The complex project complexity
Identification of five ideal research types

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Abstract: The concept of project complexity has evolved tremendously since topic discussions were initiated. A diversification was sparked a decade ago. The multiplicity of concepts makes it increasingly challenging to utilize the overall research stream of project complexity. This paper takes stock and presents a typology with five ideal types of research in project complexity. This demonstrates an overarching relationship between the type of research of project complexity and the inherent perspective on project success. The typology contributes a much-needed overview for researchers who are new to the overall topic of project complexity. The complexity of projects is an important aspect of research of rethinking of project management, and the typology has the potential of forming a theory of project complexity supporting this research.

Keywords: Ideal types, project complexity, project success

1. Introduction

Project complexity is a fascinating research area in which there are many shoulders to stand on and many viewpoints to consider. While there is much disagreement in research on the concept of project complexity, there is one thing that many papers agree upon: "There is no commonly accepted definition" (Chapman, 2016). Many studies on project complexity delve into the topic echoing this common mantra; for example (Dao, Kermanshachi, Shane, Anderson, & Hare, 2016), (Luo, He, Jaselskis, & Xie, 2017), and (Zhu & Mostafavi, 2017). The absence of a common definition of project complexity is a symptom of an underlying diversity of the research that requires attention. Theory development should not simplify complexity; it should aim at complexifying theories (Tsoukas, 2017). This statement serves as a fine starting point.
Research on project complexity has come a long way in the two decades since the appearance of the paper (Baccarini, 1996) that by many is considered to be the starting point of the research stream on project complexity. The concept is central to the development of research in project management (Cicmil, Williams, Thomas, & Hodgson, 2006) and was the first of six items on the agenda for Rethinking Project Management (RPM), which began as a UK Government-funded research network (Winter & Smith, 2006); later, RPM became a movement, according to (Svejvig & Andersen, 2015).

A recent paper concluded that its research has "established empirically the relationships between project complexity and project management performance in terms of unscheduled delays and overspending" (Bjorvatn & Wald, 2018, p. 886). While this is good news, it also illustrates one specific view of project complexity; a firm narrow perspective. Another recent paper argues for further development of the framework of project complexity, introducing institutional complexity as a new dimension for the practitioner the build there understanding of project on. (de Rezende &

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Blackwell, 2019). Research papers often refer to project complexity as a uniform concept, which is a contestable simplification. This paper will demonstrate that project complexity is a concept with high plasticity in which the purpose of the research shapes the concept of project complexity in a systematic way.

This paper takes stock of recent research on project complexity and contributes to clarifying the differences in research by identifying five research mainstays, thereby lending chief support to the overall research on project complexity. The benefit of this differentiation is the identification of the uniqueness and presumptions of each type. A typology differentiates but has the potential to unite diversity into a bigger picture, hence a rigorous classification gives credence to an integrated perspective needed to rethink project management. Moreover, the contribution of the paper is an indication of how these five ideal types of research promote a distinct relationship with the concept of project success.

Compared to project complexity, the concept of project success has a high level of consensus, although there is some diversity in the definitions. Project success can be divided into efficiency and effectiveness (Baccarini, 1999). Efficiency is about meeting specifications within time and budget, which is equal to project management performance (Mir & Pinnington, 2014) and to process success (McLeod, Doolin, & MacDonell, 2012). Project effectiveness is a more debated topic. One suggestion among many is a number of divisions: organizational benefits, project impact, stakeholder satisfaction, and future potential. (Joslin & Müller, 2015). Further elaboration of these divisions will be conducted as this paper progress, including an explanation of the identified types of research on project complexity.

This paper is to take a meta-perspective of the research on project complexity and should not be confused with a structured literature review. The goal is to demonstrate how the research perspective influences the concept of project complexity and how this relates to the understanding of projects. The paper poses the following research questions: What is the state of art in researching project complexity, and how can diversity be classified into ideal types of research?
In the pursuit of this question, the ideal types are related to perspectives on project success in order to investigate how the perspectives (on project complexity and success respectively) are related.

The rest of the paper is structured as follows. Section 2 is a literature review of the various studies on project complexity. Section 3 presents the methodology of the paper. Section 4 presents a typology of research on project complexity, and section 5 elaborates on each of the five ideal types. Section 6 discusses the paper's contribution, and section 7 presents the conclusion and suggestions for further research.

2. Literature review

Surveying the research literature on the topic of project complexity begins with an overview of the timeline. The literature sections of most studies on project complexity reference (Baccarini, 1996) as their initial paper. Here, it was proposed that project complexity should be defined as "consisting of many varied interrelated parts", which was later referred to as structural complexity. There is both an organizational and a technological component to project complexity, which can be operationalized in terms of differentiation and interdependency (Baccarini, 1996).

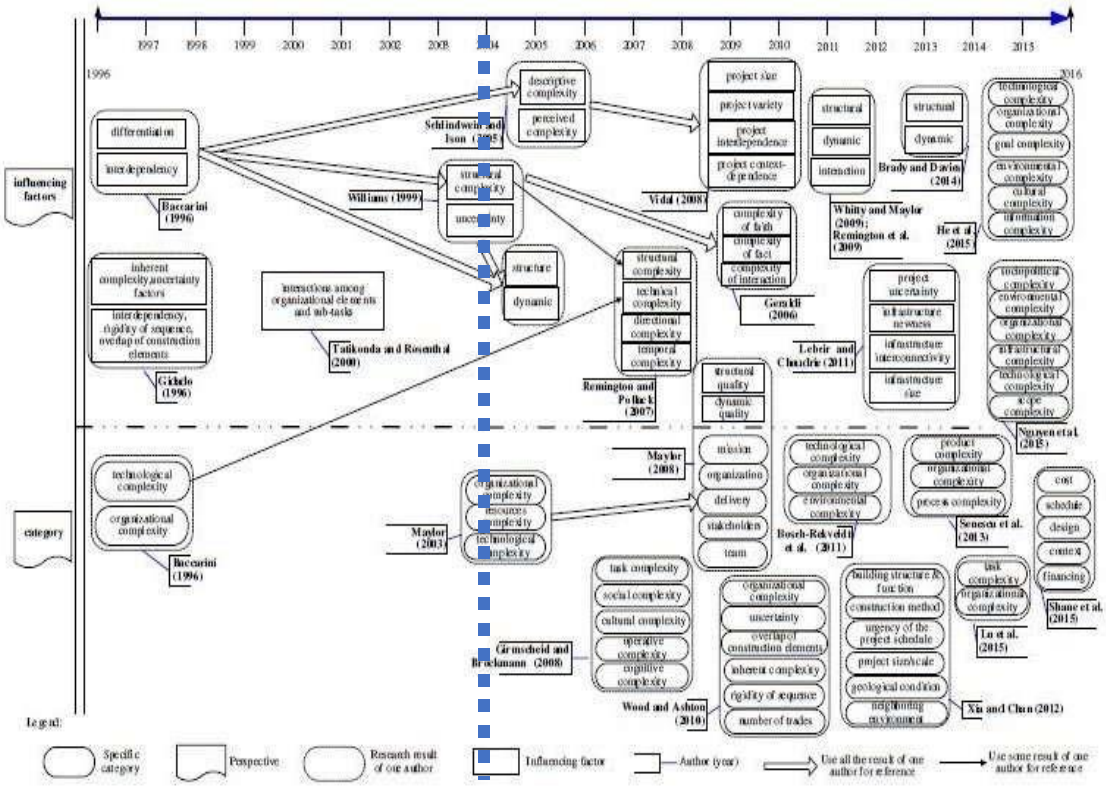

Figure 1: Miniature copy of historical ('96-'16) timeline on project complexity (Lou et al. 2017). The vertical dotted line at year 2006 was added by the author.

In 2004-2006, a network of researchers devised the concept "Rethinking Project Management" (RPM) (Winter & Smith, 2006). The research topic "project complexity" was at the top of the list of five recommended directions for research in project management. In hindsight, there are indications of a post-RPM era in the research on project complexity.

A structured review (Luo et al., 2017) presented the contributions of influential factors and categories in project complexity, from the period 1996 to 2016. A miniature of this graph is shown in **Figure 1**. The strength of this historical presentation is that the middle of the period has a visible 'spark' of diversification that coincides with the RPM initiative. Whether the RPM research network saw this diversification coming or pushed the development forward is beyond the scope of this literature review. However, it is reasonable to speak about a post-RPM era of project complexity research. This illustrates that the diversification of research in project complexity has 'only' been around for a decade. The implication is that we may anticipate further diversification of research of project complexity since we cannot expect it to have grown into its final state yet.

Before the 'spark', an early diversification is identified with the response from Williams (1999) to (Baccarini, 1996), including the argument for adding uncertainty as a dimension of project complexity with the following definition: "Project complexity can be characterized by two dimensions, each of which has two subdimensions: structural complexity (number of elements and interdependence of elements) and uncertainty (uncertainty in goals and uncertainty in methods)" (T. M. Williams, 1999). Retrospectively, this was a crossroads at which some scholars pursued the

operationalization proposed by Baccarini, while others took up the broader approach taken by Williams and looked for related dimensions to include in the concept of project complexity. Uncertainty as a dimension of project complexity is still the topic of active debate post-RPM, as exemplified by (Padalkar & Gopinath, 2016).

In the footsteps of Williams's diversification, Remington and Pollack (2008) argued for four project complexity dimensions: structural, technical, directorial, and temporal. Later, a systematic literature review concluded that the concept of project complexity had evolved to encompass new dimensions: structural complexity, uncertainty, dynamic, pace, and sociopolitical dimension (Geraldi, Maylor, & Williams, 2011). Five years later, another structured literature review was conducted, showing further development and reflecting the diversification mentioned above. According to this work, the concept of project complexity has expanded to the dimensions: emergence, autonomy, belonging, connectivity, diversity, size, and the element of context (Bakhshi, Ireland, & Gorod, 2016).

However, the operationalization path led to further studies on project complexity. Some focused on a few variables, while others identified many, as for example (Kian Manesh Rad, 2016), with 51 project complexity indicators. Another paper (Dao et al., 2016) divided the concept of project complexity into 11 categories, with 35 complexity attributes and, in total, 101 indicators. One paper reported that 128 project complexity factors had been identified as a result of a literature review covering the period 1990 to 2015 (Bakhshi et al., 2016).

Analytical Hierarchy Process (AHP) is one of the preferred methods of operationalization. AHP belongs to the multicriteria decision methodologies. For calibration of the multidimensional models, the AHP is used to estimate the weight of the dimensions, often in combination with the Delphi method and taking input from practitioners' evaluations of the suggested dimensions. An example is (Vidal, Marle, & Bocquet, 2011). Another favorite method is Structural Equation Modeling (SEM), as in the case of (Qureshi & Kang, 2015) and (Bueno & Gallego, 2017).

In the search for explanations of project complexity, complexity theory becomes evident. While there has been important work on complexity theory in project complexity prior to RPM, of which (Jaafari, 2003) is a prime example, the use of complexity theory in project management has gained momentum with studies such as (Cooke-Davies, Cicmil, Crawford, & Richardson, 2007).

Research on levels of project complexity is orthogonal to the previously mentioned dimensions of project complexity. In its simplest form, the duality of being a complex project or not comprises two levels of complexity. The differentiation of the project in two categories; complicated versus complex is mentioned in (Whitty & Maylor, 2009). A more elaborated version of this idea is found in the sense-making Cynefin framework (Snowden & Boone, 2007), which includes four domains: simple, complicated, complex and chaotic. Bakhshi et al. (2016) use Cynefin as an example of system-of-systems (SoS), as one three schools of thought on project complexity they identified. The other two schools of thought are the PMI-view and the complexity theoretical view. More recent papers on the foundation of complexity theory have contributed stratification concepts, in which project complexity is divided into levels; see (Kiridena & Sense, 2016) and (Daniel & Daniel, 2018). Based on these two papers, the complexity theory and the SoS school of thought have merged.

Another important diversification is perceived project complexity, about which it is said that "For all practical purposes, a project manager deals with perceived complexity as he cannot understand and deal with the whole reality and complexity of the project" (Vidal & Marle, 2008, p. 1096). Among research into perceived project complexity, we find examples such as a model called "MODeST" (H. Maylor, Vidgen, & Carver, 2008), with the following dimensions: mission, organization, delivery, stakeholder, team. This model is developed in workshops with practitioners of project management. Another example is based on ground theory and is a division of the overall complexity into task, social and cultural complexity (Brockmann & Girmscheid, 2007). The TOE framework (Bosch-Rekveldt, Jongkind, Mooi, Bakker, & Verbraeck, 2011) began as a framework based on perceived project complexity but was later presented as a more descriptive model, as applied by (Qureshi & Kang, 2015).

The use of case studies – as opposed to generalizations – is yet another differentiation in understanding project complexity. One prime example of case studies includes papers on megaprojects. In some studies, the project complexity of the mega-project is conducted using the same models, as in (Kian, Sun, & Bosché, 2016). To other authors, mega-projects are a separate species altogether, i.e., whereas the mega-projects are complex, they are simple per definition (Flyvbjerg, 2014); however, this has been questioned in (Pollack, Biesenthal, Sankaran, & Clegg, 2018).

As a final remark on the literature review, although much research has been conducted on and much has been written about project complexity, there remains no overarching theory. Whether this is discouraging or energizing is a matter of personal opinion.

3. Methodology

The quest to make sense of the diversity of research on project complexity requires some kind of classification, wherein "Sensemaking is a motivated, continuous effort to understand connections (…) in order to anticipate their trajectories and act effectively" (Klein, Moon, & Hoffman, 2006, p. 71). Classification is a way of making sense of the world, and this produces a set of 'boxes' with the following properties: "1) They are consistent, unique classificatory principles in operation, 2) The categories are mutually exclusive, 3) The system is complete" (Bowker & Star, 2000, p. 10). From the second property, it follows that Bowker and Star consider categories to be the result of classification. These prerequisites are too strict to utilize in differentiation of the research on project complexity.

A less categorical classification can be found in 'schools of thought', with has been used to classify project complexity (Bakhshi et al., 2016); however "schools" are generally associated with one or more charismatic founders (Swales, 2014), which is not applicable to all types of research on project complexity.

Another option is the use of genres as classification, wherein "genres of research are overarching categories for different ways of approaching research. Each genre lends itself to studying particular kinds of topics and includes a range of commonly used methods of data collection, analysis, and representation" (Leavy, 2014, p. 3). Genres of research are seen, for example, in research on

education (Bennett, 2001; Borko, Liston, & Whitcomb, 2007) or on information systems (Rowe, 2012). Genres can be attributed to a journal, such as the European Journal of Information Systems (Te'eni, Rowe, Ågerfalk, & Lee, 2015) and also methodologies, such as 'Design Science Research' (Peffers, Tuunanen, & Niehaves, 2018). However, genres are less rigorous and are therefore less suited for our quest.

In between the firm categories and the looser genres, we find the concept of typology. Typologies are not the same as classifications (Doty & Glick, 1994). Typologies have been used in research on project management, wherein it was pointed out that "unlike classification systems, typologies are not about sorting entities into mutually exclusive, exhaustive groups. Instead, typologies are conceptually derived interrelated sets of ideal types that explain a dependent variable" (Niknazar & Bourgault, 2017, p. 194). Typologies are complex theories, and the "Ideal types are complex constructs that can be used to represent holistic configurations of multiple unidimensional constructs" (Doty & Glick, 1994, p. 233). A typology comprises a set of ideal types, and "Ideal types are multivariate profiles of entities summarized by specific variables known as second-order factors/constructs. Simply put, a combination of second-order constructs is used to describe the holistic configuration of each ideal type" (Niknazar & Bourgault, 2017, p. 195). The steps in the process of developing a typology are illustrated in **Figure 2**.

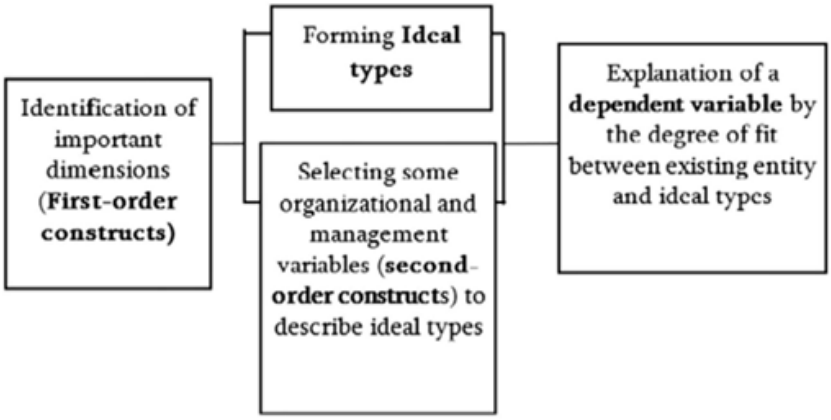

Figure 2: (Niknazar & Bourgault, 2017)

4 Theoretical foundation – the first-order construct of the typology

The presentation in the following can give an impression of a deductive process leading to the typology of research on project complexity, but this is only a retrospective perspective, since the process leading up to this point was very pragmatic, in the sense that "The pragmatic approach is to rely on a version of abductive reasoning that moves back and forth between induction and deduction" (Morgan, 2007, p. 71).

The process of identification of the important dimensions, the first-order construct, has roots in many levels of worldviews, both ontological and epistemological. As pointed out by Doty (1994), a typology is a complex theory. The dimension is 'the intention with the research'. While the ideal types are numbered and have a clear structure, they are not an ordered category variable. The ideal types of the dimension have been coined as follows: 1) positivistic construct, 2) complexity theory, 3) ontological framework, 4) managerial framework, and 5) emancipative investigation. The diversification of the five types will follow in the coming sections.

The diversity of intentions has long roots in science, starting with the two fundamental traditions in science, realism, and constructivism, where the former searches the generalizable truth and the latter a contextual understanding. Ideal types 1-3 are mostly realist, and type 5 is mostly constructivist. The third "tradition", the pragmatist approach (Dewey, 1916), accounts for how-to-knowledge; "Truth is what works" is the motto of pragmatism. The ideal type 4 is very much aligned with the pragmatist approach.

Bhaskar (2013) presents a stratification of reality, wherein mechanisms work 'behind the scenes' and cause events, which again lead to experiences. This stratification determines three domains, i.e., the real, the actual and the empirical, as illustrated in **Table 1**. The writings of Bhaskar have become an important foundation for critical realism, distancing itself from all other types of dashes of realism. The three domains in Bhaskar's stratification of reality can be approximated to the ideal types as follows: ideal type 1 relates to the empirical domain, ideal type 3 relates to the actual domain, and ideal type 2 relates to the real domain.

	Domain of Real	*Domain of Actual*	*Domain of Empirical*
Mechanisms	√		
Events	√	√	
Experiences	√	√	√

Table 1: Stratification of reality (Bhaskar, 2013, p. 2)

Neuman (2013) divided social science into five types. Of these, the so-called critical social science and feminism are not relevant here. The other three are explained in **Table 2**. In positioning this with the ideal type, type 1 relates to A, types 3 and 4 relate to B, and type 5 relates to C (see Table 2).

	A: Positivism	B: Interpretive	C: Postmodern
Reason for research	To discover natural laws so people can predict and control events	To understand and describe meaningful social action	To express the subjective self, to be playful and to entertain and stimulate
Nature of social reality	Stable preexisting patterns or order that can be discovered	Fluid definitions of a situation created by human interaction	Chaotic and fluid without real patterns or master plan

Table 2: Three types of research extracted from a more comprehensive table explaining social science (Neuman, 2013, p. 121)

The ideal types 3 and 4 can be positioned in Table 2 as borderline between columns A and B. This is also related to the stratification by Bhaskar (2013), as explained previously. An important difference is who is doing the interpretation: the researcher or the practitioner? The interpretation in the realist approach of ideal types 3 and 4 are considered by Sayer (1999): in the realist approach, the interpretation is based on scholarly knowledge. Similar thinking is found in the quote "Critical realism combines a realist ontology with an interpretive epistemology" (Munkvold & Bygstad, 2016). This approach stands in contrast to interpretivism, which builds an understanding of the interpretations of practitioners. This distinction is related to the differentiation of descriptive and perceived project complexity (Vidal & Marle, 2008): 1) "descriptive complexity considers complexity as an intrinsic property of a system, a vision which incited researchers to try to quantify or measure complexity", and 2) "perceived complexity considers complexity as subjective since the complexity of a system is improperly understood through the perception of an observer". Deduced from this, the ideal types 1, 2, and 3 use the former, whereas 4 and 5 use the latter.

Shifting to another angle, the purpose of research can be divided into description, explanation, and prediction (Hanna, 1969). The contextual understanding achieved by the interpretive approach is not covered by these three, nor is the pragmatic approach. The latter gain some momentum via a typology of theory by Gregor (2006), who states four primary goals of theory: 1) analysis and description, 2) explanation, 3) prediction and 4) prescription. The fourth is labeled 'design theory' and "says how to do something. The theory gives explicit prescriptions (e.g., methods, techniques, principles of form and function) for construction of an artifact" (Gregor, 2006, p. 618).

An additional differentiator holds ideal type 5 apart from ideal types 1 to 4, where generalizability is a common nominator. Ideal type 5 refrains from generalizations of the contributed contextual understanding of the investigated case(s).

5. Typology of research in project complexity

Based on the differentiation in section 4 and the literature review in section 3, the typology presented in the paper is illustrated in **Table 3**. In this typology the first-order construct is the intention of the research, the second-order construct is the concept of project complexity and the dependent variable is the relation to project success. The second-order construct and the dependent variable will be further elaborated later in this section.

First-order construct	Ideal type	Second-order construct explaining the ideal type	Dependent variable

Search for prediction based on law-like relations	1 Positivistic modeling	Descriptive project complexity as the independent variable providing a fixed measure of the complexity throughout the project lifecycle.	Correlation between simplified constructs
Search for an explanation of the unpredictable behavior of projects	2 Complexity theory	Descriptive project complexity explaining the emerging nature of the project based on attractors and similar concepts from complexity theory.	Relationship not relevant, hence undefinable
Search for a comprehensive description of project complexity	3 Ontological framework	Descriptive project complexity capturing the wholeness of the complex nature of projects in static or dynamic dimensions (often with high abstraction).	Implicit systemic proposition
Designing prescriptive theory for handling project complexity	4 Managerial framework	Perceived project complexity addressing the managerial challenges of handling the project's complexity.	Overlapping and intertwined concepts
Understanding project cases – without the intention of generalization	5 Emancipative investigation	Perceived project complexity setting the context for a study of the complexities of a temporary organization perceived as a project.	Integrated based on interpretations

Table 3: Typology with five ideal types of research on project complexity

In this section, the typology will be described as one ideal type at a time. The next five paragraphs cover the steps depicted in **Figure 1**. First, forming the ideal types. Second, describing the ideal type by second-order constructs. A third part contains examples as a further description of the type. Lastly, part four explains the fit of ideal types with the dependent variable, which herein is the relationship between the concept of project complexity of the ideal type and the concept of project performance.

5.1: Positivistic model

5.1.1 Forming the ideal type

The intention for the ideal type 1 is to search for law-like relations conducted using a positivistic approach. Even though studies based on this often use the term 'explain', the intention of the ideal type is interpreted as being more prediction than explanation because law-like relations between

constructs can be used for predictions such as 'If the project complexity is X, the project success rate can be expected to be Y'.

5.1.2 Second-order construct

The typical layout of a type 1 paper often includes a literature review with a high diversity of project complexity and then transforms this input into a much simpler construct using measurable independent variables and a dependent variable concerning, for example, team performance, project leadership, project success, etc.

Projects are seen as deterministic entities unchanged by the environment (the owning organization and the world around it). The complexity of the project is based on a set of simplifying assumptions, which is beneficial to the statistic model of project complexity and the dependent variable selected for the study. One basic assumption is that project complexity exits independent of the observer (the realist worldview). A further assumption is that project complexity can be measured using one variable (or a set of variables), which does not change over the project lifetime. The inference here is that the project complexity is knowable at project initiation, as opposed to only known retrospectively. Further, the environment (if included in the model) has a fixed influence on the project. However, (Lu, Luo, Wang, Le, & Shi, 2015) is an example of ideal type 1 with dynamic variables that is an exception to the rule. There is nothing in the positivistic worldview that rejects the possibility of having dynamic measures of project complexity; therefore, this simplification is more a matter of epistemology rather than of ontology.

5.1.3 Exemplification of ideal type 1

Adding to the papers mentioned in the literature review on operationalization, the ideal type 1 can be exemplified by (He, Luo, Hu, & Chan, 2015) and (Nguyen, Nguyen, Le-Hoai, & Dang, 2015) using fuzzy AHP to develop a computational model for measuring. The search for law-like relations may involve learning (Eriksson, Larsson, & Pesämaa, 2017), working methods such as lean and agile methods (Sohi, Hertogh, Bosch-Rekveldt, & Blom, 2016), and project leadership and performance against the concept of project complexity (Müller, Geraldi, & Turner, 2012). In meeting project objectives and overall satisfaction, the former is measured by project closure and the latter by one given timestamp, not taking into account that satisfaction might decrease or increase as time progresses. Floricel et al. (2016) identify a negative statistical association between technical complexity and schedule and budget performance in projects. Lastly, as mentioned in the introduction, (Bjorvatn & Wald, 2018) have established empirical relationships between project complexity and project management performance in terms of unscheduled delays and overspending.

5.1.4: Ideal type 1's relationship to project success

The concept of project complexity is reduced to a fixed measure for the project spanning the entire lifecycle. The same reductionism is used for project success. As one example of measuring project complexity against project success, the project's success was directly reflected by eight project targets, namely, time, cost, quality, health and safety, environmental performance, participants'

satisfaction, user satisfaction, and commercial value (Luo, He, Xie, Yang, & Wu, 2016), thereby including both efficiency and effectiveness. However, each of the targets measured is a fixed variable without regard for the changing of this measure over time, which is often the case with stakeholders. It is also independent of the differences in the importance of stakeholders.

Based on these simplifications, many studies have demonstrated a correlation between the concept of project complexity and the concept of project success. Sometimes project efficiency (delivering specification on time and within budget) is held as a proxy of project success. The assumed causality is that project complexity reduces the probability of project performance. The next four paragraphs, covering the other ideal type, will deepen this understanding and to some extent even contradict the study's conclusions.

5.2 Complexity theoretical type

5.2.1 Forming the ideal type

Ideal type 2 deploys complexity theory to explain the complexity of projects. The papers are motivated by 'exploration' and 'investigation'. Here, the intention is not to define and measure but to understand the inner workings of projects in their environments.
Complexity theory originated as a formal science and has successfully explained many phenomena in natural science. Complexity theory entered the social sciences via authors such as Byrne, who goes to the extreme and declares that "Positivism is dead" (Byrne, 2002, p. 37). Hence, there is a dramatic contrast between type 1 and type 2, where the latter modifies the former. The introduction of complexity theory into project management seems to hold many promises, as one paper shows by coining a new phrase: "project management second-order" (Saynisch, 2010).

5.2.2 Second-order construct

In contrast to ideal type 1, the view of the project in ideal type 2 is anything but deterministic. The explanation for the unpredictability is based on constructs such as strange attractors, emergence, butterfly effects, self-organizing, etc. (Cooke-Davies et al., 2007), whereas complexity theory is defined as "the study of how order, structure, pattern, and novelty arise from extremely complicated, apparently chaotic systems and conversely, how complex behavior and structure emerges from simple underlying rules" (Cooke-Davies et al., 2007, p. 52). A commonality of the secondary constructs is the reduced operationalizability of the variables. In type 2, the emergence (unpredictable) is contrasted with one fixed measure of project complexity, as described in ideal type 1.
The project as complex adaptive systems (CAS) is a concept made popular in studies by (Holland, 1992) and (Dooley, 1997). As mentioned in the literature review, recent papers based on complexity theory have argued for stratification in levels of complexity of the projects. A paper on profiling project complexity suggests the following notions: A) complicated systems, B) complex systems and C) complex adaptive systems (Kiridena & Sense, 2016). Another example is a three-level model: 1) algorithmic, 2) stochastic and 3) non-deterministic (Daniel & Daniel, 2018).

Uncertainty can be seen as a factor of unpredictability, and in the debate on this issue, one paper concludes that "While our finding may appear to align with complexity-theoretic concepts of a strong interrelationship between complexity and uncertainty, we argue that such confounding represents the intermingling of varying ontological and epistemological preferences within the community of project management scholars rather than a broad adherence to complexity theory" (Padalkar & Gopinath, 2016). Based on this, the uncertainty dimension is more relevant in the ideal types to be presented later.

5.2.3 Exemplification of ideal type 2

One of the first examples of the use of complexity theory in project management was (Jaafari, 2003) and it was popularized by (Cooke-Davies et al. 2007). Some early papers related project complexity to CAS (Innes & Booher, 1999), but as with the rest of the papers on complexity theory and projects, papers employing CAS have increased significantly in the post-RPM era. Currently, CAS is often seen in project management papers because "projects are socially constructed entities and so can be described as complex adaptive systems" (Whitty & Maylor, 2009). One important characteristic is that complex adaptive systems have the capability to learn (Holland, 2006). Perhaps the concept of CAS is most widespread in agile circles, since "Projects that employ agile methodologies are complex adaptive systems (CAS)" (Augustine, Payne, Sencindiver, & Woodcock, 2005).

5.2.4: Type 2's relationship with project success

Complexity theory is not concerned with success as such. A paper on innovation ecosystems (Jucevičius & Grumadaitė, 2014) made the case for the differentiation of system thinking and complexity theory as follows: 1) "Systems theory and system thinking are concerned with defining the ideal future state of the system and trying to close the gap", and 2) "Complexity theory has no ambition of predicting the future or defining the 'ideal' state of the system – it is more about describing the present and seeing what can be changed." Based on this, the relationship in type 2 between project complexity and success is not relevant, hence undefinable.

5.3: Ontological framework

5.3.1 Forming the ideal type

The common underlying question in research of this type is: What is project complexity? Therefore, the ideal type is termed 'ontological'. The use of 'framework' is a way to differentiate it from type 1, where the term 'model' would be more appropriate. The terms 'model' versus 'framework' are not used consistently in papers but might serve as an indicator. Words such as 'explore' and 'investigate' are often a part of the motivational paragraph in papers belonging to type 3. The same is seen in type 2, but type 3 does not use complexity theory as a foundation.

5.3.2: Second-order construct

In type 3, projects are seen as systems. Based on system thinking, the papers of this ideal type create frameworks, often with high-level variables. Ideal type 3 is concerned with dimensions, factors, or drivers. These are often presented without consideration for later measurement or assessment of other functional aspects of the resulting frameworks.

Type 3 is somewhat positioned between type 1 and type 2 but also counter to both. The secondary constructs in type 3 are characterized by being dimensions (as opposed to type 2) but are also often difficult to measure (as opposed to type 1). Contrary to type 1, type 3 includes uncertainty. The contribution from the ideal type 3 often serves as inspiration for ideal type 1 papers. This creates a gray zone between these two types; however, a classificatory principle clears up the gray zone, i.e., if the paper does not explicitly mention how to measure the dimensions, it belongs to ideal type 3.

The ideal type 3 is more realistic than interpretivist. As Sayer argued, in the realist view, only scholarly interpretation counts. We find this exemplified in the following quotation about the development of a complexity framework: “They started to share their experience on complexity factors and realized that the difference with the a priori ranking they had done was mainly due to some communication and psychological barriers they had” (Vidal et al. 2011, p. 724). An interpretive approach would not have dismissed the so-called “barriers” but instead would have investigated the individual perception of complexity leading to the difference in a priori ranking.

In contrast to type 1, type 3 does not assume fixed variables, although the presumption of the changeability of the variables (dimensions) is often not directly articulated in papers of type 3. The dimension of ‘change’ is often a part in the ensemble and so is the dimension of ‘uncertainty’.

5.3.3 Exemplification of ideal type 3

The frameworks in (Geraldi et al., 2011) and (Bakhshi et al., 2016) previously mentioned in the introduction are prime examples of type 3. A third example is (Xia & Lee, 2004), who divide complexity into structural and dynamic complexity. Another paper presents the complexity dimensions as structural, technical, directorial and temporal (Remington & Pollack, 2008). The definition of project complexity by Williams (1999), presented in the literature review, conforms with ideal type 3, and here the uncertainty of the goals is a part of the complexity.

5.3.4: The dependent variable for type 3

In papers regarding type 3, one can often read between the lines that the reason for the selection of the dimension is to improve our understanding of the success or failure of a project. The highly abstract dimension in the frameworks of ideal type 3 is difficult to operationalize. No correlational relationship, as seen in type 1, is found in this type. Whereas type 2 had complexity theory as a foundation, type 3 is based on system thinking. There are three requirements of system thinking: purpose, elements, and interconnections (Arnold & Wade, 2015). In other words, the desired future state is part of system thinking and is therefore related to project success. Thus, the relationship of ideal type 3 to success is therefore labeled ‘implicit systemic proposition’.

5.4: Managerial frameworks

5.4.1 Forming the ideal type

In the managerial framework ideal type, the focus is on the management of the project and removes of "what is project complexity" into "what to do with project complexity". While types 1, 2 and 3 have focus on the complexity of the project, type 4 focuses on how to handle it. This is the prescriptive knowledge of project complexity. This is often based on pragmatism (Dewey, 1916) or a pragmatic approach to research (Morgan, 2007). The purpose is not to describe, explain, or to predict but instead to prescribe a solution to a given problem (i.e., project complexity). This resembles design theory, based on design principles such as "If you want to achieve Y in situation Z, then something like action X will help" (Aken, 2004).

5.4.2 Second-order construct

The ideal type 4 focuses more on management than on the project itself. The distinction between the project and project management has been promoted by many authors. Morris argues further, that the overall management of projects can be divided into three levels: 1) the core of the project, where the work is done, 2) the Project Management level, and 3) the institutional level, i.e., the context of the project. (Morris, 2013). The managerial genre includes both levels 2 and 3. Papers of this type sometimes use the expression 'project management complexity'. This type could also be called 'complex project management', as some papers have chosen to call them (Ahern, Leavy, & Byrne, 2014).

A standard of project management competence was proposed (CCPM) but did not receive a warm welcome from (Whitty & Maylor, 2007); then again, this paper can be classified as belonging to the complexity theory, which might explain some of the reasons for its cool reception. From the perspective of the complexity theory of project complexity, the CCPM is not grounded in theory. However, from a pragmatic worldview, the CCPM has merits especially in regard to qualifications for project managers.

In this ideal type, perceived project complexity predominates over the descriptive view, based on the definitions provided by Vidal and Merle (2008). Another factor that distinguishes type 4 from the first three types is frequent references to PMBOK (Project Management Institute, 2017) from the Project Management Institute (PMI), and sometimes also to PRINCE2 (OGC, 2009). Using references such as these is not 'comme il faut' in types 1 to 3.

One paper, which we have classified as type 2, ends with a concluding remark on the need for a paradigm shift from "defining complexity and its characteristics to developing responses to project complexities" (Geraldi et al., 2011). Whereas Geraldi et al. speak of a paradigm shift, we think more in terms of different coexisting ideal types of research.

Geraldi (2011) laid the foundation for later development of the work into a tool (H. R. Maylor, Turner, & Murray-Webster, 2013) whereby management can assess the complexity of a given

project. This assessment is interpretive, and therefore very different from the positivistic approach in type 1. It is also very different from types 2 and 3, where no metrics are given.

5.4.3 Exemplification of ideal type 4

An example of prescriptive work is how to find early warnings in complex projects (T. Williams, Jonny Klakegg, Walker, Andersen, & Morten Magnussen, 2012). An example of identifying managerial strategies for handling project complexity using a Delphi questionnaire is seen in (Kermanshachi, Dao, Shane, & Anderson, 2016). The TOE framework (Bosch-Rekveldt et al., 2011) was initiated as a perceived approach to engaging practitioners. The framework was later used to conduct research of a more descriptive character, which is an example of the framework not being tied to one ideal type alone.

Since the managerial approach interests practitioners, scholars also use the book media for writings on managing project complexity, as for example (Pryke & Smyth, 2012). However, some project management books are more on the border of type 2. Hass (2008) profiles projects according to levels of complexity: 1) independent, 2) moderately complex, and 3) highly complex. However, the book is positioned as type 4 because of the second half of the book; the intention of the work is focused on how to handle project complexity. The same consideration applies to a book by Remington, who employs an adapted version of the Cynefin framework, and based on this devotes her attention to leadership as a way of handling project complexity (Remington, 2016).

5.4.4: Relationship to project success

The following two definitions illustrate how project complexity can focus on the managerial aspect: “Project complexity is the property of a project which makes it difficult to understand, foresee and keep under control its overall behavior, even when given reasonably complete information about the project system” (Marle & Vidal, 2016), and “A high level of complexity in a project implies the existence of more dependencies and difficulties in implementing and managing the project” (Zhu & Mostafavi, 2017). Here, the effect of project complexity is included in the definition of project complexity. Since management is about achieving success, the two concepts become intertwined.

One paper discusses the separation of project complexity from the severity of managing the project (Remington, Zolin, & Turner, 2009). This is relevant for ideal types 1 to 3, but in ideal type 4, the point is that the severity and the complexity are seen as one and the same. Furthermore, the causality can be somewhat backward compared to ideal type 1. Hass (2008) argues that having business success as part of the project objectives causes the project to be complex. A similar view is found in (Mikkelsen, 2018), where the more project success is oriented toward project effectiveness, the more complex the project becomes from a managerial perspective.

The relationship between project success and project complexity, when project management is included in the latter, is no longer separable. The relationship is therefore labeled ‘overlapping and intertwined’

5.5 – Emancipative investigation

5.5.1 Forming the ideal type

A project often lends itself to a good story worth telling. Case studies are important, not only for theory building but also for human learning and understanding (Flyvbjerg, 2007). However, not all case studies are ideal type 5. When dealing with cases, we must always answer the question "What is this a case of?" (Lund, 2014). It could be a case of a complex project where special themes are investigated or a case of an interesting project study that contributes to an understanding of project complexity. Ideal type 5 is the emancipative investigation of project cases in search of an understanding of the complexity of the case without the intention of generalizing findings.

5.5.2 Second-order construct

A contextual limited understand of a single case is often based on interpretive research. There is a focus on the lived experience of projects. Both ideal types 4 and 5 are of the interpretive type and will often have the management of projects as their unit of analysis.

Generally, papers of ideal type 5 are case stories, although many case studies also fit into the previous types. There are many prominent case stories that do not fit into the types mentioned thus far. That is the reason for this category. The expression "pink elephants" is taken from (Geraldi & Söderlund, 2016), where three categories of general research projects are classified as follows: 1) any projects (projects are seen as similar and comparable), 2) specific types of projects, and project contexts, and 3) 'pink elephants' with prominent ethical, theoretical and/or practical value/uniqueness. Research on the third category "follows emancipatory knowledge interests, and helps project practitioners to question work practices, and instigates them to change it" (Geraldi and Søderlund 2016). The authors based their paper on Habermas's three ways of knowing: technical (positivistic science), practical (interpretive research) and emancipatory (critical social science) knowledge (Tinning 1992), which is a trio in which essence corresponds well with the divisions in **Table 1**, i.e., positivist, interpretivism and postmodernist. Case stories in research are sometimes not given enough credit.

5.5.3 Exemplification of ideal type 5

Prime examples of cases stories about mega-projects used to investigate complexity include papers on the London Olympics (Davies & Mackenzie, 2014) and London Heathrow Terminal 5 (Davies, Dodgson, & Gann, 2016). A comparison of two mega-projects can be found in (Van Marrewijk, Clegg, Pitsis, & Veenswijk, 2008). However, a study of mega-projects might be positioned in one of the ideal types. Examples include (He et al., 2015), which fits into type 1, and (Lessard, Sakhrani, & Miller, 2014), a fine case of type 3, and (Giezen, 2012), which should go into the managerial type 4.

Pink elephants come in many sizes and forms and some might be more gray than pink. The topic might investigate problem-solving in a complex project (Bowman & Crawford, 2017) or the governance of collaboration (Chakkol, Selviaridis, & Finne, 2018). Or, papers might use the theory

of project complexity in combination with project managerial themes, such as risk, when explaining the nature of risk in complex projects (T. Williams, 2017) or related topics, e.g., stress (Jepson, Kirytopoulos, & London, 2017). Another type of case story is investigation projects or project-related topics where project complexity is used as a lens. These will often be on the borderline of the ontological or the managerial ideal types. In some cases, a paper may even position itself as a case study to avoid epistemological and methodological discussions.

5.5.4: Type 5's relationship with project success

As with type 4, project success is difficult to observe separately for the concept of project complexity. "The perceived success also depends on the perspective of various stakeholders and project roles, and thus indeed lies in the 'eye of the beholder'" (Neves et al. 2017). The absence of generalization makes is possible to see beyond the somewhat artificial borders of the project in the lived experience of the participants. The temporary organization can emerge in the permanent organization to the extent where the cost of the project cannot be clarified, and the benefit of the project is an unrepeatable part of the permanent organization. Here, the concept of project success as an isolated concept reduces its meaning. Since ideal type five is not bounded by generalization, project success can be investigated longitudinally and can further include the complexity of multiple stakeholders with respect to benefit realization, a diverse understanding of stakeholder and project success, as found in (Davis, 2017); hence, the interrelation between project complexity and success is labeled as being integrated.

6 Discussion

The parable of the elephant and the blind men, who conceptualize the animal based on the part of the elephant they are touching, is well suited for research on project complexity. Each ideal type makes sense, but no single one portrays the full picture. This paper began with the realization that there is no common definition, and based on the typology presented we can give five different versions of definitions: 1) project complexity is a fixed variable measuring the varied interrelated parts of the project; 2) project complexity is the unpredictable based on the emergent nature of the project; 3) project complexity is a set of static or dynamic dimensions capturing the wholeness of the project; 4) project complexity is the aspect of a project that makes it difficult manage; or, lastly, 5) project complexity is in the eye of the beholder.

In the discussion of the typology displayed in Table 3, we can ask the following editorial questions (Southgate, 1993): Is it new? Is it true? Is it interesting? The first question is easy since it is new. Many have classified the dimensions of project complexity, but the literature review did not find any at the level of research on project complexity, although two papers were on this path: (Bakhshi et al., 2016) and (Zhu & Mostafavi, 2017). The next two paragraphs discuss the matter of trueness from a pragmatic point of view and make an interesting contribution to the paper. In section 6.1, the truthfulness of the typology will be argued using a pragmatic approach, where the reasoning is as follows: what works is true. (May, 2011).

6.1 Trying out the typology

What is the truth is still up for discussion and is an ongoing debate between different traditions of science. One viewpoint is, that "Truth is neither absolute nor purely conventional and relative, but a matter of practical adequacy" (Sayer, 1999, p. 57). This paper has presented the five ideal types with rigor and illustrated their usefulness by explaining the dependent variable and illustrated the five different relationships between complexity and success.

Based on **Table 3**, a pragmatic set of questions has been formulated to conduct a simple trial; trying out the strength of the ideal type as attractors (in a complexity theory sense of the word) - not like categories for sorting research papers on project complexity. The questions seen as proxies for ideal types are as follows: 1) Does the paper document a correlation to prove law-like relations between constructs? 2) Does the paper use concepts from complexity theory, such as emergence, attractors, or the like? 3) Does the paper present a framework with a set of dimensions hard to operationalize? 4) Does the paper prescribe managerial approaches to handling project complexity? or 5) Does the paper refrain from generalizing the findings from a case study of a complex project?

Going through a test set of papers, the majority of them had a positive response to only one of the five questions mentioned above. A minority responded positively to more than one of the questions, but still only one dominated the others. In some cases, it was difficult to determine. One example was a paper entitled "The nature of risk in complex projects" (T. Williams, 2017). The final judgment was to identify this paper as a type 2, since the interaction of many risks was used as an explanation similar to other concepts of complexity theory. Another conundrum was the use of 'perceived project complexity' (Sohi et al., 2016), where the paper was clearly an ideal type 1. This lead to the realization that 'perceived' might refer to the use of humans as probing devices, rather than the notion put forth by (Vidal, 2008). Often there was a paragraph arguing for the paper's contribution to managing projects or something similar; hence, it aspired to ideal type 4. However, if there were no arguments about how the contributions were directly beneficial to the managers of projects, the statements were disregarded. All in all, this indicates the high usability of the typology. However, the real test of the typology is whether the researcher adopts it, in which case it will become true, not only based on a pragmatic reasoning about truth but also according to the well-known dictum by Thomas: "What people believe to be true is true in its consequences" (Nias, 1987). When people believe in a typology, it becomes true in its consequences.

6.2 Contributions of the typology

"To classify is human" (Bowker & Star, 2000), meaning that classification is of natural interest to humans, hence a contribution in itself. However, we do not close with that statement alone. To be truly interesting, the classifying typology should provide some kind of usability for future research.

The typology can be considered a theory in itself (Doty & Glick, 1994). This typology holds that the intention of research in project complexity shapes the concept of project complexity, and through this determines the relationship between complexity and the success of the project. Danial and Daniel (2018) divided project complexity into regulation and emergence, concluding that there is a need for developing theory for the latter. Further, there is the notion that "complexity resides as

much in the eye of the beholder as it does in the structure and behavior of a system itself" (Schlindwein and Ison 2004). If this all-inclusive approach to general complexity should apply to project complexity as well, there is a need for a research approach capturing all five perspectives from the ideal types of research on project complexity. This would crossover into classical traditions of science merging the positivistic approach with the postmodern, according to (Neuman, 2013). However difficult this might be achievable, according to Orlikowske and Baroundi: "From the viewpoint of weak constructionism, interpretive research is understood to complement positivist research, that is, by generating hypotheses for further investigation, and by filling in the knowledge gaps that positivist research cannot attend to, such as the contextual exigencies, the meaning systems, and the interaction of various components of a system" (Orlikowski & Baroudi, 1991). On this basis, it seems possible to have an inclusive perspective of the diversities in typology by integrating them into a bigger picture. An inclusive perspective is also found in RPM, where classical project management becomes an integrated part of the new paradigm (Svejvig & Andersen, 2015, fig 1).

7. Conclusion

This paper set out to make sense of the diversification of research on project complexity. The posited research question has been answered through the development of a typology, as a way of accounting for the diversity of research on project complexity. The typology suggests five research intentions: law-like relations for prediction, complexity theoretical explanation, ontological framework for description, a managerial framework for prescription, and investing for understanding without the intent of generalization. With the second-order construct, the typology the paper explains each of the types. The dependent variable of the typology illustrates how each ideal type corresponds to a specific relationship between the complexity and success of projects. These unique relations have been labeled correlational, irrelevant, implicit, intertwined, and integrated.

Doty and Glick (1994) argue that typologies meet at least three key criteria that all theories must have: 1) the constructs are identified; 2) the relationships among these constructs are specified, and 3) these relationships must be falsifiable subject to empirical examination. The presented typology has all three, although more research is needed to attempt falsifying and hereby potentially strengthen the theory.

Further, there is a need for research in an integrative framework based on weak constructivism (Orlikowski & Baroudi, 1991) to investigate the opportunity of a theory on project complexity, including contributions from all five ideal types of research. By being conscious of the differentiators, an integrative approach is feasible and therefore may elicit further rethinking of project management.

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