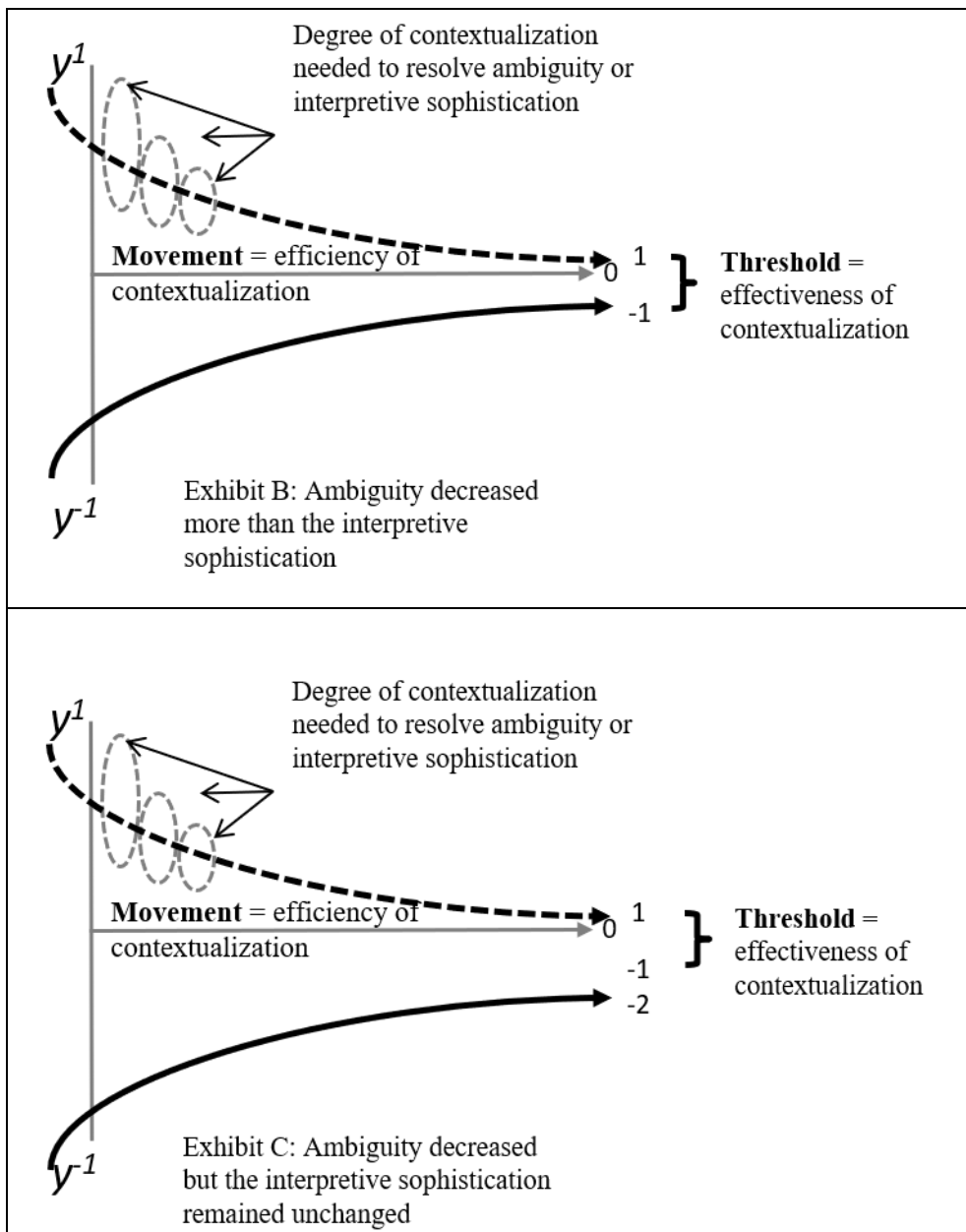
Figure 18: Exhibits showing the movement of the threshold

In summary, language is used as a collaborative tool (dialogue) to express individual and shared experiences (contexts). The cognitive process interprets and constructs what is expressed and shared (Tsvetkova, 2017). The reciprocation defines the efficiency of the linguistic-cognitive relationship in which the dialogue' effect on the collective mind can hardly be surpassed when expressed as follows:

"Dialogue, on the other hand, is a basic process for building common

understanding. By letting go of disagreement, a group gradually builds a shared set of

meanings that make much higher levels of mutual understanding and creative thinking

possible. As we listen to ourselves and others, we begin to see the subtleties of how each member thinks and expresses meanings. In this process, we do not strive to convince each other, but instead try to build a common experience base that allows us to learn collectively. The more the group achieves such collective understanding, the easier it becomes to reach a decision, and the more likely it is that the decision will be implemented in the way the group meant it to be." (Schein, 1993)

7.5.3.4 The boundary of the theory: addressing the 'who, where and when.'

In this section, the researcher addresses the limitations placed on the theory's range or contextual limitation – the question of generalisability. This question considers the context in which the theoretical arguments hold. The theory having its roots in a contextualist interpretive perspective propagates that meaning is an inference caused by context, i.e., "we understand what is going on by appreciating where and when *interpretation* [it] is happening." (Whetten, 1989, p. 492) – italics added.

Although the standard question when considering the contextual limits of the theory is the range of the propositions, there is a perspectival difference observable among scholars. E.g., generalisability is reserved for theories that analyse and describe (Gregor, 2006). In contrast, interpretivism views generalisability as one of transferability, according to Langley, cited in (Gehman et al., 2018, p. 295). Transferability means the extent to which the theoretical propositions transfer between contexts. It is this perspective that finds resonance with the researcher. However, the theory extends this meaning of transferability to reciprocated contextual meaning between interpreters because of its ordinary explanatory powers. It is notable how Whetten's (1989) definition and Gregor's (2006) definition for an explanatory theory correlate, i.e., "an explanation of how, why, and when things happen, relying on varying views of causality and methods of argumentation" (Gregor, 2006). It seems plausible that Langley's transfer refers to different contexts or "varying views" as and "when things happen" (Ibid., p.619).

Although generalisability depends on the explanation type, the theory addresses generalisable and transferable boundaries. If the explanation is applied to the same phenomenon in different knowledge domains, it would abstract the theory to higher ground or scale it up to the usual definition of generalisability. The researcher points to that

possibility Section 6.2.3 above, briefly discussed in *Appendix F: Detailed results from the quantitative measurements*. If applied to the same phenomenon in the particular context of requirements specification, the boundary would lean more towards the narrower definition of transferability. In operational terms, the theory boundary is constituted by its constructs' definitions and the events that the theory covers.

7.6   DEMONSTRATION
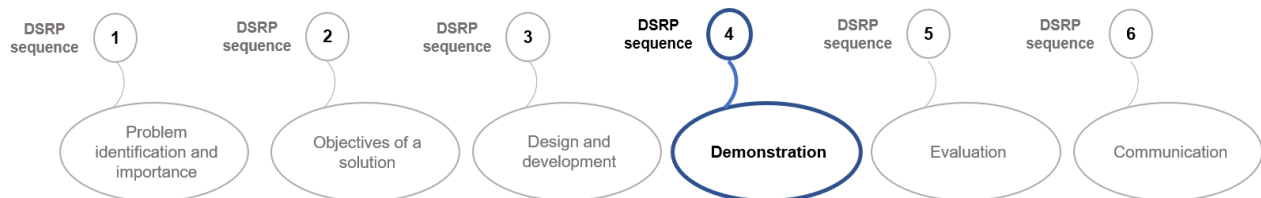
The demonstration excludes a formalisation of the principles of the theory. It undertakes merely to apply the plausibility reasoning method to a real-world problem. Therefore, the reader is expected to grasp the meaning and implications of the principles in operation. Hence, a preliminary demonstration of the theoretical framework pivots on a static or dynamic use.   A few real-world scenarios are presented to illuminate the possible operationalisation of the theory; both ambiguity and interpretive sophistication cases are demonstrated in terms of static and dynamic use. In case the demonstration lacks a particular method of validation (by individual or group survey), the following applied principles may suffice to validate the theory: "contextualisation, interaction, abstraction, generalisation, dialogical reasoning, multiple interpretations and suspicion" (O'HEocha et al., 2012). The principles, therefore, offer a reference for conducting this demonstration. Still, the researcher will not follow the last principle (suspicion) to the letter. Not because of preventing participants' distorted or biased interpretations but because the purpose is to justify a positive, engaging interaction based on the individual's subjectively rich interpretations (Ibid., p.243, Table 1). Also, the originating principles spring from the paternal hermeneutic principle of considering whole-part and their relationships, which runs parallel to the holistic principle governing the emergent theory.

7.6.1   Operationalisation of the theory

Operationalisation requires demonstrating the theory's link with the real world. In addition to using cases from industry, the theoretical terms must be linked to expected outcomes

via propositioning. The input to operationalisation is the representative form (a hypothetical framework of contextualisation (Holzapfel, 2017)).

7.6.1.1 Describing propositions

The model explains the effects of the phenomenon represented by ambiguity and interpretive sophistication, the causality between the theoretical concepts, and the effect of contextualisation (using the everyday language) measured by **correlation** and **significance**. Correlation and significance are two analytical complements. Two things correlate if they happen at the same time or show the same characteristics under certain conditions. Significance indicates the strength of the correlation. Usually, correlation persists between polarities indicated as (1,0, -1). The significance is indicated by (1) and the least significant by (-1). The sign is also an indicator of the direction in that way, i.e., more or less significant—however, it suites any analytical method of differentiation, also the Likert scale measurement.

Proposition 1 – the phenomenon of interest can be described at an abstract level as inhibitors of dialogue and interpretation decrease the potential for meaning-making drastically. At an operational level,

> [**If**] *ambiguity* increases in the dialogical function, [**then**] the loss of referential integrity increases or
>
> [**If**] the scope or scale increase (the *interpretive sophistication*) in the interpretative function, [**then**] the loss of relational integrity increases.

The opposite of what the theory intends to achieve can be seen as negation" ¬". The negation, proposition 1, describes the negative dynamic of not using contextualisation. Note that the components, ambiguity and interpretive sophistication are interdependently related and causal.

Ambiguity in a text or notation is related to the interpretive sophistication exhibited in the number of forms and functions used (scale) and the number of interpreters required to interpret them (scope).

Ambiguity and interpretive sophistication are also causally related. One influences the other because of the common denominator of form and function: the complexity of use

usually requires multiple views (forms) of the same problem; multiple forms require multiple interpretive interpretations functions or multiple interpreters. The inverse also applies. Multiple interpreters require multiple forms and functions of explanation, resulting in less agreement, thus increasing confusion or ambiguities; at least increased uncertainty.

The proposition that described the theory's working is as follows. The degrees of loss attract the degree of contextualisation needed to effect a threshold. The threshold represents the variance in movement between ambiguity and interpretive sophistication. Proposition one refers to the adverse effect where a significant variance is interpreted as a sign of great ambiguity or interpretive sophistication. Contextualisation acts as a catalyst of meaning-making, causing a decrease in the effects of the loss. As contextualisation takes effect, it positively affects both referential and relational integrity, causing a downward curvature in the y^1 axis and the upward curve in the 'y^{-1}' towards the point of maximum effect – the contextual equilibrium, a position only possible in theory. In practice, a 'threshold', a moving variance, is more plausible.

Proposition 2 – the theory

> [**If**] the meaning inferred from the construction of a context, i.e., the *contextual meaning* equals that of the *semantic meaning* of the text or notation, [**then**] in that case, semantic equivalence exists, which makes the *transfer* to the representative notation and between diverse interpretive audience *plausible.*

7.6.1.2 Measurement (results indicators)

The measurement was comprehensively described in sections 3.5.1 through 3.5.5 and will not be repeated here. This section develops the instruments described in 3.3. The problem the Use Theory of Meaning-making is challenged with is the measuring of something cognitively produced. To do so, one has to "use some observable output from it as an index." (Osgood, Suci, & Tannenbaum, 1957). How does this relate to the Use Theory of Meaning-making's operationalisation? The authors state that 'meaning' is a relational concept operationalised by linguistic-cognitive processing. They describe in detail the various perspectives or processing methods, which, although relevant, shall not be elaborated here due to essence. The essence is that they all fall short of the requirements for measuring instruments: objectivity (repeatability), reliability (same results in duplicated

contexts), validity (plausibility), sensitivity (distinctive), comparability (applies to a class of phenomena), and utility (relevance to theory and practice) (Ibid., p.11).

One of the requirements for selecting a measurement is to seek out existing measurements that apply to each unique construct or class of constructs (theoretical terms) and apply them to the Use Theory of Meaning-making. In what follows, each theoretical term and the standard measure will be briefly discussed:

- The Hartley measurement, which measures ambiguity/vagueness (uncertainty), applies fuzzy set theory in a mathematical expression. The initial problem faced was with the reality of modifiers of scope, i.e., where a word indexes truth in degrees, e.g., very tall, not so tall, less tall than, etc. Yet, to measure something, one needs to assign a symbol so that a calculation can be done. Fortunately, "a certain number of words refer to supposedly continuous numerical scales." (Klir, 2000). Uncertainty differs from ambiguity based on omitting facts, e.g., one can have a well-formed proposition, but the truth is uncertain without proof. In this case, too, the determination of uncertainty falls within degrees of truth. Usually, propositions are assigned two values of polarity. However, the advent of degrees of truth makes it possible to measure intervals of polarity and variance.

- Interpretive sophistication relates to complexity and multiplicity in a very pronounced way; by assigning two concepts: scope and scale. Their content is numerical, i.e., the number of interpreters and the number of interpretations caused by the complexity of the language used. A metric used to measure many object types were devised by (Rossi & Brinkkemper, 1996). The mathematical expressions are valuable in themselves, but more importantly, is the assumption on which the metrics are based "that a technique with many concepts is more complex…than one with fewer concepts." (Ibid., p.215). Their method also caters for a range of values.

- The Adjusted Calculation of Core Measurement technique measures a context (the ability to construct a context), but this is within the education domain. Another test proved the effectiveness of students' metaphor comprehension, construction, and inferential ability using the Cognitive Style Analysis test (Littlemore, 2001). Yet, this was also within education. The researcher could not find a suitable test for measuring context.

- Contextual meaning is the object of interpretation as a result of an agreement. A correlation coefficient (Katz & Te'eni, 2007) or Spearman's Rho can measure the level of agreement, i.e., between the Participants' inferences. This type of test uses the Likert scale.
- Formal logic can measure Semantic-contextual equivalence, but the theory focuses on a qualitative agreement between Participants. Therefore, the Interrater Agreement (IRA) test (Díaz, Pérez, Gallardo, & González-Prieto, 2021; Gisev, Bell, & Chen, 2013). This test also relies on the Likert scale Intraclass correlation coefficient (ICC) or the Kendall coefficient of concordance.

In sum, almost all the constructs of the theory are associated with the Likert scale. Therefore, the researcher deems it fit for application to the survey. One concept has not been attended to in the preceding – meaning. We have established an observable output (Osgood et al., 1957): the inferential object or contextual meaning expressed as a literary device. In this work, the authors detail several instruments. Still, one instrument that stands out is called Semantic Differential, which posits that language quite naturally *indexes* meaning using several linguistic and non-linguistic stimuli and a process of reciprocal inferencing.

Several studies found an interrelation between individual inferences of "shared significances or meanings-cross-modality stimulus equivalence" (Ibid., p.21). Such equivalences are the result of the continuous linguistic-cognitive interaction between language and experiences (contexts). One specific test used metaphorical references against its linguistic reference to establish if a relation holds. Their finding correlates with the theory's propositions. This relation offers a particular use for operationalising the theory because both referents hold semantic value (index), which is measurable by assigning relevant ordinal variables. Ordinal values in semantic differentiation apply to semantic scales of polarity, but polarity represents the endpoints of scaling across ranges, e.g., used in the Likert instrument. Hence, the Likert scale is the choice of symmetric evaluation of the outputs of the survey.

7.6.1.2.1 The researcher as an instrument

The researcher acts as an instrument in two aspects; interpretation of the secondary and surveyed and the intervention's facilitation. The researcher is actively involved throughout the theory development process, collecting, analysing, and interpreting the secondary data

from an interpretive perspective. Yet, an interpretive lens includes the researcher's personally lived experiences and acquired knowledge of the phenomenon of interest; appropriately dubbed *uncertainty*, i.e., the meaning of the current forms and functions. The researcher-instrument is non-static, evolving with the discoveries made from the secondary and primary data interactions. In both cases, the researcher uses thematic analysis to interpret and look for patterns and relationships "relying [instead] on the researcher's abilities to perceive and describe obvious patterns and themes, as well as subtleties, perplexities, contradictions, and nuances in the data" (Ibid., p.419). The first interaction was with the secondary data, which led to the constitution of a representation of the phenomenon. The final interaction requires the researcher to conduct an intervention, observations and surveys that illuminate the phenomenon under study and confirms or disconfirms the theoretical propositions (Barrett, 2007).

The confirmation phase (later in this section) reflects the evidence, i.e., the correlations and significance of the researcher's subjectivity, evidence of the phenomenon, the researcher's plausible reasoned interpretations – the theory (Ibid., p.418).

7.6.1.2.2 The survey instrument: multiple-indicator

The work of Hsu (2006) offers a useable guideline for using multiple-indicator surveys as an interpretive instrument. This instrument is apt for operationalising the theory because it offers several outcomes directly associated with the propositions, the survey content and the related questions. In this book, multiple indicators, e.g., attitude or opinion indexing or scaling (Ibid., p.234) were successfully employed to study a current state of mind and cognitive behaviour or mental model and the impact of using metaphor in communication.

The researcher dedicated a minor part to capturing the participants' historical experiences with the phenomenon of interest in the survey. Each of the participants was given the same set of questions. These questions were informally structured. They expressed the description of the implicit form of uncertainty given in this chapter's Introduction. The outcome is expected to correlate with the pretest's outcome, favouring the researcher's own experience of the phenomenon.

The next part (part 2) was dedicated to the participant's experience with the forms and functions in the problem domain. The participants were exposed to industry exemplars of

linguistic and engineering ambiguity. After that, the group was exposed to examples of the default scope of notation used in a real-world case: a Use Case decomposed to three levels with accompanying activity, process and entity relation diagrams in the URDAD design form (Solms & Loubser, 2010). After a brief reciprocation, the participants were directed to the second phase of the survey to answer questions related to proposition one. The researcher expects the experiences to indicate a ⅔ split between users, analysts and developers, leaning more towards an agreement on uncertainty.

The final part (part 3) of the survey was dedicated to the participant's experience with the theory's operationalisation. At this stage of the survey, the proposed intervention occurred; the researcher acted as a facilitator. First, the researcher described the literary devices to familiarise the group with [their] form and function. This activity was followed by explaining the indexing of uncertainty, followed by industry examples to demonstrate the theory, i.e., **case a: indexical context** and **case b: contextual index** described and explained in section 7.5.3.3 above. After that, the group engaged in dialogue to mull over and develop their reasoning over the new knowledge until they reached an agreed level of understanding (interpretation) and confidence to proceed with unassisted cases. Herein, the researcher acted only as an observer. Once satisfied, the group was directed to the final set of questions specifically designed to capture the outcome of the participants' experiences. Finally, at the end of the survey, each participant had an opportunity to express a brief self-reflection on the participant's thoughts about and experience with contextualisation: a Use Theory of Meaning-making.

The technique that matches the multiple-indicator format best is semantic differentiation, a quantitative measure of 'meaning' (Osgood et al., 1957). The notion of meaning can be considered an ordinal variable using the Likert scale parametrised as '2, 1, 0, -1, -2'. The ordinal variables were assigned to the theoretical terms that could be indexed: ambiguity, interpretive sophistication, uncertainty, dialogue, interpretation, literary device construction (e.g., metaphor), contextual meaning, and transferability.

The exception to the use of multiple-indicator questions is the pretest (*The pre-test and post-test survey: Wilcoxon ranked sign tests*). It preempts the notion of contextualisation. The survey was designed using the known Pichler Validation Board, adapted to discharge two

assumptions. The first assumed that contextualisation is well understood by the individual, which suggested that the current language, a use case in the test, was inadequate to convey meaning. The second assumed that the interpreters could construct a context similar to the proposed construction in the test. The test presented a static intervention (demonstrated later). Nine interpreters were presented with a use case without the static context and three simple 'y/n' questions. After answering the first set of questions, each interpreter received the same use case with a static context and three related questions.

7.6.1.2.3 The statistical and plausibility instruments

The statistical instrument used to report quantitative measures was IBM® SPSS® Statistics v 27 to calculate a Spearman rank correlation to validate the multiple-indicator measure for survey 1. The Spearman rank correlation applies to the Likert scale weighting assigned to the multiple-indicator questions. The multiple-indicator questions are considered ordinal and suited for measuring **correlations**. For surveys 2 & 3, the Wilcoxon signed-rank was used to measure the difference in improvement between the two datasets.

The second instrument applicable herein was plausibility. Although plausibility measures are surely quantifiable, it is not the primary focus of this thesis nor the basis of the evaluation of the theory. Suffice it to mention that it may interest future researchers to embark on the quantification journey in the vein of (Friedman & Halpern, 2013). The importance of their work is the correlation between quantification and qualification of probability-in probability theory. They replace probability with plausibility because one can then measure **uncertainties**. Plausibility measures and uncertainty measures go hand-in-hand. An uncertainty measure is defined as a type of generalisation of plausibility. Plausibility can be applied to "reason about independence and qualitative reasoning" (Ibid., p.181). Independence is of particular importance in the reasoning about uncertainty because of symmetry, i.e., if one thing is independent of another thing, the reciprocal relation also holds-thus they are said to be symmetrical. It applies to the use theory because the uncertainty is independent of the contextual meaning. Still, as they are reflexive, transitive, and symmetrical, they are semantically equal and therefore transferable from one to the other. In this article, uncertainties include measuring ordinal variables, i.e., values typically measured by the Likert scale.

7.6.1.3 Tie-in with the surveys research question(s)

The demonstration warrants three sets of thematised questions directly related to the two propositions, the measurements and the central question: ***How to naturally improve the current poor 'use' of language forms and functions in requirements specifications.***

The baseline was targeted at past experiences, theme one, determining whether the phenomenon is similar to the current career context and whether cognitive awareness is similarly associated? Note the reason for a difference in the number of participants of the Baseline and Focus Group is that not all of the 14 originally targeted participants felt they could contribute to the theory testing but could contribute to their historical and current experiences with notational languages.

The questions of the one-shot- pretest-posttest, respectively, targeted the current experience and cognitive awareness, theme two, determining whether interpreters are aware of the phenomenon, i.e., they experience uncertainty when presented with ambiguous or interpretive sophisticated text or notation. Theme three targeted the post-intervention experience and cognitive awareness, determining whether the participant can construct explanations using literary devices and whether they are shareable from one context to another? These two themes underpin propositions one and two, respectively.

Finally, five questions acted as a debriefing to the focus of the surveys, themes two and three. This set of questions requires the participant to decide whether the Use Theory of Meaning-making achieved its objectives in the individual's view.

7.6.2 Confirmation of the theory

The Focus Group Approach applied by Myers and Klein (2011) is quite suitable for the confirmation but with some different constraints: it is non-formal, non-empirical, loosely coupled (participants relate cross-functional only), encourages the use of anecdotes and other literary devices explicitly, and relies upon plausibility to confirm the Use Theory of Meaning-making's credibility and reliability – trustworthiness and plausibility.

7.6.2.1 Ethics

The type of study requires an online collaboration and feedback questionnaire from the participants due to practical reasons. The electronic questionnaire clearly states that the survey is anonymous and uses Qualtrics^{xm}, an accredited provider of industry surveys, to ensure security, anonymity and confidentiality.

The original copies of collaborations, assessments, analysis, discussions and conclusions will be held with the University of Pretoria for safekeeping. No participant will be mentioned in a public document or a published article unless specific consent is given. Questions are set up to remove any reference to race, gender or sex, or other personal identity forms. Only indicators such as professional role, years of experience, industry training, number of training completed on the current language constructs and models, and level of education are included to thematise the outcomes.

All participants are advised that they may discharge themselves from the participation for whatever reason they see fit. The participation is entirely voluntary and transparent – participants may have access to all notes, electronic or otherwise, recordings, if any, still or moving imagery taken during the focus group study. A copy of the Ethical Clearance is attached (Appendix A)

7.6.2.2 The focus group and survey design

The design appropriate for confirming or falsifying the Use Theory of Meaning-making's propositions is the "one group pretest-posttest design" (Swanson, 2013). The motivation for using this design is it compares one group interpretation of two scenarios. The advantage of this design is that it is an economical means of explaining causation between the theoretical concepts. It provides confirmable or falsifiable observations and experiences of the participants. The drawback is it does not provide a basis for conclusive results. However, the researcher believes that the plausibility criterium is a countermeasure to the drawback. Hence, the results may prove plausibility.

The group demographic consists of business users, analysts and programmers. The Participants represent cross-functional experiences and a single observer exposed to the typical constructs and models presented in a requirements specification, UML, and the

preferred organisational development method: Agile. The survey design consisted of four distinct themes:

1. a historical or extant mental model regarding the notion of fallout, e.g., imposter syndrome, and its possible recurrence in requirements engineering (relating to poor requirements specifications),

2. a recent experience of poor requirements specifications using two exhibits,

3. the new experience of contextualisation by applying the theory's concepts and process to the two exhibits, and

4. opinions of the Participants about the theory's success and future application.

7.6.2.3 Measurement design

The Likert scale measurement was employed throughout the four themes, which were reported respectively as the Baseline, the Pre and Post-test (combining themes two and three), and a Debriefing. The baseline and pre and post-test surveys show the results of combinations of related questions. The quantification of the Likert scale outputs or answers accommodated the survey questions by following non-parametric measurement instruments: correlation, significance, uncertainty, confidence interval, and consistency indicators. The readings from the outputs were tabularized to reference the values representing each of the instrument results quickly. The results are interpreted using the industry-standard meanings assigned to each instruments indicators.

The basic design steps followed are: define the null hypothesis and the alternative hypothesis; define and calculate the test statistic; set the significance threshold; calculate the respective p-values (if the p-value > significance accept the null hypothesis, else reject it. The four themes had to be compared to the two leading propositions of the Use Theory of Meaning-making, resulting in hypotheses for each theme.

The **Baseline** measurement deals mainly with the relationship between the historical and current experiences with the text-notation or form-function problem and the extant effect on the participant's mental model.

The **pre-test and post-test** measurements deal directly with the two propositions; hence, the overarching null hypothesis states that contextualisation has no decreasing effect of

either ambiguity or interpretive sophistication. The alternative is the hypothesis (H_1) that contextualisation positively affects referential and relational integrity, causing a decrease in ambiguity and interpretive sophistication. The measurement for these two surveys differs from the preceding because here, the researcher intended to determine if the Use Theory of Meaning-making succeeded to improve the claimed ill effects of the form-function problem, i.e., referring to ambiguity and fragmentation (interpretive sophistication). The appropriate measurement is the Wilcoxon 'two-related-samples test'. It compares the indicators from each participant in the pretest to the same number in the posttest. The difference can be negative, positive or a tie.

7.6.2.4 Data collection method

The data was collected using self-assessed surveys only collected online via Qualtrics XM. The first survey served as a baseline of experiences and cognitive awareness. It was individualised to capture the career context of the participant, the participant's historical experience with text and notation at secondary school level, and the participant's cognitive awareness of the similarities found in the current vernacular in requirements specifications.

The second survey acted as the pretest. It presented the participants with nine questions directly related to the experience, including cognitive awareness, embedded in two examples, exhibiting ambiguity and fragmentation (interpretive sophistication). The last two questions relate to the degree of ambiguity or fragmentation experienced. Participants were required to indicate the levels of each given a view of the theoretical framework of contextualisation.

The third survey collected the participant's experience and cognitive awareness after the treatment, which consisted of a researcher facilitated intervention. The researcher explained the notion of contextualisation to familiarise the participants. After that, the pretest was called up to serve as the basis for the posttest survey. The difference was that Participants were required to adjudicate whether the treatment achieved the objectives.

The fourth and final survey collected data from each participant using five questions. The data collected in this survey is the opinion, preferences to either one of the theory's

processes, and projections about the future of the theory. As with the first survey, the baseline, this survey is also highly subjective.

7.6.2.5 Data analysis

7.6.2.5.1 Scoring of the questions

The questions were scored based on their respective goals in each survey and can be categorised as follows: Situational (demographic), open-ended and ordinal. The ordinals used were numbered for statistical purposes, using (2) as the positive extreme and (-2) as the negative extreme. A null value indicated neutrality. The baseline questionnaire asked questions relating to the career situation and historical experiences, and cognitive awareness of each participant. The pretest and posttest questionnaires mainly entailed ordinals because the goal was to compare participants' experience and cognitive awareness before and after treatment.

7.6.2.5.2 Quantitative analysis

Likert scale ordinals were used across the surveys except for the career context and a single open-ended question in the Debriefing survey. The data were quantitatively analysed using IBM® SPSS® Statistics v 27 and cross-checked manually in Microsoft® Excel®. Statistical analyses included *Spearman's* rank tests to establish the correlation coefficient. The Spearman rank test applied mainly to the Baseline survey because the aim was to establish if a correlation exists between historical and current experiences of a similar kind. The correlation coefficient indicates the strength and direction of a relationship between two data sets. The pretest and posttest datasets warranted a *Wilcoxon* signed-rank test because the aim was to determine if the treatment had the expected effect. The Debriefing survey was not subjected to any quantitative measurement because it aimed to capture the participants' personal opinions on the success of contextualisation. A simple matrix is included to display the results.

The **correlation coefficient (r_s)** is a value between 1.0 (a perfect positive correlation) and -1.0 (a perfect negative correlation); the signs indicate the relationship's strength and direction. A 0 value means there is no correlation. For the Use Theory of Meaning-making with specific reference to the Hypothetical Framework, a change in the value of the

Ambiguity variable correlates with a change in the value of the associated *loss of referential integrity* variable. Figure 19 portrays the strength of the correlation.

The strength of a correlation

Value of coefficient R_s (positive or negative)	Meaning
0.00 to 0.19	A very weak correlation
0.20 to 0.39	A weak correlation
0.40 to 0.69	A moderate correlation
0.70 to 0.89	A strong correlation
0.90 to 1.00	A very strong correlation

Figure 19: The strength of a Spearman correlation (copied from (Centre))

A value between 0.5 and 1.0 is regarded as a moderate to a strong positive correlation. The minus sign indicates the inverse. The two possible interpretations of the correlation coefficient are

- an increase in one variable correlates with an increase in the other variable for a *positive number*, and
- for a *negative number*, a decreasing trend results between the data sets. The trends mentioned herein were analysed and reported alongside the comparative statistics in *Appendix F: Detailed results from the quantitative measurements*. Taken together with the explanation of the coefficients, the correlation between the results from Spearman's analysis and the trend analysis should be unequivocally apparent.

With correlation runs significance; **statistical significance (ρ)**. Significance indicates the probability of getting the same answer under the same conditions. Significance was calculated using a p-value. However, the caveat in using statistical significance is that on one side, a significant difference between respondents does not bear a truth component to the theory, only that a particular test in the continuum of tests did. On the other hand, if the response rate is 100% between correlating tests, the p-value equals 1, i.e., a repeat will result in a 0% difference in responses each time.
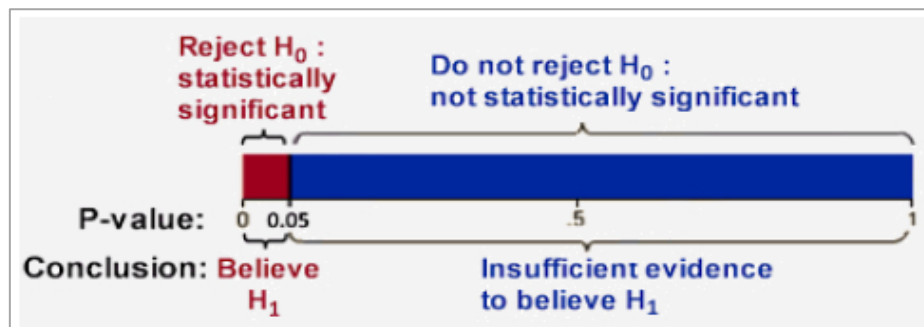
Figure 20: Statistical significance (p-value) indicator (copied from (Centre))

Another quantitative measure used is the **Uncertainty formula (μ),** which determines the plausibility at a certain confidence level. This value is calculated with a percentage of confidence level, e.g., 95%, which translates to the percentage of measures or values that fall within the standard deviation. The usefulness of measuring uncertainty for the Use Theory of Meaning-making aligns with the principle of abduction, the reasoning mode, and the constructive grounded theory method for the best explanation. Hence, the measure can be articulated such that the measurements from the instrument equal the reading's probability ± the uncertainty. E.g., if the standard deviation is used, the variance in the choice of the group of participants will move between the deviation indicator (value) ± the uncertainty indicator. The rule for uncertainty is that the measurements are *consistent* or said to agree if the ranges of the values overlap, else it is discrepant. The **Confidence Interval** (CI) is a measure that complements the Uncertainty formula (μ). It parallels the readings of the Uncertainty formula because it also indicates confidence at 95%. Both correlate with the following instrument in terms of indicating consistency.

In sum, the four statistical instruments used to analyse the data were:
- Spearman's rank correlation coefficient (ρ)
- Spearman's statistical significance (p-value)
- The uncertainty formula (*u*)
- Wilcoxon T-test and Signed rank test

7.6.2.5.3 Qualitative analysis

A qualitative analysis corresponds with the constructive grounded theory, mainly because of the interpretive nature of the study. Following the method encourages the

researcher's observations and subjective interpretations as significant to the study's outcome. Because the thesis is the work of the single researcher, the researcher's interpretation of the participants' feedback upon open-ended questions and the few recorded text entries remain the basis for qualitative analysis. The participants' answers were then analysed according to the themes developed through the secondary research and expressly coded for the questionnaires. After that, the data directed the coding and analysis. The test for the qualitative portion of the survey is based on the two terms, uncertainty and plausibility. The two are complements of each other: uncertainty is regarded as the inverse measure of plausibility. A low uncertainty reading suggests a high plausibility. The uncertainty readings have been explained in the results and will not be repeated here. However, the significance bears on the aspect of plausibility such that there is an insignificant possibility of not getting the same results via a repeat survey. How does this equate to or at least fundamentally support plausibility?

Concerning the interpretation, there was one question left to the Participants' opinions in the debriefing. This question asked how the Use Theory of Meaning-making can improve, specifically in future research or other contexts, i.e., applications or domains.

Only one survey needed coding or re-categorisation: the baseline survey. The questions (*Appendix E: The survey questions listed for easy reference*) relating to the career context (questions 1-5) were separated from the rest of the survey (questions 6-19), which relates to the participant's historical experience and cognitive awareness with similar problems. The aim was to establish if a relation holds between secondary school experiences and career experiences. Finally, in particular, two questions (questions 10 and 12) dealt with the extant mental model resulting from the historical and current experiences.

The researcher ignored two questions from the baseline survey; questions 11 and 13. Question 11 was not answered by a participant at all. The researcher's analysis suggests it was misconstrued, and the researcher failed to add a formal validation check to prevent the oversight. However, the gist of the question was captured between questions 10 and 12. Question 13 was a separation from question 12, and thus a repeat.

7.6.2.6 Results and interpretation of the analysis

The results are summarised according to the statistical and plausibility instruments, using explanatory text, figures and tables. The comprehensive data analysis and results can be scrutinised in *Appendix F: Detailed results from the quantitative measurements*.

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7.6.2.6.1 The statistical results

The statistical instruments used to analyse the data are summative, starting with the Baseline survey results. Then follows the results from the pre-test and post-test surveys (two and three), which were combined to measure the effect of the treatment. Finally, this section concludes with the results from the Debriefing survey.

Mainly, the **Baseline** instrument was employed to measure the similarity of experience of the form-function problem referring to the historical and current experiences and their effect on participants' cognitive awareness. The Baseline results are separated into three categories: Career context, Similarities and Cognitive Awareness. The Similarities and Cognitive awareness categories were scaled using a Likert five-point scale. The career-related questions were not scaled for correlation. However, they give valuable insight into the profiles of the participants, as can be seen from the following four figures. The list of questions can be viewed in *The Baseline survey: Spearman's correlation tests*.

The *Career* categories **Error! Reference source not found.**, Figure 22, Figure 23, Figure 24 (Table 17) show that seventy-five per cent (75%) of participants have been in the career context for more than 10,000 hours, which is considered a high level of expertise. Close to 20% of participants were categorised as business users, a normal distribution of representation on a small Agile team. The more significant operational roles assigned to the analytical function are mainly within the business system domain. These statistics seem to correlate well with the quantified results in Table 18, categorised according to the pairing of questions and the corresponding measurements, i.e., the results of the Spearman's instrument indicate a team characteristic and share experiences across the team distribution.

Table 17: Participants' career distributions

Figure 21: Participants' functional employment

Figure 22: Participants' operational role split

Figure 23: Participants' functional positioning

Figure 24: Participants' hours of expertise
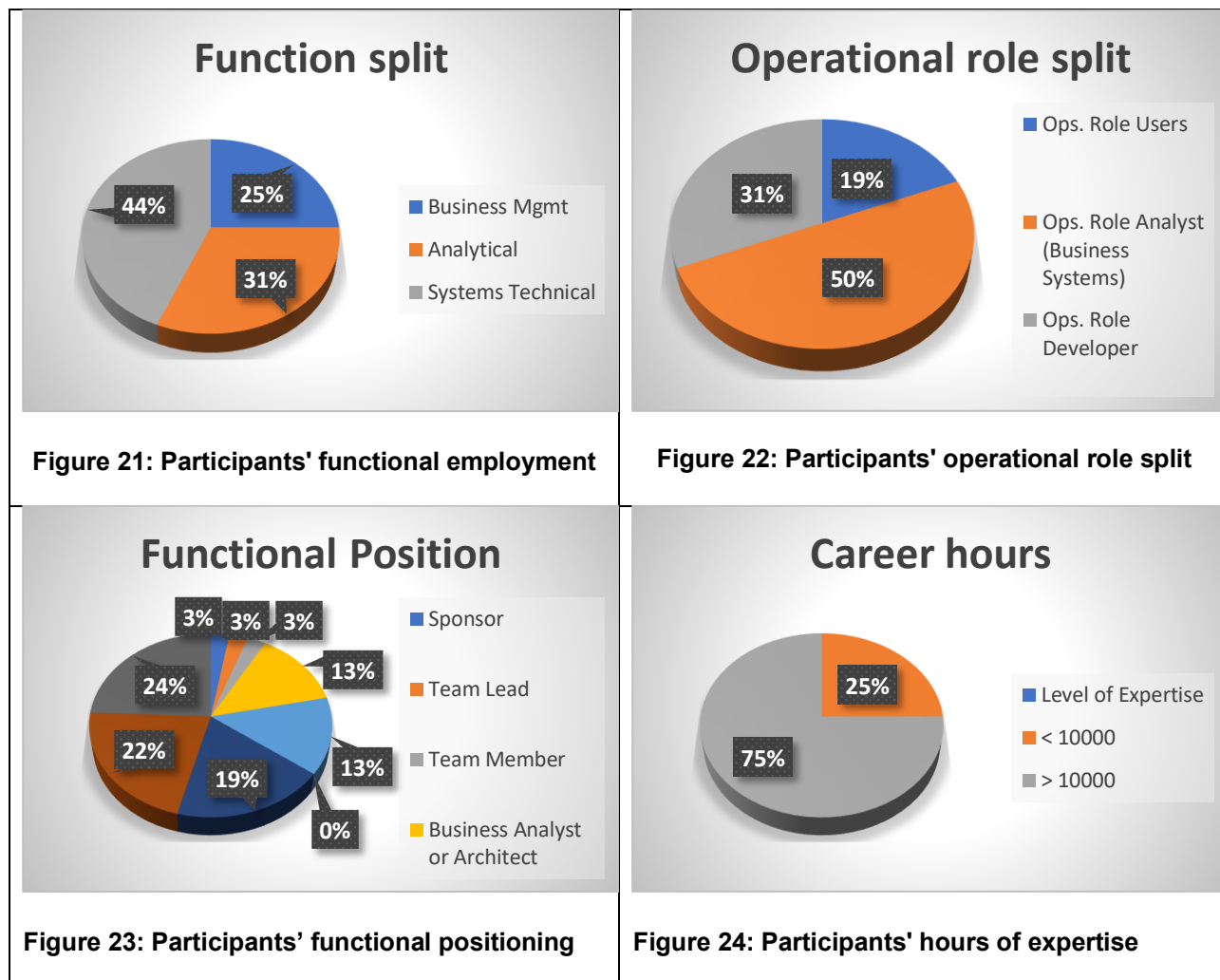
The *Similarity* category presents the results of the four instruments used to analyse the relationships of historical and current experiences, pairing related questions to compare the historical and current experiences. In this case, the form-function relationship null hypothesis (H_0) states no similarity (correlation) between the historical form-function problem (e.g., in mathematics) and current languages. The alternative hypothesis (H_1) states a significant correlation exists, i.e., the historical experiences are transferred to the current experiences. The historical experience refers to the relationship between a school subject such as mathematics, which uses similar form-functions as information systems. Participants were asked to indicate the degree to which their experiences were similar.

The UML and Text Notation correlations (R_s) are both moderate. Yet, the more important indicator is the p-value < significance (0,05). The UML experience correlates at the edge of statistical significance while the other shows a strong significance. The uncertainty and confidence readings overlap, which means the measurements are in agreement, i.e., the accuracy of the measurements is acceptable.

The text and notation in the subsequent dataset relating to the experiences with text-notation types prevented the preferred separate correlation tests with the historical and current datasets. Thus, these relationships were manually categorised between the three historical types, word problems, diagrams and schematics, and the current text-notation types in use (A detailed exposition can be viewed in *The Baseline survey: Spearman's correlation tests*). The number of possible text-notation types were eight. The Participants (n=14) had to rank the types according to difficulty, starting with the lowest. The total number of responses (n=120) were distributed across the three historical types as follows, showing the count and the percentage which the type represents: word problems (n=15, 12,5%), diagrams (n=74, 62,5%), and schemas (n=31, 25%). This distribution indicates that diagrams (five types) pose the greatest difficulty to understanding and meaning. An additional significance is the order of difficulty experienced (the category is shown in [] with the order from lowest to highest): [*word problem*] Use case narrative, [*diagrams*] SQL script and Use case diagram, Interface diagram, Activity diagram, Business process diagram. The entity-relationship diagram appeared more than three times than any other type.

The *Cognitive* category presents the effect of the historical experience on the linguistic-cognitive processing of the participants. The mental model null hypothesis (H_0) is that the participant's mental model is unchanged or influenced by the historical experience. The alternative (H_1) is a historically significant effect that resurfaces in the mental model since being affected earlier in life is observed.

The noteworthy reading in this category is the strong correlation between historically negative cognitive experiences and the unwillingness to raise that awareness with superiors. This fact can be seen by the p-value (0,000), which indicates a perfect correlation. This awareness can be attributed to the reasons given, which strongly relate to the notions of fallout, i.e., imposter syndrome and psychological safety. Additionally, the cognitive

awareness correlations have a 'good' internal consistency to strengthen the significance of this result. However, the mental model effect indicates a lower correlation and questionable consistency; its meaning and the preceding two support the null hypothesis's interpretation: if one variable increases, the other also increases. E.g., if the difficulty increases, i.e., the cognitive effort of interpretation or cognitive processing, then the fear of being singled out increases. Therefore, the factor of not raising the issue increases. These two correlations relate to the subsequent (0,52) reading for the mental model. The reading is sensible because, with an increase in mental effort perceived as unfavourable, the corresponding reasons tend to be negative. The correlation between the number of languages and the mental effort to master them via training shows a weakly positive correlation. The p-value is slightly < significance, yet statistically significant. The reading also makes sense because the increased number of learning languages increases the effort, perception, or belief for increased mental effort.

The crux of the confirmation lies in the **pre-and post-test** instrument results ($n = 10$). Table 19 displays the two main categories named after the two models of the Use Theory of Meaning-making. Each of the categories expounds the results according to the theory components. Suffice it to highlight the most important indicators and their respective meanings. They will be associated with their respective hypotheses to provide context for understanding the interpretation of the statistical results.

Concerning the **Hypothetical Framework**. The null hypothesis (H_0) states that contextualisation affects the population's dialogical or interpretive experiences negligibly. The alternative (H_1) states that a significant difference is experienced after contextualisation.

For *Ambiguity*, the H_0 states that the experience of ambiguity between the two observations will not differ either negatively or positively. I.e., between the preintervention and postintervention observations, ambiguity will neither increase nor decrease. The alternative H_1 states that a significant decrease in ambiguity is expected in the postintervention results. The rank sign is substantially positive ($n=6$), which indicates that the postintervention > preintervention. Translated meaning the ambiguity was experienced by six participants to diminish. The p-value > significance (0,05), missing the significance criteria by 0,008. Strictly interpreted, the H_0 must be accepted, but the increment is

negligible, and the three ties mean some indecision on the part of three participants, which warrants a cautionary acceptance of H_1.

For *Fragmentation*, the H_0 states that neither scope (the number of interpreters or diversity) nor the scale (number of forms of language) affect interpretation negatively or positively. The alternative H_1 states that a significant improvement is experienced in both scope and scale. In this case, the positive rank test is very high and together with a statistically significant value (0,039), the H_1 hypothesis is accepted.

For *Referential integrity*, the H_0 states no correlation between ambiguity and the loss of referential integrity and no improvement on the loss due to contextualisation. The alternative H_1 states that a correlation exists and that contextualisation improves the loss.

For *Relational integrity*, the H_0 states no correlation between fragmentation and the loss of relational integrity and no improvement due to contextualisation. The alternative H_1 states that a correlation exists and that contextualisation improves the loss.

The results of comparing ambiguity and the loss of referential integrity and fragmentation and the loss of relational integrity, represented by the two asymptotic lines graphically depicted in the framework, is shown in Figure 25 and Figure 26, respectively. The mean is indicated on the Y^1-axis and Y^{-1}- axis, which indicates the line's asymptotic movement. The general hypothesis applies here again. If the H_0 is retained, i.e., not rejected, then no noticeable movement in the threshold is expected. The H_1 predicts a noticeable movement in the threshold preintervention and postintervention.

Pretest result of the Threshold			
Q8: How severely do you perceive the loss of referential integrity to be, i.e., inability to come to a mutual understanding? Your choice represents a spot on the (y1) axis		Total	
	Weighted Total Count	10	
	High	3	
	Medium	7	
	Low	0	
Q9: How severely do you perceive the loss of relational integrity to be, i.e., cohesion or lack thereof because of the interpretive sophistication? Your choice represents a spot on the (y-1) axis.		Total	
	Weighted Total Count	10	
	High	6	
	Medium	3	
	Low	1	
Threshold		6,7	
	average 1	3,3	
	average 2	3,3	

Figure 25: Pre-test results of the threshold superimposed graphically

Posttest result of the Threshold		
Q8: To what degree was referential integrity restored or improved, i.e., the ambiguity resolved?	Total	
	High	4,0
	Medium	4,0
	Low	2,0
Q9: To what degree was relational integrity restored or improved, i.e., a shared meaning possible?	Total	
	High	6,0
	Medium	3,0
	Low	1,0
Threshold		6
	average 1	3
	average 2	3
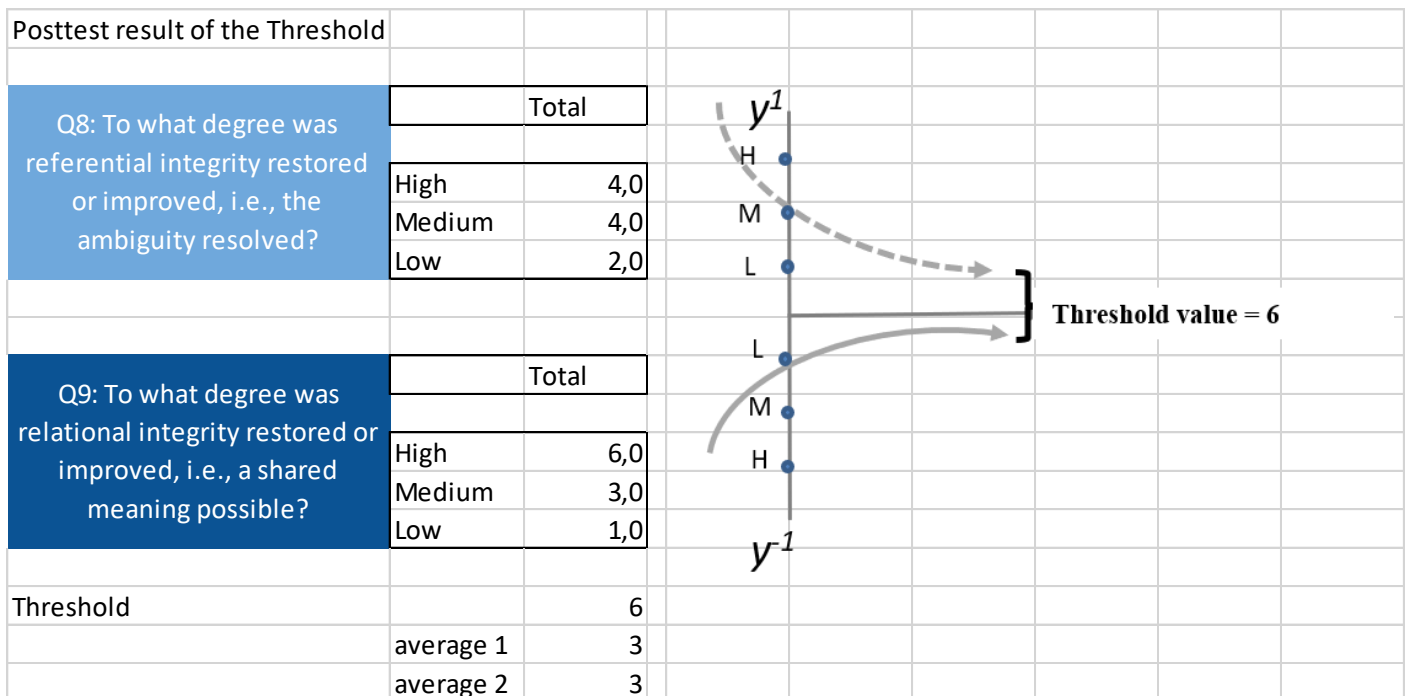
Figure 26: Post-test results of the threshold superimposed graphically

The **Movement Model**'s null hypothesis states that the population will have no different linguistic-cognitive experience with or without literary devices. The alternative states that the population will experience considerable linguistic-cognitive improvements with the use of literary devices.

Concerning the effect of multiple interpretations (*uncertainty*), the H_0 states that multiple interpretations do not affect shared meaning. Alternative H_1 states that the multiple meanings were consolidated into a shared meaning. The results of this test were slightly weaker than the test for ambiguity regarding the significance (0,06). Yet, the H0 states negligibility as the criteria, which hardly qualifies for rejecting the hypothesis outright due to the high positive ranking. In this case, there seems to be more evidence needed, i.e., a larger segment of the population. Note the marked difference in the p-value score of the interpretive diversity test, which warrants an outright rejection of that H_0.

Concerning the ability to *construct* a context with a literary device, the H_0 states that the contribution of the literary device is negligible. The H_1 states that the construction of meaning was improved with the use of a literary device. This result is significant (p-value < significance). The low p-value indicates a strong motivation for rejecting the H_0 and accepting that the uncertainty was removed using a literary device.

Concerning the population's engagement in *dialogue:* the H_0 states that no noticeable difference would be experienced between the pre-intervention and post-intervention. The alternative H1 states using a literary device. In this case, the positive rank is lower than expected. Yet, the p-value of 0,047 is statistically significant, which means sufficient evidence that the dialogue is invoked using a literary device.

Concerning the crux of the Use Theory of Meaning-making, which centres around the notion of 'use', which causes a contextual meaning, i.e., the coming to a shared understanding, the H_0 is that shared understanding is not a result of using a literary device. The alternative H_1 is that the contextual meaning is the direct result of using a literary device. The signed rank (7) is the second-highest, behind fragmentation only, but all indicators have

the highest p-value. Not only does this mean the H_1 hypothesis is accepted but more so confirms one of the basic tenets of the Use Theory of Meaning-making: inference.

The final test is to determine whether the group's diverse backgrounds influenced the outcome of the study. The H_0 is that diversity is unrelated to eliciting understanding and meaning. The H_1 states that diversity is related and beneficial to using literary devices in meaning-making. The results show that the H_0 remains intact, which is heartening in the Use Theory of Meaning-making. It confirms that individuals "come to an understanding" (Weigand, 2016) using others' interpretations; a diverse background has no influence.

The statistical results for the debriefing survey, Table 20 using Spearman's measurement, show a high correlation coefficient, but more so a p-value of 0,00, which translates to a resounding rejection of the H0 that the Use Theory Meaning-making is ineffective. The alternative H1 is that the Use Theory of Meaning-making successfully achieved its goal of meaning-making considering the combined test across the key components of the theory: *dialogue*, which points to the outer process, and *devices*, which points to the inner process. Another relevant indicator is that the question to participants which one of the two movements they preferred resulted in a tie. One can infer that both movements are equally effective in constructing and inferring meaning.

Table 18: Baseline results from statistical analysis

Baseline survey	Non-paired	Paired			rank correlations (r_s)	significance ρ	uncertainty (μ)		Confidence (CI) @ 95%		
Career context											
Function	Q1										
Role	Q2										
Position	Q3										
Level of expertise	Q4										
Duration of career	Q5										
Similarity: Experience											
UML experience		Q6	Q14		0,49	**0,0441**	3,6±1	3,6±0,8	0,3353	0,4716	na
Text & Notation		Q7	Q8	Q14	0,55	**0,0173**	0,9±0,8	0,9±0,9	0,5547	0,4991	0,4936
Type of experiences		Q9	Q15								
Cognitive awareness											
Group raising awareness	Q10	Q17			0,56	**0,0165**	0,8±0,9	0,6±0,7	0,4215	0,4215	na
Group Cognitive Awareness	Q10	Q12			0,83	**0,0000**	1,0±0,5	1,0±0,2	0,4215	0,7751	na
Mental model	Q10	Q12			0,53	**0,0249**	1,1±0,4	1,1±0,8	0,3756	0,7751	na
Training obligation	Q18	Q19			0,20	**0,4792**	1,0±0,4	1,0±0,3	0,5930	0,6644	na

Table 19: Pretest-posttest results from statistical analysis

Survey 2 & 3			Ranks				Significance	Z
	Neg. ranks	Pos. ranks	Ties	N	Mean Rank	Σ ranks	ρ	
Hypothetical Framework								
Ambiguity preintervention	1	**6**	3	10	3,50	3,50	**0.058**	**-1.897**
Ambiguity postintervention					4,08	24,50		
Fragmentation preintervention	2	**8**	0	10	4,00	8,00	**0.039**	**-2.064**
Fragmentation postintervention					5,88	47,00		
Referential integrity	2	**5**	3	10	3,50	7,00	**0,2060**	**-1.265**
					4,20	21,00		
Relational integrity	0	**8**	2	10	0,00	0,00	**0,0080**	**-2.640**
					4,50	36,00		
The movement model								
Uncertainty	2	**6**	2	10	2,50	5,00	**0,064**	**-1.852**
					5,17	31,00		
Construction	2	**7**	1	10	2,00	4,00	**0,027**	**-2.215**
					5,86	41,00		
Dialoguing	1	**6**	3	10	2,50	2,50	**0,047**	**-1.983**
					4,25	25,25		
Contextual meaning	0	**7**	3	10	0,00	0,00	**0.014**	**-2.456**
					4,00	28,00		
Interpretive diversity	3	**4**	3	10	2,50	7,50	**0,2600**	**-1,127**
					5,13	20,50		

Table 20: Participants' opinion of the theory's success

Debriefing survey	Non-paired	Paired	rank correlations (ρ)	significance	uncertainty (u)
meaning-making achieved		Q1			
continuous dialogue		Q2			
devices achieved goal		Q3	2,00	0,00	NA
movement preferred		Q4			
	Q5				

7.6.2.6.2 The plausibility result

The plausibility criteria have been definitively explained and used throughout this thesis. Still, to recap, it applies to a qualitative work such as this, but more so serves as the basis for interpretative confirmation. It means that the work, in general, must provide sufficient evidence for its arguments. In particular, sufficient evidence means that the specialist and non-specialist reader should agree to a large extent on the outcomes derived from the argumentative evidence. Said otherwise, it should be that the statistical and subjective results supporting the theoretical assumptions are **plausible**. Concerning the subjective results, the researcher's observations and subjective interpretations are presented in what follows.

The researcher intervened in the reciprocation of the problem cases by briefly explaining the linguistic and engineering ambiguity and notation complexity. Note that preintervention means the group interaction before being introduced to contextualisation (the treatment). The dialogue was sparse and noticeably constrained in the researcher's interpretation because of the forms' characteristics, i.e., the UML language constructs and model notations. The reactions to the problems also confirmed an immutable mental mode observed from the dialogue. Interpretations were restricted to the individual knowledge and experience with the UML language constructs and notations.

The researcher experienced a noticeable relief once the group understood the basis and process of contextualisation. Even before the dialogue turned to the two problems, the reciprocation increased. Individual representations emerged in literary devices, mostly analogy, some metaphors, and one anecdote. It must be said that the researcher's involvement increased from the preintervention due to the predicted unconscious competence factor. Unconscious competence means that the participants agreed to use literary devices daily in an informal context but not in the career context. The group had to be guided. However, considering the exhibit representing an interpretive sophistication or fragmentation, several literary devices emerged from a lively dialogue. The researcher posited an idiosyncratic device in the form of a switchboard. The reason was to test whether a reference from before many of the participants was born would successfully make meaning. The result is included in the statistical outcome. Still, the group agreed that a) the device plausibly achieved its goal, and b) their linguistic-cognitive processing of the problem was relaxed yet enhanced. Finally, the group consensus was that contextualisation presented this way was enjoyable.

Following are the researcher's observations and interpretations of the participants' participation during the two interventions. No recordings were allowed; therefore, the reporting hereafter is subjective. The coming to an understanding is a golden thread that runs through the three surveys. What understanding is and how one comes to it is a matter of debate, sometimes confusion. During the first intervention, the recognition of the form-function problem was pertinent, even energetic. All participants agreed that the phenomenon exists and have experience in both cases, i.e., ambiguity and fragmentation. The active participation of a few marked the discourse around the two ambiguity exemplars, a little more discussing fragmentation. The picture changed somewhat during the second intervention. However, the discussion was facilitator-led. The researcher acting as the facilitator, tried to intervene only when necessary, but the demand was more prominent than anticipated. The reason for this seemed to discharge the researcher's assumption that although people are aware of their use of context in everyday life, they are consciously unaware of its potential in the workplace. By the final example of an analogy, the switchboard, the entire group had come together, engaged in an active discussion, which

resulted in the agreement that the analogy is appropriate, effective, and constructible, as was demonstrated.

Finally, the only theme, which required participants to voice their opinion was during the debriefing. Noteworthy is one participant specifically mentioning improving the psychological/emotional/mental experience, which relates directly to psychological safety. The participant stated that "*Creating more common understanding between individuals creates a safe environment. Individuals who feel safe perform better and their work are of higher quality*". Two participants pointed to improvements in or aids to education. At least five Participants emphasized the main benefit of coming to an improved understanding, e.g.,

- "*Creating more common understanding*",
- "*Without context new product creations/concepts can be difficult to get across to other participants*",
- "*…in requirements the gathering processes are not necessarily interpreted or understood the same way by everyone*",
- "*could be beneficial in more informal settings or when new approaches should be considered*", and
- "*it may be useful in a number, or even any, scenario where a common understanding, and adoption, of a process is required by a group of affected people*". A particular comment from one participant needs to be accentuated because it articulates the form-function and interpretive sophistication problems accurately in the researcher's opinion. The participant states that when users are in new or unfamiliar territory, unexpected misunderstanding is caused by "*the phenomenon of "being separated by a common language"*". The explanation is that although a common language is used and users may non-verbally indicate understanding, it does not mean "*they have a common interpretation*".

7.6.2.7 Connection with the theory (discussion)

In this section, the results are connected with the propositions and related questions. The overarching question that the surveys aimed to answer was whether the current from-function issue in language use could be resolved? The question related to the two propositions tested by the surveys whose outcomes either disaffirms or confirm the Use

Theory of Meaning-making. The overarching question was segmented into minor questions related to each theme.

The baseline question was whether historical experiences contributed to the observations of current language use. The question relates indirectly to the theory but directly to the implications of a prevalent mental model. The linguistic-cognitive process gives form to the mental model, which affects and re-affects the linguistic-cognitive process.

7.6.2.7.1 The linguistic-cognitive effect (the Baseline survey)

Although the Baseline survey is not directly related to the two propositions of the Use Theory of Meaning-making, they do have significance for the notion of uncertainty. In the Use Theory of Meaning-making introduction, the researcher suggested that uncertainty is rooted in historical experiences, prevalent in the mental model and affecting the current linguistic-cognitive process.

The correlation coefficients, in all tests, ranged positive with p-values < significance, which signifies that each H_0 was rejected. A rejection translates to sufficient evidence to support the partial hypothesis. Additional support comes from the overlapping uncertainty and confidence readings averaging an internal consistency of 0.70, which is acceptable. Therefore, the combined results allow the rejection of the null hypotheses stating that there is no correlation between the form-function and the linguistic-cognitive experience, historically and currently. That leaves accepting the alternative that the linguistic-cognitive experiences with the historical form-function interactions form a mental model prevalent and apparent in the current career context. One can invert this hypothesis sensibly to state that the linguistic-cognitive difficulties with the current form-function relate to historically similar difficulties.

7.6.2.7.2 The dialogical-interpretive hypothesis (the pre-and post-test surveys)

The first proposition (Section 7.6.1.1), summarised here, stated that ambiguity and the loss of referential integrity are related. A change in the first independent variable causes a change in the second dependent variable. The statistical evidence confirms the proposition to be true. Hence, in situations where a textual or notational (respectively represented by the linguistic and engineering ambiguity exhibits) ambiguity prevails, the negative impact is apparent. One can then assume or predict that an increase in the independent variable can

cause the dependent variable to increase. The opposite is also true, evidenced by the post-intervention statistics, which evidenced the successful treatment of the ambiguity-referential integrity relationship as a whole, i.e., their combined function. The statistics referred to entail dialogue (Table 21). The statistical values of the two validate their holistic function: to decrease ambiguity and consequently decrease the loss of referential integrity. Therefore, dialogue and interpretation are confirmed key components of the Use Theory of Meaning-making.

On the flip side of the proposition sits the interpretive domain. Accordingly, the proposition states that an increase in either scope or scale increases the loss of relational integrity. Also, this part of the first proposition is evidenced statistically. Unexpectedly, the evidence turns out to indicate a higher level of improvement in this relationship in pre-intervention and post-intervention statistics. The statistics referred to here entail interpretation. Accordingly, the evidence supports the claim that contextualisation improves the combined effect of the fragmentation-relational integrity relationship (Table 22). The improvement in the correlation coefficient p-values evidence this plausibility:

Table 21: Percentage improvement in the dialogical domain of the hypothetical framework

The combined ambiguity-referential integrity results: pre-intervention	0,777
The combined ambiguity-referential integrity results: post-intervention	0,071
Percentage improvement (negative value indicates improvement)	**-90,85**

Table 22: Percentage improvement in the interpretive domain of the hypothetical framework

The combined fragmentation-relational integrity results: pre-intervention	0,822
The combined fragmentation-relational integrity results: post-intervention	0,402
Percentage improvement (negative value indicates improvement)	**-100**

In conclusion, proposition one holds from the evidence as to the first part of the Use Theory of Meaning-making.

7.6.2.7.3 The constructive-transfer hypothesis

The second proposition (Section 7.6.1.1), also summarised here, stated that contextualisation causes a practical inference; a referent or object in text, notation of mental form: a contextual meaning. This object was evidenced by the positive rankings from the Movement Model section of statistics. As impressive as the results are individual, they must answer whether contextualisation enables the user to construct and transfer meaning. Note the premise applicable to this proposition that individuals construct meaning better due to the reliance on the group dialogue and interpretation ties the evidence for this proposition to the evidence of the preceding through dialogue and interpretation.

Besides the individual p-values recorded that support the proposition, the best support is an inference from two angles. The first is the difference in the threshold values (Table 23).

Table 23: Percentage improvement in the contextual meaning according to the movement model

The threshold: pre-intervention	8
The threshold: post-intervention	6
Percentage improvement (negative value indicates improvement)	**-25**

The other is the observations of the researcher tied with the results from the debriefing survey. On average, the results confirm that the group could construct contextual meanings and that the meaning semantically equated to the problem at hand. The group also indicated that the contextual meaning suited every participant individually and the group as a whole. Suffice it to mention the problem example used in the intervention. It introduced the group to contextualisation and, particularly, the mechanisms: indexicality and literary device. The problem (Figure 27) was exemplified by visualising the inherent complexity of a use case diagram at two levels, demonstrating fragmentation or an interpretive sophistication. The complexity was associated with a lengthy textual brief. The researcher-facilitator prompted the group by asking what cognitive experience they have and what other explanation they can produce by association. E.g., one participant said it reminded of a brain map; another said a spiders web. Both were potentially good explanations of form and function. However, the facilitator's contribution to an old switchboard trumped the others. The experience and knowledge of the form and function of a switchboard, i.e., a central hub (secondary use case coloured pink) which **connects** several **forms** (tertiary use cases coloured blue or beige) to **functions** (inferred from the brief), according to a **reason** (inferred from the brief).
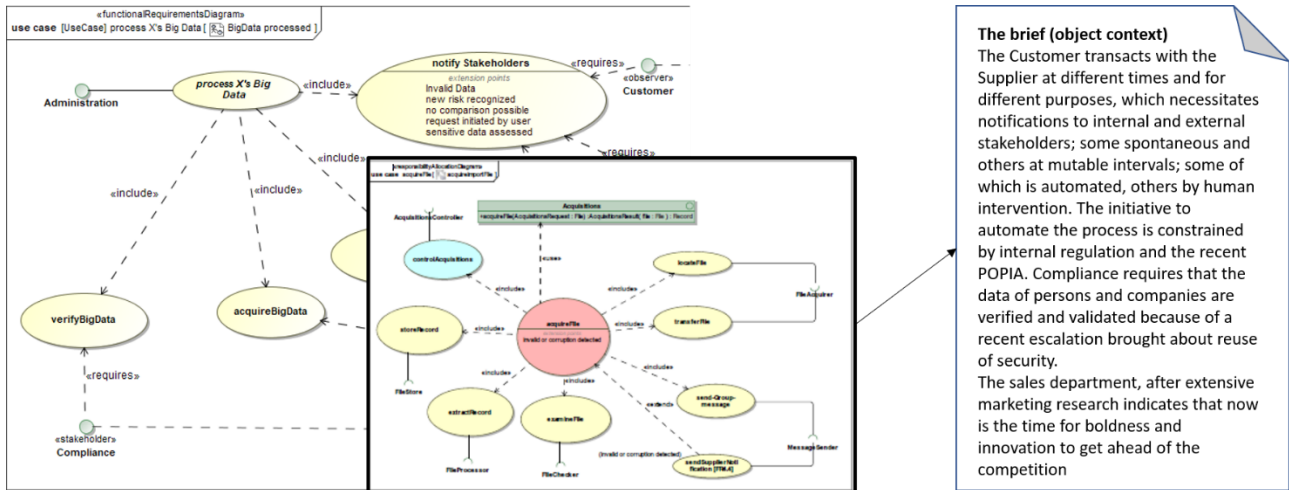
Figure 27: Example of fragmentation used in the intervention to explain contextualisation

The association with the switchboard (**form**) (Figure 28) caused the group to understand that the meaning (**reason**) for the use case centres around risk. They could then plug (**connect**) several risk components identified in the brief, e.g., the reference to regulations and the Protection of Personal Information Act (POPIA) to the '*examineFile'* use case (**function**) according to the following meanings (**reason**): consequence, goal, personas/user characteristics, and impact across functional areas.
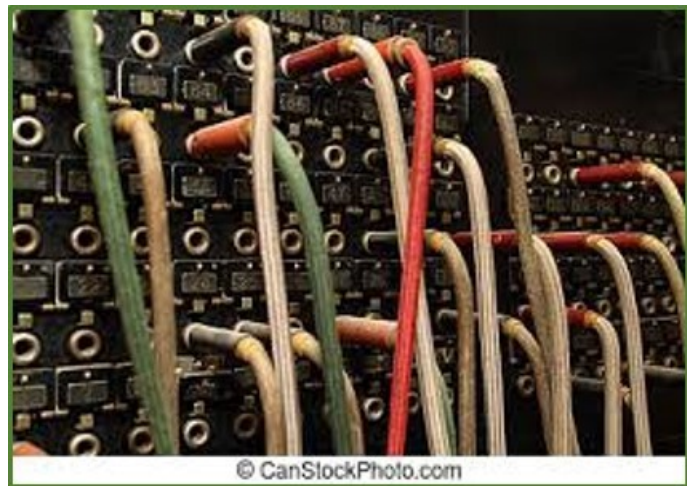
Figure 28: Example of an explanatory literary device - analogical (courtesy of http://www.istockphoto.com)

In conclusion, proposition two holds from the evidence as to the second part of the Use Theory of Meaning-making.

7.7 EVALUATION OF THE THEORY
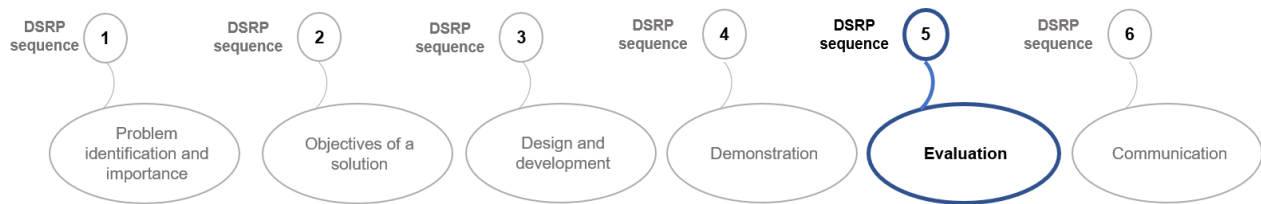
The Use Theory of Meaning-making's evaluation is made from two perspectives: literature and the focus group study. The latter's evaluation relies in whole on the criteria set out by Klein and Myers (1999). The former is subsequently divided into two evaluative categories: the theory build or construction and theoretical contribution.

A precondition of evaluating the theory is that it does not purport any form of quantified proof-theoretic to evidence its operationalisation. Instead, it must have become clear throughout the preceding [it] relies on qualification; hence, the basic tenets of the Use Theory of Meaning-making are evidenced via plausibility (a secondary mechanism to commonsense reasoning). The "validity of the design knowledge rests on good reasoning and arguments, rather than 'experimental' proofs … 'arguments as dialogical encounter' could impart rigour … enhance a researcher's ability to uncover implicit assumptions, conceptual distinctions and relationships together helping to justify their ideas" (Khambete, 2019, pp. 4,5). The qualification of plausibility or commonsense reasoning applies to the first evaluative perspective. The focus group study employs an industry-standard empirical measure for survey-based research – the Likert scale uses proven statistical methods to analyse the data.

Therefore, this evaluation aims to validate the "reliability of the knowledge outcomes" (Baskerville et al., 2018), which in the case of the Use Theory of Meaning-making produces prescriptive knowledge in the form of a "usable … theory" (Ibid., p.4). The reliability validation is synchronic for two reasons: it favours a "human risk and effectiveness" strategy (Ibid., p.14) due to the subjective intervention of researcher and focus group participants with the artefact, and the outcomes are validated within a single case in which the variables are

1) the individualised and group interpretations characterised by the selections of literary devices,

2) the "causal relationships" (Ibid., p.8) between them,

3) possible patterns emerging from the choice of device,

4) possible themes emerging from the intervention, and

5) the further possibility that idiographic predictions may surface due to the collective patterns, which may be observed during the interaction between the focus group and the material (partial artefacts in the current and alternative 'use' as prescribed by the theory). This evaluation aim correlates well with the notion of ex-ante evaluation of a process via a naturalistic evaluation: an evaluation with real people in real scenarios using, e.g., surveys (Gray, 2013; Peffers, Rothenberger, Tuunanen, & Vaezi, 2012, pp. 5,6). The evaluation and validation techniques of this approach permit a degree of imprecision because of its interpretive nature. Figure 29, partially reproduced from Peffers et al. (2012, p. 11), explains the evaluation approach succinctly.
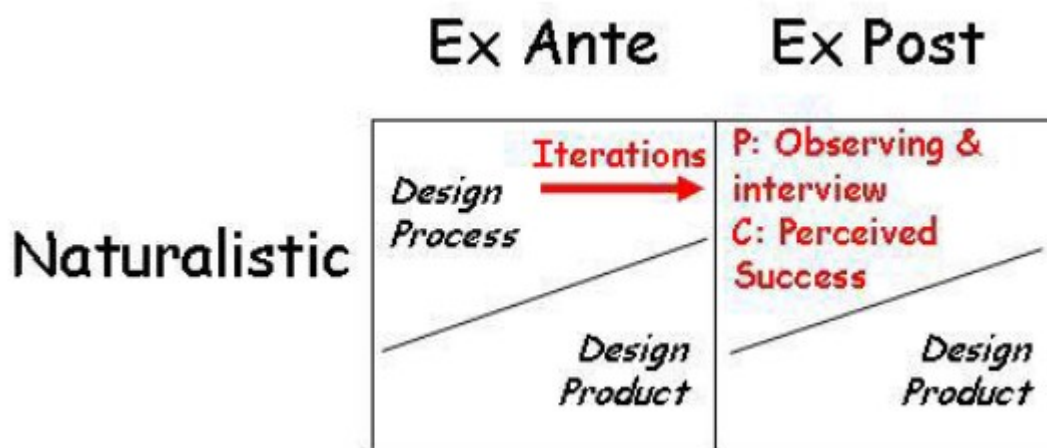
Figure 29: An ex-ante - ex-post naturalistic evaluation strategy (Arnott, 2006)

7.7.1 Evaluation from the literature

7.7.1.1 The theory's build/construction quality

The guidelines of Weber (2012, p. 4) are used to evaluate "how well the researcher has articulated each of the parts … and on the quality of the theory considered *in toto*." Parts refer to the theory's components: the constructs, associations and boundaries of the theory.

- The theory's *constructs* are discussed and defined in detail in Chapter 6, section 6.2 and again in Chapter 7, section 7.5, specifically sub-section 7.5.3.3. The 14 constructs and their meanings are shown as follows: five in the framework (Figure 10) and nine in the referential-inferential model (Figure 15). The meaning of the main attributes of form and function is associated in each of the 'uses':
  - The synthesis of the attributes.
  - The associations of the components, and
  - The propositions.

The relationships between the classes of constructs: the **mechanisms** of indexicals, context, and literary devices and the **operations** of dialogue, interpretation, construct and transfer are distinct. The same constructs are used consistently to synthesise the attributes and associations of the components and define the propositions.

- The *associations* between the constructs are concretely differentiated. The changes in one value were shown to cause an effect in the other via the different representations of the cases 'a', Figure 16: the single-referential-inferential movement and 'b', Figure 17: the double-referential-inferential movement. Accordingly, the direction of association is concretised, which "implies causality" (Ibid., p.6). The theory tests the precision of the associations' levels by showing the association's direction and function. The direction (causality) between the constructs are depicted and explained consistently. The function or amount of change is witnessed in the results of the focus group study in Figure 25 and Figure 26. As a result of clear causality, the theory's explanatory powers are credibly proven. In future, it provides grounds for empirical tests (e.g., the asymptotic depiction of the model suggests the possible creation of a statistical model). The directional and functional associations are well defined and articulated in each of the two propositions. The first defines the negative causality between the independent variables, ambiguity in the dialogical domain and scope and scale in the interpretive domain, which clearly shows a strong association. The second is trickier. Although it defines directionally, the functional association is weaker due to the abstractness of the constructs. That is not to say it cannot be measured. Yet, measurement results confirmed the positive change of values, which confirms the propositional implications.

- The *boundary* specification confines the Use Theory of Meaning-making to linguistic-cognitive constructs in utterance, text or notational representation. In the narrow sense, the boundary confines the theory to the partial artefacts of the requirements specification:

language constructs and models. However, the generalisability of the theory to areas outside information systems of uncertainty associated with the phenomenon was accentuated in the secondary literature and evidenced in the results from the survey's questions posed in theme one: the Baseline survey. A clear correlation exists between the historical and current experiences concerning uncertainties of the same kind. The events for which the theory holds were limited events of discourse and interpretation at the intervals associated with an Agile project. Notably, the changes in values, i.e., interpretations, were demonstrated to change the values of inferences. The associated rules definitively described the constraints which determine in which cases of events the theory holds.

Although the parts may pass the evaluative criteria, unless the parts form a representation that explains some phenomenon, it fails to answer the definition of a theory. As a whole, the theory must pass the tests of importance, novelty, and simplicity.

- *Importance* is judged according to the weight and currency of the phenomenon of interest. The weight indicates the effect the problem exerts in industry, and the currency indicates relevance. The phenomenon of 'poor requirements specifications' weighs heavy in the information systems industry, as witnessed in the many literary references to growing complexity and multiplicity – the wickedness characteristic of requirements engineering. The fact that this characteristic remains active in the academic and industrial discourse today proves relevance. Finally, the focus group study results show that the treatment is considered adequate (effective) and useful (practically relevant) to resolve the phenomenon of interest.

- The *novelty* of the theory is demonstrated firstly by the researcher positioning the notion of contextualisation within the current body of knowledge. Because the problem concerns language, the weight or gravity of its implications extended the scope of the theory beyond the confines of information systems alone and into several others. However, the theory is coherently discussed throughout. Secondly, the theory resolves the long-standing problem in information systems via the detailed problematising in the systematic review and the subsequent detailed discoveries of a possible solution made in the reference theories (Chapter 6). The contribution is enacted by bringing these two positions together in practical detail in Chapter 7; thus, constituting a clear contribution.

- The theory must exhibit *simplicity*. Simplicity means the theory has a good balance between the number of its parts and the explanatory effect it proposes. The Use Theory of Meaning-making is well balanced. The theory uses only seven common and seven unique constructs to explain the effects of the problem and treatment. The common constructs aside, the theory then adheres to the 'seven, plus or minus two' rule (Miller, 1956 cited in (Weber, 2012)). The Miller (1956) heuristic is standard in information systems, particularly in requirements specifications, to aid humans in retaining an understanding of constructs and associations. The theory's constructs are causally associated via four associations in the referential-inferential model and three more in the framework; thus, totalling seven.

- The *level of explanation* determines the theoretical contribution. Early on, the Use Theory of Meaning-making self-proclaimed its mid-range position. Based on the novelty criteria, the theory sits at the mid-range level because the problem it solves is one of current and continued interest among scholars and practitioners, as the literature demonstrates. It addresses two of the four attributes of language use, i.e., language constructs and models, because of its impact on the explanation captured in the requirements specification. The focus on language seems narrow until one observes the theory's impact on the requirements specification document as a whole and the human interventions in the requirements engineering process.

- The *falsifiability* test seems to be passed. Falsifiability means the theory's explanatory power must be so that the theory undergoes empirical testing over time. The survey outcomes attest to a reasonable level of falsifiability. The population sample used in the focus group confirmed the Use Theory of Meaning-making propositions sufficiently but not conclusively because the suggested scaling up to larger groups remains untested.

7.7.1.2 The theory's contribution

The Use Theory of Meaning-making's theoretical contribution is judged by the criteria outlined in Chatterjee (2015). Although the theory's construction was evaluated in the preceding, Chatterjee (2015) provides a different perspective of the contribution; a relationship between the purpose of the theory and level of grounding in existing theory (Ibid., Figure 2, p.7). A scale of 1-5 indicates the contributions, 5 being the highest contribution in both cases. The taxonomy refers only to 'predictive powers' on the x-axis (testing existing theory), but the researcher believes it is not incorrect to include explanatory

powers. The theory's contribution could be described in terms of the taxonomy as follows (the number in [ ] indicates the intersecting value on the taxonomy (Figure 30 adapted for this purpose) where the x-axis represents the theory's contribution to the testing of existing theories and the y-axis represents the construction of a new theory. From a theory-building perspective (y-axis) the Use Theory of Meaning-making could qualify as introducing a new mediator, i.e., context as facilitating or causing meaning [3]. The theory also qualifies as addressing a previously neglected or poorly examined relationship [4] in information systems, i.e., the language-context-meaning relationship. Ultimately, the theory introduces new constructs, associations and boundaries [5] of explanation via the two models that represent contextualisation. From a testing perspective, the Use Theory of Meaning-making seems to qualify as grounding its 'explanations' with existing theory.
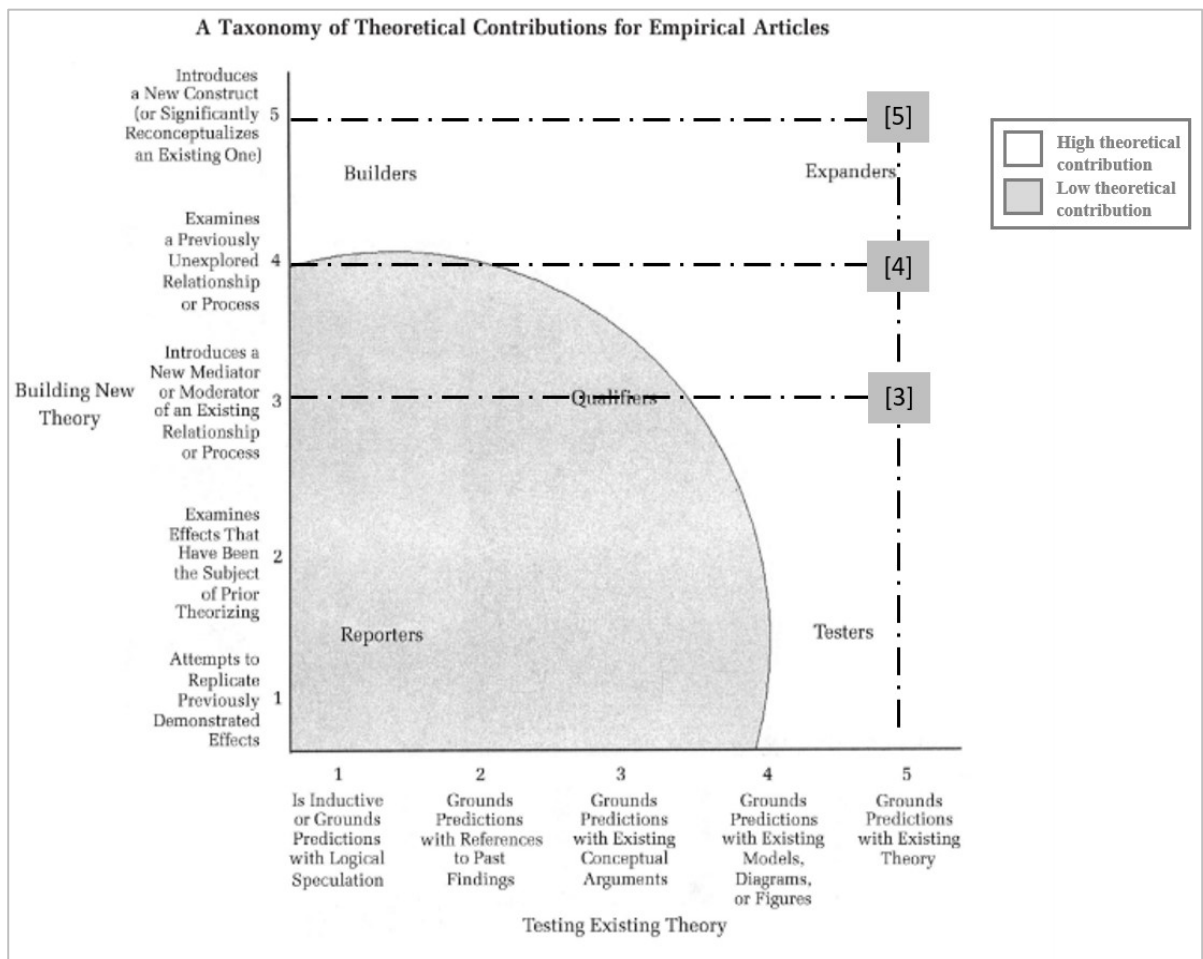
Figure 30: Colquitt taxonomy adapted

Chatterjee (2015) goes on to outline the criteria for the three types of theories. The Use Theory of Meaning-making qualifies as a substantive (midrange) theory because it is "categorical, explaining relationships … within a bounded domain." (Ibid., p.6).

A summary of the theory's components or "anatomy" is tabularized in Table 24 (Ibid., Figure 3, p. 8) to demonstrate the theory's explanatory relevance in real-world contexts.

Table 24: A summary of the theory's contribution to real-world situations

The theory's general components	Definition
Means of representation	a theory of use (intervention) that encompasses a framework and models, comprising the abstract concept of contextualisation that explains and increases understanding of the form-function phenomenon apparent in requirements specifications. The theory is represented graphically in Figure 13
Constructs	Examples of the form-function problem constructs are ambiguity and fragmentation. According to function, examples of the theoretical terms are dialogue, interpretation, construct and transfer. According to form, examples of the theoretical terms are the context of use, the context in use, indexical-context, contextual index, and contextual meaning.
Statements of relationship	The movement models state associative, directional and potentially causal relationships as follows: Context applied acts as the potential causal agent to make meaning, i.e., potentially causing the inference, called a contextual meaning.
Scope	A significant amount of uncertainty of the meaning of a text or its representative notation exists in some context. An example of an information systems context is the partial artefacts contained in a software requirements specification or the

	verbal and non-verbal discourse during the requirements engineering process.
The theory's specific components	**Definition**
Causal explanations of the form-function problem	The complexity of language use requires multiple views (forms) of the same problem, which require multiple interpretive functions or multiple interpreters. Inversely this multiplicity requires multiple forms and functions of explanation, causing less agreement, thus increasing confusion or ambiguities - increased uncertainty.
Causal explanations of the form-function solution (the theory)	A dialogue activates the construction of context via interpretation. This dynamic relationship seems to cause an inference (contextual meaning): *means* The inference by design, i.e., everyday meaning, is transferable between many users (interpreters): *purpose*
Testable propositions (hypotheses)	The current form-function is an inhibitor of dialogue and interpretation, causing a decrease in referential and relational integrity or causing an increase in uncertainty of meaning. Contextualisation acts as a catalyst of meaning-making, causing a positive effect by increasing the potential for meaning-making in referential and relational integrity.
Prescriptive statements	A dialogue that ensues between individuals initiates contextualisation. During dialoguing, interpreters construct a collective reference, i.e., an indexical-context or contextual index depending on the direction. The cooperative (the collection of interpreters) interprets the constructed reference (context of use). The collective interpretation is an inference drawn from the interpretations held inside the context of use. The collective interpretation is associated with a single device, which acts as the referent. The referent is the contextual meaning. The contextual meaning is transferred either as the final usable

	referent or as a partial explanation/interpretation to construct another context of use or reinterpretation.

7.7.2 Evaluation from the focus group study

The authoritative work of Myers and Klein (2011) in assessing the credibility of the Use Theory of Meaning-making is applied here in abbreviated form (the assessment criteria are italicised and bold-faced for clarity).

The *principle of **interpretation***, part of the hermeneutical whole, repeatedly considers the whole-part relationship, e.g., the interpretation of individual experience/utterances joined to the collective mind. Two tests confirm this principle. The uncertainty test, i.e., the extent to which the group shared the interpretive sophistication and the test for contextual meaning, scored high insignificance, especially the shared interpretation inferred from the context – near-perfect p-value (0,014). The group could not otherwise have inferred a contextual (shared) meaning than having combined their partial interpretations in the context of use to accumulate a whole interpretation. Although the work of a single researcher poses a drawback in empirical research, the researcher believes its negatives are alleviated or softened by an interpretive study. Such a view does not undermine the requirements of qualitative work to adhere to acceptable standards to qualify as a work of integrity. The mixed-method approach guards against the negative influences, which the single observations, analysis and interpretive results could have on the study.

The reader has been continuously ***contextualised*** throughout the thesis, e.g., by employing pictograms or distinct referencing. The research context included the phenomenon of interest and the discovery of an alternative in great detail. This exposition critically reflects the background setting of the research. The subsequent theory development shows how the theory emerged from that contextualisation.

Where the ***interaction*** in the group is concerned, there is always the danger of diminished or compromised participation due to power play or fear of identification. The researcher took care to de-identify persons. Additionally, participants were not grouped or segmented in any way to give an impression of individualisation. Finally, the researcher removed management from the group, i.e., management was disallowed to observe, monitor

or receive reports about participants. Although the dynamics associated with a focus group study may be enhanced by fears of dialoguing or giving individualised interpretations, these have been overcome by explaining the focus on the group interpretation, a collective understanding and responsibility. The researcher took the following precaution in constructing the dialogue and survey free of opinion or judgements. It was explicitly mentioned that the purpose of the study is discovery, which can be subjective because the goal is meaning-making, but that the acceptance depends on the groups' collective agreement.

The criteria of *abstraction and generalisation* follow. The abstract concepts are easily related to case data (part of operationalisation and confirmation). It was shown in the results that the individual's understanding of the concepts extended to cases outside of the focus group context (generalisation).

The criterium of *Dialogical reasoning* follows. The cases and the accompanying questions were designed to capture the development of understanding during the session and collect critical reasoning that challenged the Use Theory of Meaning-making. Transparency was afforded by de-identification and selecting industry examples unrelated to the workplace or specific knowledge domain. The researcher analysed the survey data critically, but concepts were stable and trustworthy to their original definitions. No apparent reason surfaced to change any of them.

As mentioned before, the study encourages *multiple interpretations* because the theory is built around that principle. The test was if a consensus emerged from the dialogue and multiple interpretations. More importantly, the theory is credible because one can plausibly conclude that the mechanisms, indexicals and literary devices caused the contextual meaning and semantic equivalence. This plausibility manifests as combining the first and last questions from surveys 2 & 3 to represent the asymptotic lines depicted in the hypothetical framework. Together with the individual results, they draw the same conclusion.

On the criterium of *suspicion*, defined as the biases, distortions of self-reflection, and subjective narratives, the researcher, initially facilitated the session, using only 'nudges' to guide individuals. As the intervention regarding the treatment with contextualisation

progressed, the researcher discovered the constraints of the mental model afflicting the group's linguistic-cognitive processing. At this point, the participants' confessed that their daily use of literary devices was without consciously thinking about them, hence their struggle to articulate it during the intervention in a career setting. The researcher then participated actively in the dialogue but only nudged the interpretation. Therefore, the study's goal to determine if the theory invokes and maintains unforced participation/free dialoguing and interpretation was only partially achieved.

7.8   CONCLUSION

The Use Theory of Meaning-making complies with the criteria for a type II theory of explanation because the theoretical contribution is based on "new and interesting insights". Firstly, the approach to the phenomenon of interest, the wickedness in language use, from experience gained outside of Information systems, and including related works from exogenous disciplines proved invaluable. In particular, taking a holistic view of language and thought and joining them together in a linguistic-cognitive union brought the hidden meanings to the fore. Secondly, this approach developed new insights into the form-function problem and the solution; contextualisation is insightful and new. The theory complies with the following requirements: "plausibility, credibility, consistency, and transferability of the arguments made" (Gregor, 2006).

A final word accrediting the theory as "explanatory" comes from the Dialogue Theory of Language Use (Weigand, 2016), which supports the essence of the Use Theory of Meaning-making: dialogue, interpretation, construction and transfer. Adjectively, explanatory refers to a purpose, use or means to change (or improve). It was demonstrated that the essence of the Use Theory of Meaning-making intends exactly that. There is a clear correlation between use, purpose and means, and a dialogue (ibid., p.230). Dialogue is the human-only trait of reflection: the reciprocation between thought and expression multiple times, reiterating and reifying the purpose of meaning construction and transfer. It is essentially a dialogue that constitutes "the coming to an understanding." (Ibid., p.219) – the common ground between the Dialogue Theory of Language Use and the Use Theory of Meaning-making.

8 CHAPTER 8: CONCLUSION

8.1 INTRODUCTION

The final chapter in this academic work (the thesis) involves reflecting on the outcomes of the individual sections and the work as a whole. The work set out to answer a central question, presumably vital to academics and practitioners in information systems. The answering of that question and sub-questions are addressed next. After that, an evaluation of the work for academic quality and practical usefulness is addressed. It is followed by a declaration of the contribution that the work makes to academia and industry. The penultimate section is devoted to what the Use Theory of Meaning-making proposes for future research. The chapter ends with concluding remarks, summarising the golden thread of the thesis as a whole and the Use Theory of Meaning-making in particular.

The golden thread from start to finish centred around the notion of 'use' and how the meaning thereof depended on worldviews and still does. The 'use' impacts the effectiveness of understanding complexities and multiplicities inherent to information systems *in toto* and the phenomenon of interest in requirements specifications. The researcher took an innovative approach and discovered a new alternative in information systems – contextualisation (context of use and context in use), which is naturally used in everyday life as a reference point and the explanatory referent. Contextualisation was then used to develop the Use Theory of Meaning-making components comprehensively demonstrated for their use. One can therefore see the centrality of the notion of 'use, throughout. This concluding chapter reflects on this golden thread.

8.2 ANSWERING THE RESEARCH QUESTIONS

The research questions were comprehensively answered by the main feature of the Use Theory of Meaning-making: contextualisation. It starts with the central question *how to naturally improve the current poor 'use' of language forms and functions in requirements specifications*. Besides the overwhelming empirical evidence, the theoretical arguments plausibly and unequivocally answered in the affirmative. Contextualisation also encompasses the secondary questions, which were answered as follows:

Sub-question one: *How is meaning explained within general theories of meaning*, was answered in theme one, the generalisation of use. 'Meaning' was found to be an end (a thing or object) and a means (a process).

Sub-questions two and three: *What constitutes poor use* and *what causes it* was comprehensively answered in theme two as the delimiting characteristics of the current use and the dominant worldview associated with the field. The outcomes of the preceding answered sub-question four of *why alternatives were necessitated*.

That answer invoked sub-question five: *what the alternative was*. In theme three, part one, the answer emerged as 'context' in all its forms and functions.

Finally, sub-question six, *why is a 'use' theory based on design science,* was answered during the theory-building phase. The Use Theory of Meaning-making is based on design science because it addresses the whole artefact (holistically). Secondly, it answers, in particular, the questions about the failures of partial artefacts of language constructs and notations. Thirdly, it provides a framework for improving human-human-machine intervention.

8.3   EVALUATION OF THE RESEARCH

As mentioned before, the rigour and credibility criteria that apply to quantitative research are replaced with trustworthiness and plausibility in qualitative research.

8.3.1   Trustworthiness criterium

Using Bitsch (2005), whose work reflects the tenets of (Klein & Myers, 1999; Venkatesh, Brown, & Bala, 2013), the researcher evaluates the thesis for academic quality. In this work, a single measure of quality is used: trustworthiness. Trustworthiness is defined as the qualitative equal to the quantitive research' requirement for scientific rigour. Trustworthiness guides the evaluation of the thesis' credibility, transferability, dependability and confirmability (Venkatesh et al., 2013). Bitsch' (2005) stance was accentuated throughout the thesis from the outset, which qualifies the Use Theory of Meaning-making as qualitative research. Credibility is evaluated as the degree to which the researcher's interpretations, the data and the participants' responses correlate (Ibid., p.82). Table 25 provides a compact evaluation using techniques of the credibility criterium from the perspective of literature.

Table 25: The researcher's evaluation of the Use Theory of Meaning-making's credibility

The time of engagement with the data	The requirement of "prolonged" or "enough" (Ibid., p.82) depends on the context. The researcher will answer whether 'enough' time was spent in the affirmative based on the extensive reference works cited, the depth of analysis, the researcher's knowledge and experience in the field, and the duration of the current thesis.
Level of observation	The use of different research methods for the different themes and contexts proves the study's depth. The researcher's detailed analysis and theoretical argumentation substantiate the requirement of observation.
Peer debriefing	The researcher has been continuously engaged in the discourse concerning the study. The researcher's findings were expressed in the survey questions, which were pre-and post-tested.
Negative case analysis	The requirement should be mitigated in a work where a single researcher reports. Therefore, the researcher mitigated this requirement by applying practical examples to the theory's two propositions and case illustrations. These examples were the only ones used in the confirmation.
Progressive subjectivity	The researcher and participant biases were mitigated, as explained in Section 7.6. The rival hypothesis from the systematic review was considered and rejected based on the researcher's findings of "what was already expected." (Ibid., p.83)

Member checks	Notwithstanding the prohibition of recording the focus group interventions, the researcher's recollection of the discourse suffices as a testimony to the Participants' input and interpretations of the material. Feedback was captured in the debriefing survey, which further testifies the reciprocation of the interventions, data, and findings.
Triangulation	It should be clear from the study content that the researcher applied multiple resources, methods, kernel and reference theories, and perspectives to interact with the literature to surface explanations worthy of consideration.

8.3.2 Plausibility criterium

The criteria in qualitative work are underpinned by plausibility. Even if a work does not tick all the boxes, "it does not mean it is useless. As long as the reviewer is confident that a plausible case for trustworthiness of the study is made, deeper audit can be left to potential users." (Ibid., p.82). Plausibility is ".. the degree to which a proposition is rationally supported by evidence." (Steinhart, 2001, p. 190. In (Juthe, 2005). In this article, the reasoning mode is also of everyday use: argument by analogy. This mode of argument differs from other modes. The conclusions are drawn (inferences made) from one-to-one relations between the comparative elements in different contexts, but never from comparative semantics or structures. Therefore, an argument is plausible if the inferences drawn are "inconclusively certain" or plausible (Ibid., p.24). The evidence of plausibility is thus a matter of sufficiency based on the particular case of certainty. Sufficiency, in turn, is closely related to the reasoning mode followed.

Apart from the preceding main evaluative criteria, which pertain to qualitative work through the interpretive lens, the following validation criteria specified for qualitative work are also closely related. Venkatesh et al. (2013) adopt these three criteria from Cook, Campbell, and Shadish (2002)

8.3.3 Inferential validity

The criterium of plausibility adopts the logic of default reasoning from which is derived: "if A can be consistently assumed, then assume A". The reasoning is a reciprocation (inverse) of verifying the absence of relevant or evidential information. If, for example, the cooperative of interpreters share the/an interpretation or find it the most plausible interpretation, the contextual meaning is assured, i.e., a causality holds between the uncertainty and the common sense inference (Ekbia & Maguitman, 2001). Thus, this criterium backs the result of an adherence to the primary context rule: commonsensical boundedness. A fourth criterium is 'holism'. However, an absolute holism cannot survive a theory of meaning with the above premise of cooperative/collective construction. Note that the researcher's paradigmatic stance propagates a holistic view, which does not purport holism. Pure holism negates holistic inferences – what then is left? At this point, the principles of individual competence and commonsensical boundedness apply. They manifest as "basic inferential competence is construed in typical situations together with basic referential competence" (Penco, 2001, p. 299). Thus, the contextual meaning is constructed only from inferences adhering to plausibility, relevance and affordance. Inferential reasoning of this kind seems to counter Rast (2014) concern of how an individual's preferential interpretation can be determined. The theory assumes that the concern is reducible due to a cooperative context-in-use over the individually constructed context-of-use.

8.3.4 Analytical validity and the reasoning criterium

The criteria displayed in Figure 32 adapt the well-known Toulmin reasoning practice, apt for assessing the Use Theory of Meaning-making because it is based upon 'everyday arguments'. The thesis claims that **Contextualisation augments the current vernacular in information systems artefact development, acting as a causal mechanism to construct and transfer meaning via continuous dialogue and interpretation dynamically.** It has been argued that the current form and function fails to produce meaning because of the constraints placed upon it by a unilateral worldview. This lengthy argument has been sustained by the literature presented throughout theme 2. The second main argument was for an alternative 'use' over the vernacular or an improvement, which adhered to simplicity (parsimony), called everyday use. The notion of 'context', which was found implicit in theme 2, was investigated as an alternative. The extensive data analysis and supporting literature validated its use as an apt alternative. The next theme [three] argued

for an emergent theory of use. Suffice it to point out that compliance with the Constructive Grounded Theory method was employed for structuring the theory-building process. The basics of the Toulmin reasoning practice aids in the justification of the arguments via the plausibility assessment criteria. The value of specifying the mode of reasoning is twofold: 1) it aids in the consistency of the particular method, i.e., theoretical sampling via constant comparison and theoretical saturation; and 2) it aids in establishing coherence between the components: form (Novel form: context-of-use) and functions (Novel function: context-in-use via construct and transfer; dialogue and interpretation), associations and boundaries.

The reasoning mode used herein is abductive, in line with the method. This mode is apt as it is "reasoning to the best explanation" (Juthe, 2005) in line with the method's criteria of subjectivity and emergence. Moreover, the reasoning mode demonstrates an affinity for analogy as an entailment of reasoning. It relates favourably with its use specifically as a form of the theory and general reference to everyday reasoning. The depiction in Figure is a synthesis of the criteria associated with this mode of reasoning. A good argument has its premises and conclusions "adequately related", and its premises reliably evidenced for the conclusions. These criteria are referred to as relevance, sufficiency and acceptance (Juthe, 2005, p. 4) in their notes citing Blair and Johnson.

Criteria for assessing the **legitimacy** of grounds: clarity, consistency, coherence, certainty, and **acceptability**

Criteria for assessing the **plausibility** of claims (conclusions): *relevance* and **sufficiency**

Use of '*analogy*'

Relational matching has a higher potential for analogical acceptance (Gentner & Hoyos, 2017)

enough

+ **evidence**:   a) the relational focus in analogy supports abstraction (construction) and transfer
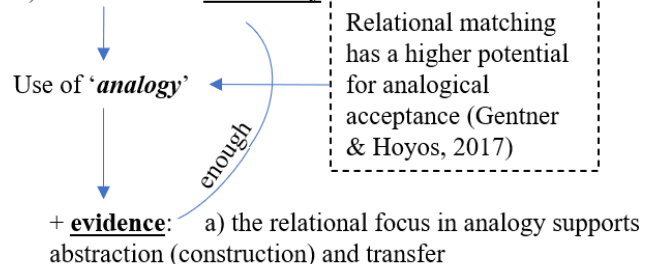
Figure 31: Synthesis of the Toulmin reference to 'analogy' and its validation of the theory

These methods from everyday arguments also entail "… abductive, analogical and other forms of reasoning" (Khambete, 2019, p. 7). Still, the methods correlate with the thesis premise of meaning-making using everyday mechanisms in the final analysis. The 'use' is

the link between the criteria and the argumentative practice—both align with the method of theory development.
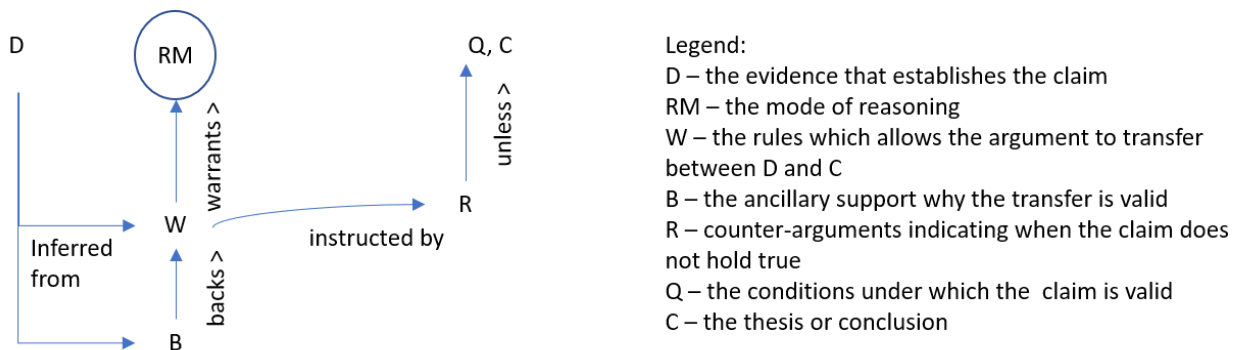
Figure 32: Adaptation of the Toulmin reasoning practice (Khambete, 2019)

8.3.5 Design validity

The research proposes a high degree of transferability of the arguments between contexts, e.g., different roles and functions assumed by human interpreters. The criterium of transferability features strongly in defining theories according to contribution (Gregor, 2006). By that definition, the Use Theory of Meaning-making qualifies as an explanatory theory because it shows participants in the requirements engineering process "how the world may be viewed in a certain way, with the aim of bringing about an altered understanding." (Ibid., p.624). The type II theory described herein must give plausible and credible accounts of the real world and justify the arguments' transferability. The Use Theory of Meaning-making emphasises the sharing of contextualised content, i.e., the inference known as a contextual meaning. What is shared is the set of assumptions as constructing the interpreters' linguistic and cognitive context of use. The direction taken here is more holistic of how meaning is made and transferred. The holistic feature in this sense points to generalisation, which is an interpretive paradigm that refers to transferability. Transferability, therefore, means "what *principles* of reasoning enable us to recover … intended meaning, given the significant influence of context on what is understood … and what people can take to be *evidence* for communicative intentions" (Wedgwood, 2007, p. 8). How can a relevant inference be evidenced? It seems sufficient for the Use Theory of Meaning-making to illustrate the following:

- The strength of evidence is *relational*, i.e., relational matching of structures over attributive properties. The evidence is *referential,* i.e., structures can be explained by referencing interpretations of metaphor in which the association is relational information. In the same way, interpretations using analogies succeed because a typical relational structure is recognized between the two. From such commonality, often the referential "candidate inferences are projected, or common abstractions are derived, or both" (Gentner & Kurtz, 2006, p. 610).

- The evidence is profoundly *subjective* (a vital feature of the emergent theory), relying on the individual competence of users/interpreters and the rule of acceptance, which requires plausibility between the projected inference and its relevance to the analogies. A supporting feature of this evidence to the notion of 'transferability' is that the outcome of using two analogies to interpret a third is more successful than using one or none. The evidence rule posited here is not without limitations. One is where the relational dependence outweighs attributes. However, the emergent theory's counter is and remains the interpretive competence of the group (joined with the principle of social cooperation). Another is that inferential strength may be too narrow for assessment. If the stance is positivist, the argument is warranted. Still, a holistic orientation assumes that inference considers a context of use as a container filled with the entire analogical content of the interpreters' interpretation to derive/infer a commonality. The assumption correlates with the Use Theory of Meaning-making's contextual and commonsensical boundedness (Jaffe, 2009). A final criterium for relational evidence is flexibility, which is required due to how humans assess analogy in everyday use.

8.4 CONTRIBUTION OF THE RESEARCH

The thesis is obligated to demonstrate a significant contribution to the body of knowledge in Information Systems and communicate it to academia and industry.
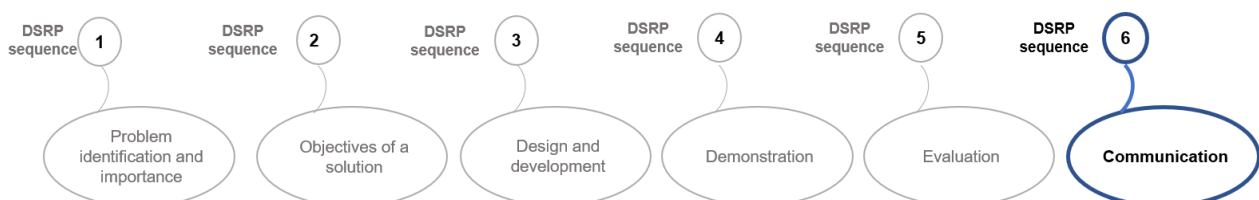
Firstly, the holistic theorising of a complex problem about the usefulness or effectiveness of existing artefacts and the human interaction during its construction produced intuitive and inventive thinking about it; usable in several ways: invoke renewed debate around the current perspectives; elicit new thinking about the aspect of design in design science; encourage more transdisciplinary involvement. If mirrored against the requirement of creating knowledge via theorising (Gregor, 2009), the thesis confirmed the centrality of artefacts in IT systems. It highlighted a problem surrounding the purposefulness of a particular artefact – the requirements specification. During theorising, the inclusion of theories within theories illustrated the need for theory in design science.

Secondly, the theorising led to discovering a novel alternative, culminating in a Use Theory of Meaning-making. Thus, progressing knowledge about the use (Baskerville et al., 2018) of the requirements specification in two ways:

a) an inventive use of the partial artefacts (e.g., language constructs and models) contained in the specification document (whole artefact), and

b) as a design intervention (Ibid., p.364), both evidenced in theory and confirmed by the focus group study.

8.5   FUTURE RESEARCH

Further research is necessary to determine how the theory's effect or product, i.e., the contextual meaning, can be instantiated effectively in the requirements specification artefact. One such possibility has been mentioned using the informal *Comment* or more formal *Use Case Contract* in the Unified Modeling Langauge. Another possibility involves the creativity aspect associated with the construction of meaning. The notion is to enhance the contextual meaning, the literary inference drawn from the context with an explanatory visual depiction, an emoji of sorts. A visualisation might interest transdisciplinary research from the likes of Behavioural Linguistics.

Another area open to future research is integrating the Use Theory of Meaning-making's processes, i.e., the single and double movements of inference into the requirements engineering processes such as Agile.

Considering the aspect of 'design' in design science and engineering, it crossed the researcher's mind that the design principle questions current design practices in requirements engineering. It seems to be the case that the current artefacts are designed only with static content (requirement or project) in mind, without considering changing contents. E.g., currently, a use case is depicted graphically as a representation of content for use. It is common knowledge that the dynamics of business attracts contextual changes. Therefore, one would expect the content of a use case to change in due course; hence, a need for designs to change because of contextual change. This dynamic caused by context should be further researched in terms of the possibility of changing design technologies to better align with perpetual change (current and future).

Another possibility for future research is developing a statistical model to quantify the effect and efficiency of the theory's application. The model exhibits an apparent asymptotic profile.

Further along, the Use Theory of Meaning-making may assist with overcoming the challenges of digitalising commonsense reasoning in Artificial Intelligence (Bouquet et al., 2008).

8.6   CONCLUDING REMARKS

This work necessitated particular methods to achieve its purpose to develop a substantive (mid-range) theory. Because these particular methods required a structure, the established Peffers *et al.* (2006) framework was employed to great success. It provided a holistic framing for the otherwise partial methods. Additionally, it aligned well with the required steps of theory building, specifically the method guiding the theory-building process – the constructive grounded theory. The mixed-method approach allowed freedom of movement and choice necessary for this qualitative work.

The theory-building activity was duly supported by the themes focusing on the centrality of 'use' starting with the generalisation of meaning and its positioning in theories of meaning. With its constructive interpretive underpinnings, the Use Theory of Meaning-making aligns with theories of meaning, which are described as narrowly pragmatic interpretive. The interpretative orientation is the backbone of these explanatory frameworks. The problematic

use, known as the form-function problem, featured prominently in the secondary literature. Its many forms and functions were cause for concern because it failed to unify the separation of understanding and meaning. Understanding surfaced as recognising patterns governed by immutable semantics while meaning was demonstrated as surfacing from a continuous reciprocation of partial explanations until a suitable one was found. A suitable explanation results from the act of contextualisation, putting the partial explanations in a relevant context. The context causes plausible inferences to be drawn. However, the current linguistic-cognitive mechanisms to benefit from inferencing were still too complex or sophisticated. The situation called for an inventive alternative: contextualisation. Contextualisation uses two everyday mechanisms to achieve inferencing much easier. Indexicality and literary devices that are well-known to most persons, technical or non-technical. Literary devices such as analogy and metaphor were investigated and tested in a focus group study to confirm their innovative use to construct and transfer meaning across contexts. Together, the operations and mechanisms developed as contextualisation: a use theory of meaning-making.

Finally, the researcher intentionally mentions the work of Alpay *et al.* (2008) as the most relevant work compared to the Use Theory of Meaning-making because it involves the centrality of context in shared meaning, a vital component of the Use Theory of Meaning-making. However, the element separating the Use Theory of Meaning-making from the work of Alpay *et al.* (2008) is the active ingredient: the two processes of construction of meaning via dialogue and the transfer of meaning via interpretation. This element is missing from that impressive and leading work but made essential by the Use Theory of Meaning-making in the quest for, among others, shared meaning in requirements specifications (narrow boundary) and information systems (broader boundary). This missing element was plausibly argued throughout the thesis and evidentially holds in the theoretical boundary set by the Use Theory of Meaning-making. The researcher concluded that the Use Theory of Meaning-making complies with all the requirements of a substantive theory. The Use Theory of Meaning-making is a combination of the definitions in the introduction to theory-building: **a theory of use (intervention) that encompasses a framework and models, comprising the abstract concept of contextualisation that explains and increases understanding of the form-function phenomenon apparent in requirements specifications.**

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APPENDICES

APPENDIX A: ETHICS APPROVAL LETTER FROM THE ETHICS COMMITTEE

Faculty of Engineering, Built Environment and Information Technology

Fakulteit Ingenieurswese, Bou-omgewing en Inligtingtegnologie / Lefapha la Boetšenere, Tikologo ya Kago le Theknolotši ya Tshedimošo

7 September 2021

Reference number: EBIT/107/2021

Mr HR Holzapfel
Department: School of Information Technolo
University of Pretoria
Pretoria
0083

Dear Mr HR Holzapfel

FACULTY COMMITTEE FOR RESEARCH ETHICS AND INTEGRITY

Your recent application to the EBIT Research Ethics Committee refers.

Approval is granted for the application with reference number that appears above.

1. This means that the research project entitled "Contextualisation: A Use Theory of Meaning-making" has been approved as submitted. It is important to note what approval implies. This is expanded on in the points that follow.

2. This approval does not imply that the researcher, student or lecturer is relieved of any accountability in terms of the Code of Ethics for Scholarly Activities of the University of Pretoria, or the Policy and Procedures for Responsible Research of the University of Pretoria. These documents are available on the website of the EBIT Research Ethics Committee.

3. If action is taken beyond the approved application, approval is withdrawn automatically.

4. According to the regulations, any relevant problem arising from the study or research methodology as well as any amendments or changes, must be brought to the attention of the EBIT Research Ethics Office.

5. The Committee must be notified on completion of the project.

The Committee wishes you every success with the research project.

Prof K.-Y. Chan
Chair: Faculty Committee for Research Ethics and Integrity
FACULTY OF ENGINEERING, BUILT ENVIRONMENT AND INFORMATION TECHNOLOGY

APPENDIX B: A SYNTHESIS OF THE LITERATURE ON POOR REQUIREMENTS SPECIFICATIONS

The following legend applies to all the tables presented below:

1 denotes the terms ascribed to the delimitation: ambiguity [a]; defects [d]; errors [e]; faults [f], and smells [s]

2 connotes a referential ascription of ambiguity: engineering ambiguity [Ea]; linguistic ambiguity [La]; and the cognitive delimitation [c]

3 assigns an identifier to the type of goal reported by the paper's researchers as either a detection [det] or improvement [imp]

4 assigns an identifier to the type of partial artefact as to the language-of-use: constructs [co]; graphical model or notation [mo]; method [me]; and instantiation [in]

5 assigns an identifier to the method of validation reported by the paper: empirical or experiential demonstration [E]; case/field/participative study [S]; demonstration [D]; Illustration [I]; and theory/conceptual [T]

Table A.1: Poor requirements

S#	# cit.	*I*	Study identification	Source	Year publ.	Circumscription			Goal 3	Artefact 4			
						denotes 1	connotes 2	indexical		[co]	[mo]	[me]	[in]
1	775	29	(Van Lamsweerde, 2000)	[Eh]	2000	[e]	[Ea]	complex	[imp]	Ö			
2	215	29	(Van Lamsweerde & Letier, 2002)	[Ix]	2002	[d]	[La]	complex	[imp]	Ö			
3	276	14	(Kaiya & Saeki, 2006)	[Eh]	2006	[d]	[La]	unfit	[imp]			Ö	
4	104	4	(Kamata & Tamai, 2007)	[Eh]	2007	[d]	[c]	[hint]	[det]			Ö	
5	113	29	(van Lamsweerde, 2009)	[Eh]	2009	[f]	[c]	[hint]	[imp]	Ö			
6	68	10	(Asghar & Umar, 2010)	[Eh]	2010	[d]	[La]	complex	[det]	Ö			
7	95	4	(CastaÃ±eda et al., 2010)	[Gs]	2010	[d]	[Ea]	[hint]	[imp]		Ö		

8	59	10	(Yang et al., 2010)	[Eh]	2010	[d]	[La]	limited	[det]	Ö			
9	83	12	(Katina et al., 2014)	[Eh]	2014	[d]	[c]	limited	[imp]		Ö		

Table A.2: Ambiguity delimited by use

S#	# cit.		Study identification	Source	Year publ.	Circumscription			Goal [3]	Artefact [4]				Vali
						denotes [1]	connotes [2]	indexical		[co]	[mo]	[me]	[in]	
10	169		(Glinz, 2000)	[Gs]	2000	na	[La]	[hint]	[imp]	Ö				[S]
11	56		(Kamsties & Paech, 2000)	[Gs]	2000	na	[La]	[hint]	[det]		Ö			[T]
12	80		(Leveson, 2000)	[Gs]	2000			[hint]	[det]				Ö	[S]
13	2776		(Nuseibeh & Easterbrook, 2000)	[Eh]	2000	[e]	[La]	[hint]	[imp]	Ö				[T]
14	314		(Shull, Rus, & Basili, 2000)	[Eh]	2000	[d]	[La]	[hint]	[imp]			Ö		[S]
15	165		(Fabbrini et al., 2001b)	[Gs]	2001	[d]	[La]	[hint]	[det]	Ö				[T]
16	131		(Fabbrini, Fusani, Gnesi, & Lami, 2001a)	[Gs]	2001	[e]	[La]	[hint]	[det]		Ö			[S]
17	165		(Kamsties et al., 2001)	[Gs]	2001	[d]	[La] & [Ea]	[hint]			Ö			[E]
18	86		(Lawrence et al., 2001)	[lx]	2001	[d]	[La]	[hint]	[det]		Ö			[T]
19	82		(Krogstie, 2002)	[Sl]	2002	[d]	[Ea]	[hint]	[imp]	Ö				[T

20	69		(Toval, Olmos, & Piattini, 2002)	[Ix]	2002	[e]	[La]	[hint]	[det]	Ö			[T]
21	153		(Denger et al., 2003)	[Ix]	2003	[d]	[La]	[hint]	[imp]	Ö			[S]
22	241		(Fantechi, Gnesi, Lami, & Maccari, 2003)	[Gs]	2003	[d]	[La]	[hint]	[imp]	Ö		Ö	[S]
23	119		(Zowghi & Gervasi, 2003)	[Eh]	2003	[e]	[La]	[hint]	[imp]		Ö		[T]
24	64		(Boddu, Guo, Mukhopadhyay, & Cukic, 2004)	[Eh]	2004	na	[La]	[hint]	[imp]	Ö	Ö		[S]
25	158		(Berry & Kamsties, 2004)	[Ix]	2004	[d]	[La]	[hint]	[det]	Ö			
26	65		(Firesmith, 2004)	[Eh]	2004	[d]	[La]	[hint]	[imp]		Ö		[T]
27	90		(Rosenhainer, 2004)	[Gs]	2004	[d]	[La]	[hint]	[det]		Ö		[S]
28	96		(Aurum & Wohlin, 2005)	[Eh]	2005	[d]	na	[hint]	[imp]			Ö	[T]
29	70		(Berry & Kamsties, 2005)	[Ix]	2005	na	[La]	[hint]	[imp]	Ö			[S]
30	66		(Katasonov & Sakkinen, 2006)	[Ix]	2006	[e]	[La]	[hint]	[imp]	Ö		Ö	[T]
31	72		(Miller, Tribble, Whalen, & Heimdahl, 2006)	[Sl]	2006	[e]	na	[hint]	[det] & [imp]	Ö	Ö	Ö	[D]
32	56		(Berry, 2007)	[Gs]	2007	na	[La] & [Ea]	[hint]			Ö		[T]
33			(Firesmith, 2007)	[Eh]	2007	[d]	[La]		[imp]	Ö			[S]
34			(Feather, 2007)	[Sl]	2007	[d]	na		[det]		Ö		[E]
35			(Kordon, 2007)	[Sl]	2007	[f]	[La]	[hint]	[imp]		Ö		[E]

36			(Goedicke & Herrmann, 2007)	[Sl]	2007	[d]	[Ea]	[hint]	[det]	Ö			[S]
37	316		(Rodríguez, Fernández-Medina, & Piattini, 2007)	[Eh]	2007	na	[La]	[hint]	[det]		Ö		[T]
38	50		(Van Lamsweerde, 2007)	[Eh]	2007	[d]	[La]	[hint]	[det]	Ö			[D]
39	58		(Alspaugh & Antón, 2008)	[Eh]	2008	[e]	[Ea]		[imp]	Ö			[T]
40	149		(Kiyavitskaya, Zeni, Mich, & Berry, 2008)	[Ws]	2008	[a]	[La] & [Ea]	complexity	[det]			Ö	[D]
41	84		(Popescu, Rugaber, Medvidovic, & Berry, 2008)	[Ws]	2008	[d]	[Ea]		[det] & [imp]	Ö		Ö	[D]
42	101		(Hansen, Berente, & Lyytinen, 2009)	[Gs]	2009	[e]	[La]	[hint]	[imp]	Ö			[S]
43	157		(Bencomo, Whittle, Sawyer, Finkelstein, & Letier, 2010)	[Eh]	2010	NA	NA		[imp]	Ö		Ö	[E]
44	165		(Gleich, Creighton, & Kof, 2010)	[Sl]	2010	[d]	NA	[hint]	[det]		Ö		[E]
45	141		(Houmb, Islam, Knauss, Jürjens, & Schneider, 2010)	[Gs]	2010	[e]	[Ea]	[hint]	[det]	Ö			[D]
46	59		(Yang et al., 2010)	[Gs]	2010	[d]	[La]		[imp]		Ö	Ö	[D]
47	56		(dos Santos Soares et al., 2011)	[Eh]	2011	[e]	[Ea]	[hint]	[imp]	Ö			[I]
48	107		(Yang, de Roeck, Gervasi, Willis, & Nuseibeh, 2011)	[Eh]	2011	[d]	[La]	[hint]	[det]	Ö	Ö		[E]
49	72		(Kamalrudin, Hosking, & Grundy, 2011)	[Gs]	2011	[e]	[La]	[hint]	[det]	Ö			[T]

S#	# cit.	Study identification	Source	Year publ.	denotes	connotes	indexical	Goal	[co]	[mo]	[me]	[in]	Validation
50	50	(Fanmuy, Fraga, & Llorens, 2012)	[Gs]	2012	[d]	[La]	[hint]	[det] & [imp]	Ö		Ö		[S]
51	65	(Massey, Rutledge, Antón, & Swire, 2014)	[Gs]	2014	[a]	NA	complexity	[det]		Ö			[S]
52	57	(Alshazly et al., 2014)	[Sd]	2014	[d]	[La] & [Ea]		[imp]		Ö			[E]
53	53	(Ralph, 2013)	[Eh]	2014	NA	NA	[hint]	[imp]		Ö			[T]
54	66	(Tiwari & Gupta, 2015)	[Sd]	2015	[d]	[La]	[hint]	[imp]	Ö				[S]
55	76	(Femmer, Fernández, Wagner, & Eder, 2017)	[Eh]	2017	[s]	[La]	[hint]	[det]	Ö				[E]

Table A.3: Systematic Literature Reviews

S#	# cit.	Study identification	Source	Year publ.	Circumscription denotes [1]	connotes [2]	Goal [3]	Artefact [4] [co]	[mo]	[me]	[in]	Validation	Gap
56	131	(Nicolás & Toval, 2009)	[Sd]	2009	[d]	[La] & [Ea]	[imp]	Ö	Ö			[T]	Trans... ventur...
57	210	(Walia & Carver, 2009)	[Eh]	2009	[e]	na	[imp]		Ö			[S]	Taxon... studie...
58	380	(Dikert et al., 2016)	[Eh]	2016	[e]	[Ea]	[imp]		Ö			[T]	Exten... secon...
59	21	(Anu et al., 2018)	[Sd]	2018	[d]	[c]	[imp]		Ö			[T]	More... activit...

Table A.4: List of Human Error Theories

S#	# cit.	Study identification	Source	Year publ.	Circumscription denotes [1]	connotes [2]	indexical	Goal [3]	Artefact [4] [co]	[mo]	[me]	[in]	Valid...
60	15	(Hu, Carver, Anu, Walia, & Bradshaw, 2016)	[Gs]	2016	[e]	[c]	complex	[det] & [imp]		Ö			[T]

S#	# cit.	Study identification	Source	Year publ.	denotes	connotes	Goal	[co]	[mo]	[me]	[in]	Validation
61	3	(Hu, 2017)	[Gs]	2017	[e]	[La] & [Ea]	complex	[det]			Ö	[S]
62	2	(Anu, 2018)	[Gs]	2018	[e]	[c]	[hint]	[det]	Ö			[D]
63	20	(Manjunath, Anu, Walia, & Bradshaw, 2018)	[Ix]	2018	[f]	na	[hint]	[imp]			Ö	[T]

Table A.5: Theoretical or conceptual research on language-of-use

S#	# cit.	Study identification	Source	Year publ.	Circumscription		Goal [3]	Artefact [4]				Validation	Gap
					denotes [1]	connotes [2]		[co]	[mo]	[me]	[in]		
64	100	(Baskerville & Pries-Heje, 2001)	[SI]	2001	[d]	[La]	Use theory	Ö		Ö		[S]	Theory
65	1	(Lucassen, 2017)	[Gs]	2017	[e]	[La]	Use theory	Ö				[S]	Despite express
66	1	(van der Schalk, 2017)	[Gs]	2017	[e]	[La]	[det]	Ö				[S]	[imp] similari
67	9	(Bäumer & Geierhos, 2018)	[Gs]	2018	[f]	[La]	Use theory	Ö				[D]	A first sentenc context
68	0	(Younso, 2018)	[Gs]	2018	na	na	[det] & [imp]	Ö	Ö			[I]	Ambigu althoug
69	0	(Bjarnason et al., 2019)	[Gs]	2019	[d]	na	Use theory			Ö		[S]	The m multiple
70	0	(Valkenier, 2020)	[Gs]	2020	[d]	[La]	Use theory	Ö				[E]	Limited but cou

APPENDIX C: AN INTRODUCTION TO EDUCATION AS A POTENTIAL AREA OF APPLICATION OF THE THEORY

The wicked problem described in the thesis seems to appear in other disciplines too, or at least the problem seems analogously defined. This can be seen from the following insights from the analogous phenomenon observed in Education. The researcher posits that it can be used as an argument for the generalisability of the emergent theory. The phenomenon pertains to the human ability to abstract away from particularities to generalities. This is a particular cognitive trait of conceptualising or individual competence to form an immaterial representation of a material occurrence (Baskerville & Pries-Heje, 2010). However, the trait depends on conceptualising, which is where STEM education fails in many cases. The minority of students find abstraction easy while the majority struggle. Take the case of the translation of word problems to notational representation in either algebra or geometry, which manifests two distinct phenomena: 1) the failure to move between two vastly different interpretive means, and 2) the mental model of resistance, ineptness and fear that forms due to the failure. The problem is aptly summarized in the following finding regarding the phenomenon: " 'We got the solutions. But I'm not sure how to explain how we got to the solutions, although it makes perfect sense to me'… points to a fundamental problem in mathematics education. Students are trained to compute solutions, but they have difficulty articulating explanations" (Stahl, 2007, p. 10).

In the natural sciences, mathematics, in particular, is observed amongst school pupils as poor at expressing the textual equivalence of a mathematical notation using natural language. They know too well how to solve the expression but do not know its meaning, hence being unable to express it in words. The inverse is equally true as it appears that students struggle most at interpreting and solving 'word problems'. There is more emphasis or reliance on the function of solving the notation (the formal construct as a model or sign) rather than understanding its intent; its meaning (Engelbrecht, 2008). In this article, on page 56, the authors confirm this phenomenon in the dilemma of sense-making or meaning of surroundings (contexts) to navigate between mathematical (notational) expression and word problems. Another article concerning mathematics describes the necessity for learners to be skilled in finding ways to represent functions and recognise and articulate algebraic relationships that require "reasoning and sense-making" by connecting the two

mathematical elements of knowledge; words and model (Nebesniak, 2012). The authors conclude that poor performance can be explained as:

- "inadequate language skills set in solving 'word' problems" (Engelbrecht, 2008:p68), and

- interpretation "since the text is not explicit about the format of the table, students must draw on their algebra skills and a correct interpretation" (Miller, 2009:p72). The main issue is a lack of sense-making irrespective of whether function or procedure is correctly applied. Lack of language and interpretative skills is evident.

Following the preceding Twiner et al. (2014) draw on sociocultural theory in an exploratory study of meaning-making as a "dynamic and situated facet of classroom interaction … The findings indicate dialogue as a means of initiating and evolving the construction of meaning. This is evidenced in this article by analysing a discourse between individuals and the collective. In this article, the potential of shared meaning is argued as a moment of convergence between intention and instantiation; the dialogical process makes convergence possible to decrease meaning potentials. This position supports the thesis threshold hypothesis of contextual meaning (Ibid., p. 99). Another is the essence of dialogue: the reciprocity requirement (Ibid., p.98).

In the context of adult learning, the translation of experience is considered the main source of learning, i.e., the meaning-making from all experiential sources. This includes past experiences of success and failure. The latter accentuates the presumption of related emotional experiences, which in some cases may be horrifying. "Adults can reflect on past experiences to make and re-make meanings." (Zepke & Leach, 2002, p. 206). This alludes to the possibility that 'bad experiences' can be remade too because "… adult's unique life situations form contexts … These influence the meaning they will draw from experience" (Ibid., p.206). In light of the findings from the demonstration, it seems plausible that the theory also holds in the contexts of education and law; the application thereof being a deliberate recommendation to researchers in those disciplines because "contextualized meaning-making – constructing knowledge in distinctive settings … is central to experiential learning" (Ibid., p.209).

Mutonyi (2016) study of meaning-making includes the influence that cultural context plays in the teaching of African children in predominantly Western Scientific culture. The author finds that literary devices like "stories, proverbs, and anecdotes drawn from the student's cultural context helps them understand science concepts" (Ibid., p.943).

In sum, the gap that contextualisation in this theory fills is the potential to teach students to construct contexts via their interpretations and, through the collective dialogue, hone the interpretations down to an ordinary meaning, shareable across cultures. Such a skill adds value to the already capability to draw inferences from a given context.

APPENDIX D: EXAMPLES OF THE THEORETICAL CATEGORIES FROM THE RESEARCHER'S MEMOS

An example of categorisation:

Context	Meaning
context	meaning - constructed
context - determinant of meaning	meaning - contextual relations
context - micro: influence the group dialogue	meaning - continuum
context - referentiality	meaning - human artifact
context - relational rule	meaning - implicature
context - relevance rule	meaning - movement from context to context
context - socio-cultural factor	Meaning - scholarly discipline of CS
context - type: macro influence on the dialogue	meaning - shared
contextal indexicals	meaning - shared understanding
Contextual equilibrium	meaning - socio-cultural influence
contextual equivalence	meaning-making
contextual indexical	meaning-making - definition
contextual meaning	meaning-making - movement
contextual pattern	meaning-making - transfer
contextual variables	meaning-making: process attribute
Contextualisation - importance in text	meaning-potential (Halliday)
contextualism	mechanisms of meaning
contextualization	

Two examples of the researcher's memos:

Chapter 1: 1.1 Meaning the central problem of language #1, 1.2 the failure of semantics #2, the functions of symbols - communicating reference #9, 1.3 A diagram of reference and referent #10, 1.4 the relation of words to things indirect through interpretation #11, 1.5 a **theory of interpretation** based on observation #19

Chapter 2: 2.1 History of language - the Greek dialectic #34, 2.2 a **theory of signs** indispensable to an analysis of the meaning of symbols #47

Chapter 3: 3.1 **theory of meaning** depends on a theory of signs - Reference #48, 3.2 Restatement in terms of recurrent contexts # 55, Definition of context #58, generality of contexts #59, 3.2 the **context theory of reference** #62, detailed investigation of contexts #66, 3.3 conformity of the context theory with modern scientific attitudes # 73

Note: Specfic reference is made to the findings that contextualization may be detrimental where collborators have the same perspectives - investigate why?

Keywords: contextualization, mutual understanding, misunderstanding, collaboration, adaptive behaviour

p 261: the word **phenomenon** appears to denote collaborations via <u>distributed work: virtual collaborations</u>

'contextualization' is defined herein as an adaptive behaviour: an act of putting explicit context with parts of communication. The authors claim that the lack of C is one of the main reasons for failing communication. Acording to them C contains either a perspective as content or a description of a situation. This seems to be the trend (Mousavi, ; Dey, 2001).

p 262: the authors make the claim that in 'all' communication that requires contextualization, a presumption of misunderstanding is made. This presumption includes varying perspectives; herein, defined as different business functions (e.g. finance, marketing, etc.). Unlike the authors, I am skeptical as to this claim. I believe to be a very narrow attribution. I contend that any variation worth mentioning is of a socio-cultural nature. In the very next paragraph the authors attribute 'worldviews' to be the same as functional differences; a dichotomy. A wordlview certainly taints or influences how we dialogue and interpret within our work context. A risk averse persona assuredly will behave

differently from a risk taking persona but the context of a function in an organization is not the person's perspective; hence, my argument against this definition given my the authors. What I do find substantial is the finding that the phenomenon causes the need for contextualization due to the context itself making communication more complex, i.e. in the context of (computer supported ...; see Stahl, 2006) CSCL & cmputer-medaited communication CMC. I extrapolate this line of argumentation positing that communication through an artefact such as RS would increase the likelyhood of misunderstanding because of the dialogue and interpretation being void of collaborators/interpreters.

The authors categorically state that contextualization carries a cost to the organization in shared knowledge or shared perspective cases and is therefore not a silver bullet to solve misunderstanding.

p 263> The reference to 'metaphor' here is incorrect; simile is used here becuase one can insert the word 'like' in the use and not change the sentence (cF Davidson,). I intend to refute the line of argumentation here that contextualization equals adaptive behaviour; arguing that contextualization is a means to an end, not the end in itself as is the case with this definition. C is not adaptive behaviour; however, it may be a causality in adaptive behaviour (among other forms of behaviour).

the next argument is that of cost-benefit. They argue that C increases const due to the cognitive effort in the construction and interpretation of it. I propose another dichotomy in their line of argument; using context and contextualization as synonyms: "The speaker will spare the cost of contextualization whenever the listener can be assumed to already know the context", citing Horton and Keysar (1996). Context by their definition is a situation; by inference being employed in some functional department. Contextualization is the adaptive behaviour invoked as a result of different departments collaborating; that is saying a situation elicits a perspective. I cannot agree.

p 264. The examples given here by the authors prove my point regarding the socio-cultural aspect that overrides the functional aspect. They use the scenario of a foreigner making a request as opposed to a local. This exmaple dfeats their objective. What if, in thsi scenario, a manager makes the foreigner attentive to the correct labeling or naming convention such as a definition: x means y. Could they still argue the point of contextualization? I think not.

What is 'adaptive behaviour'? What is the definition of 'context' and 'contextualization'

The Baseline survey	
Career category	
Q1	Please, indicate your functional unit
Q2	What is your operational role?
Q3	What is your functional position?
Q4	How many years have you been in this position?
Q5	Please, indicate your level of expertise in your Functional position (self-assessed)
Q6	Please, confirm how confident you are with interpreting UML diagrams
Q7	Please, indicate to what degree as a secondary school student you were challenged with the understanding of word problems (not only mathematics)?
Q8	How difficult did you find the interpretation of algebraic notation?
Q9	Which type of notation challenged you most?
Q10	What would you say was your cognitive awareness or experience of this type of challenge?
Q11	Ignored
Q12	If you did not raise your awareness, which of the following reasons could it be?
Q13	Were you ever told that you ...
Q14	To what degree would you consider the UML or other notations presented to you a similar challenge to your historical experience?
Q15	Which of the following notations present a challenge
Q16	As a developer, what is your opinion towards a multiplicity of 'languages'?
Q17	If you were unable to understand any notation(s), would you raise your uncertainty in a meeting?
Q18	Would you consider that in order to understand multiple notations you would likely be in need of training?
Q19	If you knew that there are some 100 natural languages and more than 20 notational languages, would you still consider training an option
The pretest-posttest survey	
The pretest questions	

Q1	Do you agree that the two possibilities present uncertainties to you, i.e., you perceive or otherwise experience uncertainty?
Q2	Do you agree that the diagrams add to your uncertainty or increase the interpretive sophistication?
Q3	To what degree did individuals or the group share this uncertainty; hesitant to respond?
Q4	To what extent did multiple opinions/interpretations of the uncertainties surface?
Q5	What was the willingness among participants or the group to engage in dialogue?
Q6	With what amount of effort were the uncertainties resolved, i.e., the group came to a shared understanding)?
Q7	To what degree did the group diversity, i.e., backgrounds, experience, etc. influence the dialoguing and interpretations?
Q8	How severely do you perceive the loss of referential integrity to be, i.e., inability to come to a mutual understanding?
Q9	How severely do you perceive the loss of relational integrity to be, i.e., cohesion or lack thereof because of the interpretive sophistication?
The posttest questions	
Q1	To what degree was the ambiguity resolved?
Q2	To what degree was the diagram's meaning improved?
Q3	To what degree was the group's uncertainty resolved or the challenge decreased?
Q4	To what degree was the individual and group able to construct devices of meaning?
Q5	What was the willingness among the participants or the group to engage in dialogue?
Q6	To what extent did contextualisation improve understanding, i.e., narrowed down to a single inference?
Q7	To what degree did contextualisation influence the group, i.e., brought energy and contentment?

Q8	To what degree was referential integrity restored or improved, i.e., the ambiguity resolved?
Q9	To what degree was relational integrity restored or improved, i.e., a shared meaning possible?
The Debriefing survey	
Q1	Do you feel contextualisation achieved its goal of effective meaning-making without the need for formal training?
Q2	Do you think that contextualisation will encourage and maintain dialogue and interpretation during the software engineering process?
Q3	Do you think the use of everyday language via literary devices efficiently improved the current form-function problem, i.e., complex languages and models?
Q4	Which of the movements, i.e., the single-referential-inferential movement or double-referential-inferential movement, did you find the more effective in constructing and inferring a shared meaning?

The Baseline survey: Spearman's correlation tests

UML Correlations			Q6	Q14
Spearman's rho	Q6	Correlation Coefficient	1,000	0,488
		Sig. (2-tailed)		0,077
		N	14	14
	Q14	Correlation Coefficient	0,488	1,000
		Sig. (2-tailed)	0,077	
		N	14	14

Text-notation Correlations			Q7	Q8	Q14
Spearman's rho	Q7	Correlation Coefficient	1,000	.533[*]	0,233
		Sig. (2-tailed)		0,050	0,423
		N	14	14	14
	Q8	Correlation Coefficient	.533[*]	1,000	0,282
		Sig. (2-tailed)	0,050		0,329
		N	14	14	14
	Q14	Correlation Coefficient	0,233	0,282	1,000
		Sig. (2-tailed)	0,423	0,329	
		N	14	14	14

*. Correlation is significant at the 0.05 level (2-tailed).

Raise Awareness Correlations

			Q10	Q17
Spearman's rho	Q10	Correlation Coefficient	1,000	.556[*]
		Sig. (2-tailed)		0,039
		N	14	14
	Q17	Correlation Coefficient	.556[*]	1,000
		Sig. (2-tailed)	0,039	
		N	14	14

*. Correlation is significant at the 0.05 level (2-tailed).

Cognitive Awareness Correlations

			Q10	Q12
Spearman's rho	Q10	Correlation Coefficient	1,000	.831[**]
		Sig. (2-tailed)		0,000
		N	14	14
	Q12	Correlation Coefficient	.831[**]	1,000
		Sig. (2-tailed)	0,000	
		N	14	14

**. Correlation is significant at the 0.01 level (2-tailed).

Correlations

			Q10	Q12
Spearman's rho	Q10	Correlation Coefficient	1,000	0,531
		Sig. (2-tailed)		0,0507
		N	14	14
	Q12	Correlation Coefficient	0,531	1,000
		Sig. (2-tailed)	0,0507	
		N	14	14

*. Correlation is significant at the 0.05 level (2-tailed).

Correlations

			Q18	Q19
Spearman's rho	Q18	Correlation Coefficient	1,000	0,202
		Sig. (2-tailed)		0,488
		N	14	14
	Q19	Correlation Coefficient	0,202	1,000
		Sig. (2-tailed)	0,488	
		N	14	14

Additional descriptive statistics to the questionnaire responses

Q7		Q8		Q14	
Mean	4	Mean	3,1	Mean	3,5
Standard Error	0,256776296	Standard Error	0,231030726	Standard Error	0,228468383
Median	4	Median	3	Median	3
Mode	5	Mode	4	Mode	3
Standard Deviation	0,960768923	Standard Deviation	0,864437822	Standard Deviation	0,854850414
Sample Variance	0,923076923	Sample Variance	0,747252747	Sample Variance	0,730769231
	-		-		-
Kurtosis	0,393939394	Kurtosis	1,635223341	Kurtosis	0,202971544
	-		-		
Skewness	0,607152583	Skewness	0,306217377	Skewness	0,430977217
Range	3	Range	2	Range	3
Minimum	2	Minimum	2	Minimum	2
Maximum	5	Maximum	4	Maximum	5
Sum	56	Sum	44	Sum	49
Count	14	Count	14	Count	14
Largest(1)	5	Largest(1)	4	Largest(1)	5
Smallest(1)	2	Smallest(1)	2	Smallest(1)	2
Confidence Level(95,0%)	0,554731461	Confidence Level(95,0%)	0,499111539	Confidence Level(95,0%)	0,493575934

The pre-test and post-test survey: Wilcoxon ranked sign tests

Q1 Ranks

Ambiguity postintervention - Ambiguity preintervention		N	Mean Rank	Sum of Ranks
	Negative Ranks	1[a]	3,50	3,50
	Positive Ranks	6[b]	4,08	24,50
	Ties	3[c]		
	Total	10		

a. Ambiguity postintervention < Ambiguity preintervention

b. Ambiguity postintervention > Ambiguity preintevention

c. Ambiguity postintervention = Ambiguity preintervention

Q1 Test Statistics[a]

	Ambiguity postintervention - Ambiguity preintervention
Z	-1.897[b]
Asymp. Sig. (2-tailed)	0,058

a. Wilcoxon Signed Ranks Test

b. Based on negative ranks.

Q2 Ranks

Fragmentation postintervention - Fragmentation preintervention		N	Mean Rank	Sum of Ranks
	Negative Ranks	2[a]	4,00	8,00
	Positive Ranks	8[b]	5,88	47,00
	Ties	0[c]		
	Total	10		

a. Fragmentation postintervention < Fragmentation preintervention

b. Fragmentation postintervention > Fragmentation preintervention

Q2 Test Statistics

	Fragmentation postintervention - Fragmentation preintervention
Z	-2.064b
Asymp. Sig. (2-tailed)	.039

a Wilcoxon Signed Ranks Test

b Based on negative ranks.

c. Fragmentation postintervention = Fragmentation preintervention	

Q3 Ranks

		N	Mean Rank	Sum of Ranks
Uncertainty postintervention - Uncertainty preintervention	Negative Ranks	2[a]	2,50	5,00
	Positive Ranks	6[b]	5,17	31,00
	Ties	2[c]		
	Total	10		

a. Uncertainty postintervention < Uncertainty preintervention

b. Uncertainty postintervention > Uncertainty preintervention

c. Uncertainty postintervention = Uncertainty preintervention

Q3 Test Statistics[a]

	Uncertainty postintervention - Uncertainty preintervention
Z	-1.852[b]
Asymp. Sig. (2-tailed)	0,064

a. Wilcoxon Signed Ranks Test

b. Based on negative ranks.

Q4 Ranks

	N	Mean Rank	Sum of Ranks
Negative Ranks	2[a]	2,00	4,00

Q4 Test Statistics[a]

	Construct postintervention - Construct preintervention
Z	-2.215[b]

Construct postintervention - Construct preintervention	Positive Ranks	7[b]	5,86	41,00
	Ties	1[c]		
	Total	10		

a. Construct postintervention < Construct preintervention
b. Construct postintervention > Construct preintervention
c. Construct postintervention = Construct preintervention

Asymp. Sig. (2-tailed)	0,027

a. Wilcoxon Signed Ranks Test
b. Based on negative ranks.

Q5 Ranks

		N	Mean Rank	Sum of Ranks
Dialogue postintervention - Dialogue preintervention	Negative Ranks	1[a]	2,50	2,50
	Positive Ranks	6[b]	4,25	25,50
	Ties	3[c]		
	Total	10		

a. Dialogue postintervention < Dialogue preintervention

Q 5Test Statistics[a]

	Dialogue postintervention - Dialogue preintervention
Z	-1.983[b]
Asymp. Sig. (2-tailed)	0,047

a. Wilcoxon Signed Ranks Test
b. Based on negative ranks.

Q6 Ranks

		N	Mean Rank	Sum of Ranks
Context meaning postintervention - Context meaning preintervention	Negative Ranks	0[a]	0,00	0,00
	Positive Ranks	7[b]	4,00	28,00
	Ties	3[c]		
	Total	10		

a. Context meaning postintervention < Context meaning preintervention

b. Context meaning postintervention > Context meaning preintervention

c. Context meaning postintervention = Context meaning preintervention

Q6 Test Statistics[a]

	Context meaning postintervention - Context meaning preintervention
Z	-2.456[b]
Asymp. Sig. (2-tailed)	0,014

a. Wilcoxon Signed Ranks Test

b. Based on negative ranks.

Q7 Ranks

		N	Mean Rank	Sum of Ranks
Diversity postintervention - Diversity preintervention	Negative Ranks	3[a]	2,50	7,50
	Positive Ranks	4[b]	5,13	20,50
	Ties	3[c]		
	Total	10		

a. Diversity postintervention < Diversity preintervention

b. Diversity postintervention > Diversity preintervention

Q7 Test Statistics[a]

	Diversity postintervention - Diversity preintervention
Z	-1.127[b]
Asymp. Sig. (2-tailed)	0,260

a. Wilcoxon Signed Ranks Test

b. Based on negative ranks.

Q8 Ranks

		N	Mean Rank	Sum of Ranks
LoRef postintervention - LoRef preintervention	Negative Ranks	2[a]	3,50	7,00
	Positive Ranks	5[b]	4,20	21,00
	Ties	3[c]		
	Total	10		

a. LoRef postintervention < LoRef preintervention

b. LoRef postintervention > LoRef preintervention

c. LoRef postintervention = LoRef preintervention

Q8 Test Statistics[a]

	LoRef postintervention - LoRef preintervention
Z	-1.265[b]
Asymp. Sig. (2-tailed)	0,206

a. Wilcoxon Signed Ranks Test

b. Based on negative ranks.

Q9 Ranks

		N	Mean Rank	Sum of Ranks
LoRel postintervention - LoRel preintervention	Negative Ranks	0[a]	0,00	0,00
	Positive Ranks	8[b]	4,50	36,00
	Ties	2[c]		
	Total	10		

a. LoRel postintervention < LoRel preintervention

b. LoRel postintervention > LoRel preintervention

c. LoRel postintervention = LoRel preintervention

Q9 Test Statistics[a]

	LoRel postintervention - LoRel preintervention
Z	-2.640[b]
Asymp. Sig. (2-tailed)	0,008

a. Wilcoxon Signed Ranks Test

b. Based on negative ranks.

Q1 & Q8 combined Ranks

		N	Mean Rank	Sum of Ranks
LoRef postintervention - Ambiguity postintervention	Negative Ranks	1[a]	5,00	5,00
	Positive Ranks	6[b]	3,83	23,00
	Ties	3[c]		
	Total	10		

a. LoRef postintervention < Ambiguity postintervention

b. LoRef postintervention > Ambiguity postintervention

c. LoRef postintervention = Ambiguity postintervention

Q1 & Q8 combined Test Statistics[a]

	LoRef postintervention - Ambiguity postintervention
Z	-1.582[b]
Asymp. Sig. (2-tailed)	0,114

a. Wilcoxon Signed Ranks Test

b. Based on negative ranks.

Q1 & Q8 combined Ranks

		N	Mean Rank	Sum of Ranks
LoRef preintervention - Ambiguity preintervention	Negative Ranks	1[a]	3,50	3,50
	Positive Ranks	5[b]	3,50	17,50
	Ties	4[c]		
	Total	10		

a. LoRef preintervention < Ambiguity preintervention

b. LoRef preintervention > Ambiguity preintervention

c. LoRef preintervention = Ambiguity preintervention

Q1 & Q8 combined Test Statistics[a]

	LoRef preintervention - Ambiguity preintervention
Z	-1.633[b]
Asymp. Sig. (2-tailed)	0,102

a. Wilcoxon Signed Ranks Test

b. Based on negative ranks.

Q2 & Q9 combined Ranks

		N	Mean Rank	Sum of Ranks
Fragmentation postintervention - LoRel postintervention	Negative Ranks	2[a]	2,00	4,00
	Positive Ranks	5[b]	4,80	24,00
	Ties	3[c]		
	Total	10		

a. Fragmentation postintervention < LoRel postintervention

b. Fragmentation postintervention > LoRel postintervention

c. Fragmentation postintervention = LoRel postintervention

Q2 & Q9 combined Test Statistics[a]

	Fragmentation postintervention - LoRel postintervention
Z	-1.734[b]
Asymp. Sig. (2-tailed)	0,083

a. Wilcoxon Signed Ranks Test

b. Based on negative ranks.

Q2 & Q9 combined Ranks

		N	Mean Rank	Sum of Ranks
Fragmentation preintervention - LoRel preintervention	Negative Ranks	1[a]	2,50	2,50
	Positive Ranks	4[b]	3,13	12,50
	Ties	5[c]		
	Total	10		

a. Fragmentation preintervention < LoRel preintervention

b. Fragmentation preintervention > LoRel preintervention

c. Fragmentation preintervention = LoRel preintervention

Q2 & Q9 combined Test Statistics[a]

	Fragmentation preintervention - LoRel preintervention
Z	-1.414[b]
Asymp. Sig. (2-tailed)	0,157

a. Wilcoxon Signed Ranks Test

b. Based on negative ranks.

The Debriefing survey results

	achieve effective meaning-making	encourage dialogue and interpretation	everyday language improved the problem	most successful movement
	5	5	5	1
	5	5	5	1
	5	5	5	1
	5	5	5	3
	5	5	4	3
	4	4	4	2
	3	4	4	1
	2	4	4	3
	4	4	3	2
	2	4	3	3
Definitely not	0	0	0	4
Probably not	2	0	0	4
Undecided	1	0	2	4
Probably yes	2	5	4	4
Definitely yes	5	5	4	4
Rank Average	**5**	**4**	**5**	**3**
Single movement				4

Equal	2
Double movement	4
Rank Average	**4**

The demonstration of the dynamic use draws on Sherman regarding the meaning of the indexical, which is caused by some particularity of the context: meaning that between the literary devices being constructed and the uncertainty a relevant relation holds, from which an inference is plausibly drawn, i.e., a relational comparison is found (contextual boundedness). However, the contextual boundedness is not on the content of the placeholder/reference/context but its interpretability. Such a constraint opens up the possibility and plausibility of choosing a representative contextual meaning (Sherman, 2015) - an essential feature of using everyday mechanisms, such as a literary device. A literary device such as analogy is cast as a powerful means of constructing meaning because "people use them to create generative mental models, models they can use to arrive at new inferences" (Collins & Gentner, 1987). The following two sets of processes demonstrate an analogical mapping between complex tasks in a requirements specification unfamiliar to some interpreters. The analogy explains the context-of-use, context-in-use and the movement or relations between them (Ibid., p. 248), i.e., cognitively relating some familiar parts of the analogy to the equitable 'same' parts of an unfamiliar problem.

Exemplar one: an illustration of constructing a dynamic context to resolve a linguistic and engineering ambiguity

One explanation of the importance of coherence is illustrated using two user stories presented by two product owners over time. In this scenario, 2) takes over from 1). Sometime during the project 2) copied the first's story and changed the wording due to other user input as follows:

> 1) As an Administrator, I (indexical) want the requirements *for* effective teamwork applied to our IT project
>
> 2) As an Administrator, I (indexical) want the requirements *of* effective teamwork applied to our IT project.
>
> At first glance, more so to the unspecialised interpreter, there would not seem to be

a material difference until the words 'for and 'of' are pointed out. However, also assume that unbeknown to the interpreter, the requirements had been given separately to two analysts to model, whose interpretation respectively outputs to the following exhibits:

3)
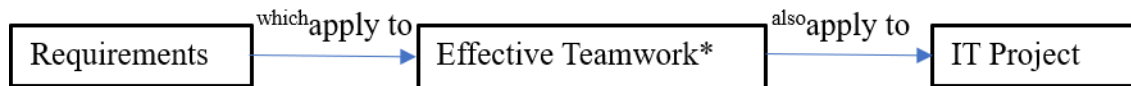
Figure 33: Exemplification of the preposition 'for'

4)
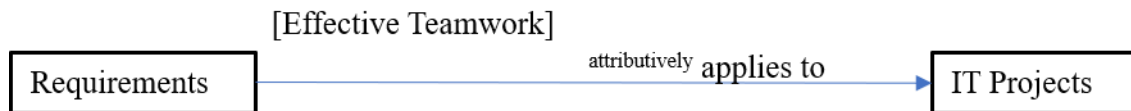
Figure 34: Exemplification of the preposition 'of'

From an analytical perspective, neither would be wrong, but two distinct and defeasibly different designs for the implementation would be applicable. Further, assume that the interpreters do not have access to a linguistic specialist who would point out (superscripted) the difference as follows:

- The conjunctive property of the preposition in (3) is a relationship between effective teamwork and IT projects,
- Whereas (4) points to a set of requirements being an attribute/property of teamwork.
    The ensuing dialogue may be set up as follows (allowing a facilitator familiar with the theory to facilitate):

Facilitator: "Seeing that there is an uncertainty of which user stories to sign off, how do we resolve the uncertainty? Can anyone think of an analogy or exemplar of current use, which compares to any stories? (Without labouring a lengthy dialogue, a possible direct answer is given). "Can anyone relate this in terms of the responsibility of the (Administrator) role?"

User/interpreter: " As an Administrator, I am responsible for *accurately* capturing the requirements …."
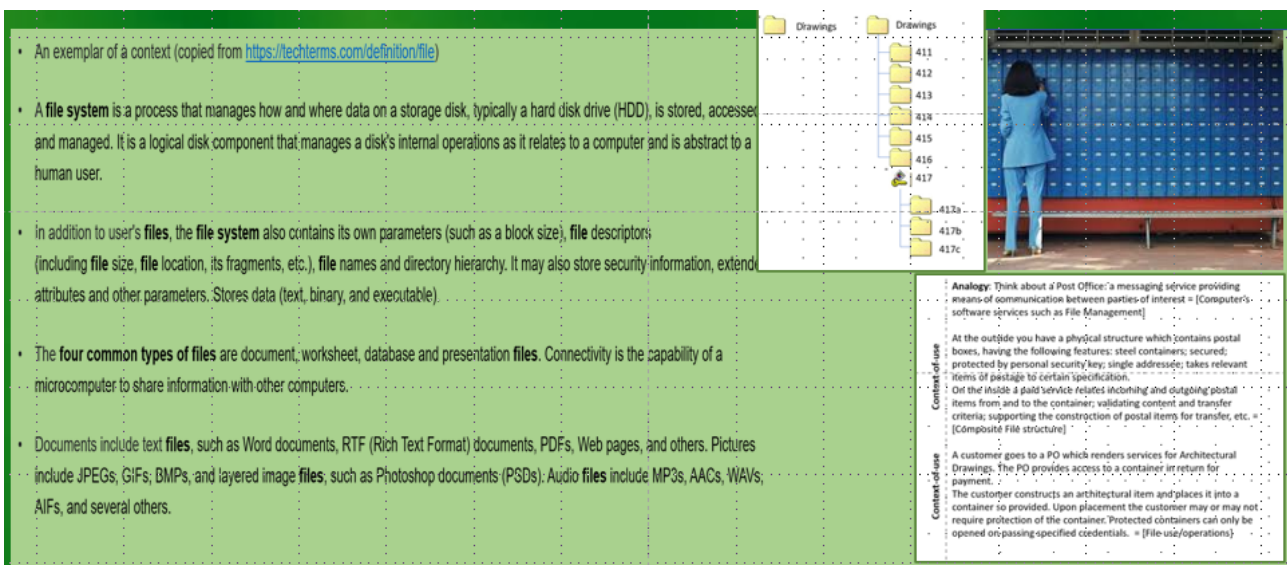
Facilitator: "Is it conceivable that the analogy refers to a rationale between teamwork and projects: effective = accurate?"

User/interpreter: "Yes."

Facilitator: "The inference is drawn from 1) that the requirements apply to both in the same degree. The inference is drawn from 2) that effective teamwork is one attribute among a set of others that applies to the IT project. Now, I think we are in a clear position to select the preferred inference to be recorded in the artefact".

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The exemplar also demonstrates a recurring context apart from applying a literary device as a contextual reference (context-of-use). This answers the earlier question of how context and formalism fit. Another way of asking the same question is how the context, which is open-ended and unsystematic, solves the ended precision of the formalism? It is done as a contextual update that coordinates or correlates (cohesively) something pertinent or true to both contexts, whether a referent or truth condition in the case of 3) and 4) (Stojnić, 2017).

Exemplar two: contextualisation of the technical concept of a file system using the Post Office System as an analogy and the post boxes as a mental model

Figure 35: Example of an analogy and mental model applied to a real-world case.

Exemplar three: demonstrates the application of the 'single-referential-inferential move'

In this case, we point the uncertainty to a context, which can be constructed using an industry template like this (Maguire, 2001). Let me present you with a case in point. Let us say we are to come up with a UX that accommodates the diversity of this group, i.e., we need to describe the persona of the collective (group) to the design team. You need to come

up with a metaphorical description or heuristic of yourself or a colleague. Then we pool together to derive/infer a team meaning. E.g., you've heard of the metaphorical expression 'he is the typical absentminded professor', right? It describes the person so because the person is immersed in or completely focused on their task. Let me place my description in the context of use: I have been called the lone ranger because I operate well alone, I don't need to be entertained or looked after.
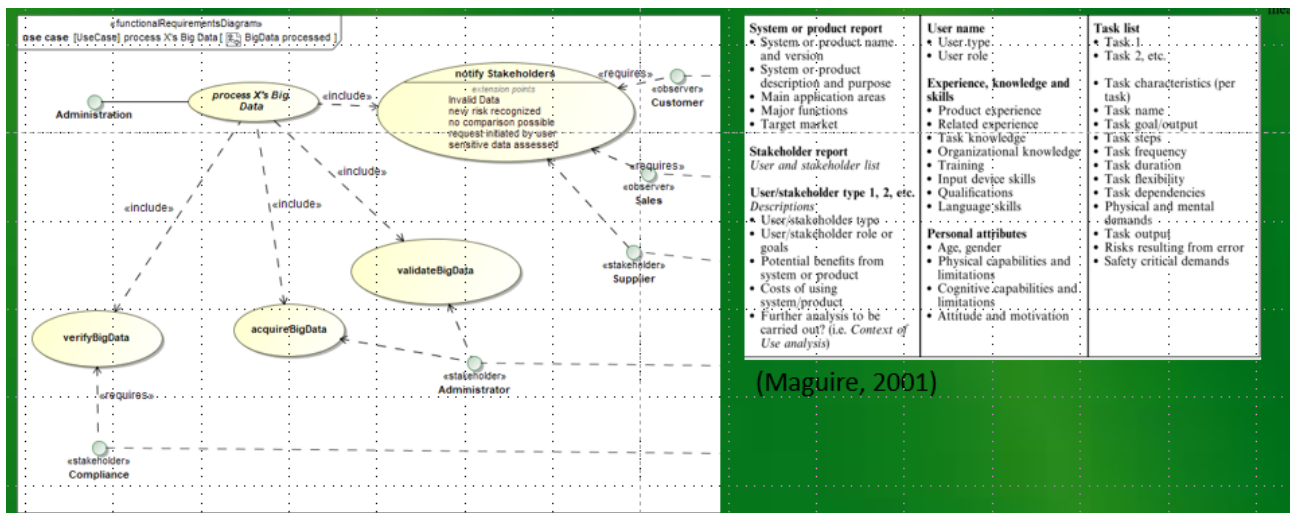

Figure 36: Example of a static context constructed using an industry template

If each business unit uses the template one probably ends up with something like the following . What I show here is that you can add this to the artefact (the requirements spec)
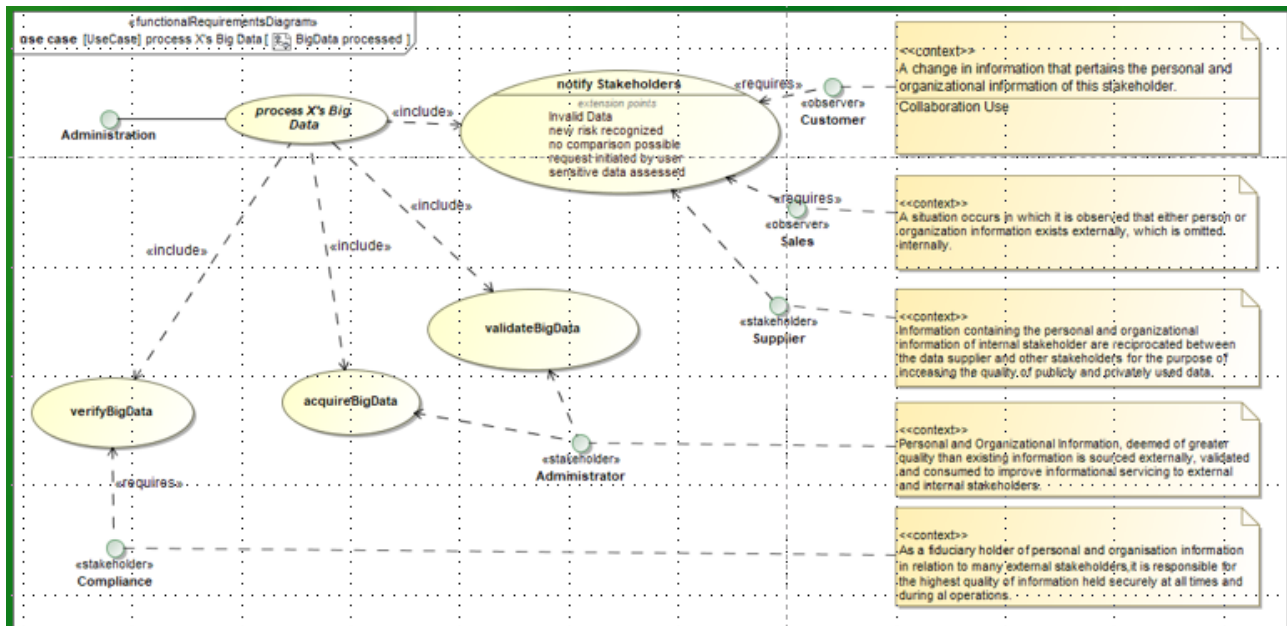
Figure 37: Example of supplementing the requirements artefact with contexts

Exemplar four: Illustrates the result of contextualisation – a single metaphor that explains (resolves) each stakeholder's uncertainty

The construction of context has to come from inserting literary devices, a shorthand of explanation (I just used a heuristic to explain the use of a literary device). To help you, think about **essences** like any of the following:

1. **Consequence** or continuation (movement)
2. Purpose or function or **goal**
3. Structure or **form**
4. Type of stakeholder, recipient of information, **persona**
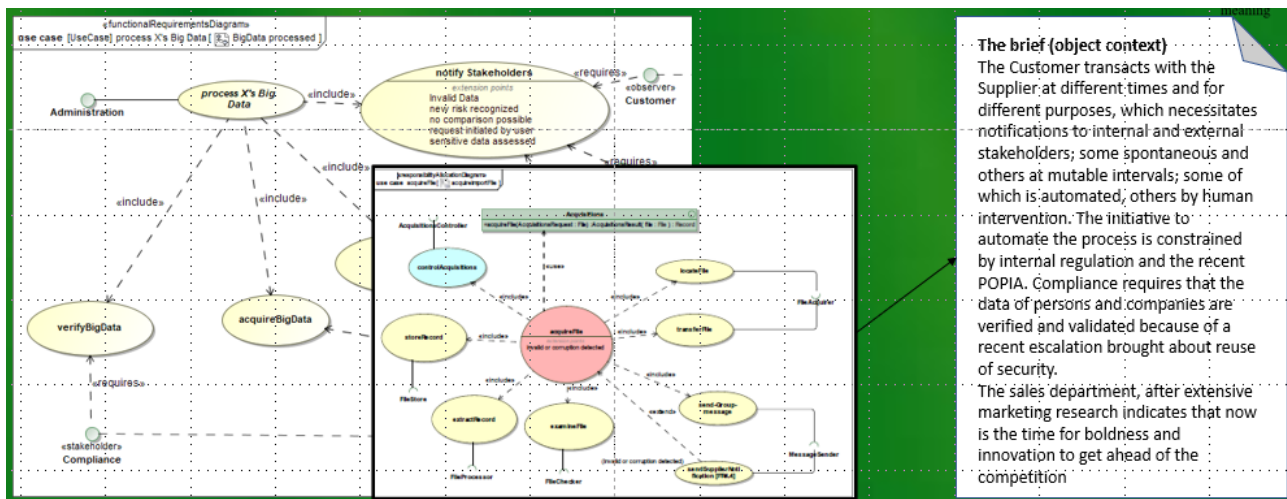5. Outcomes or **effects**
6. Socio-culture dynamics

Figure 38: Example of complexity and multiplicity in an industry setting

What analogy can one use for the *extension* use case: An *extending* or *extension* use case *extends* a *base* use case if the extending one names the base one and under what circumstances it interrupts the base use case. The base use case does not name the extending one. This is useful if you want to have any number of use cases interrupt the base one, and don't want the maintenance nightmare of updating the higher level use case each time a new, interrupting use case is added (Cockburn, 2000) – say what? Who can give us another perspective/translation? What does it look like? Think about form and function.

Returning to our use case levels. What explanation will enable you to understand the functioning of the primary use case and the secondary use cases? If they don't fully get it, give them a 'nudge': **risk heuristic: trust the data but verify.** What familiarity can you come up with to semantically match the different **functions** in respect of different **forms** of risk the brief contains? E.g., Spiders web, Brain map, switchboard (because it matches the complexity in form and function).
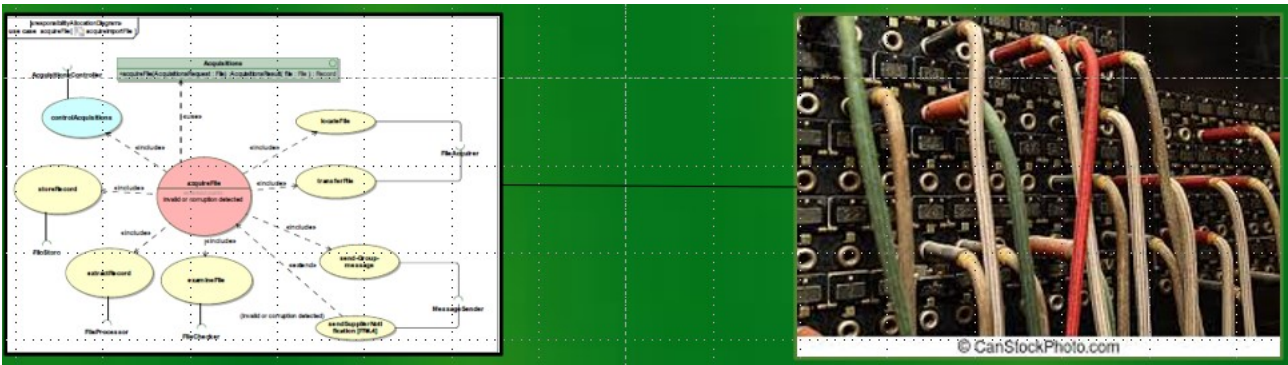
Figure 39: Example of the inferred contextual meaning

The result of applying contextualisation is the 'Switchboard', which can act as an analogy, metaphor, heuristic, exemplar or mental model; any of which is a contextual meaning that semantically equates to the complexity/multiplicity/uncertainty.