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A critique of project management research

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Abstract: Project management studies are predominantly conducted by inductive reasoning based on a positivist philosophy. This paper is an organised attempt to shed light on the hidden weaknesses of project management research. The weaknesses are categorised in three categories: research design, definitions and measurements, and analysis. The key weaknesses discussed in this paper include lack of a general underlying theory, issues with positivism and statistical modelling, and dearth of explanatory models. To address these weaknesses, mixed-method research based on a critical realist philosophy is suggested. As an example, the effects of environmental complexity on projects were presented. This example demonstrates how a mixed-method approach, grounded in critical realism, can provide deeper insights and a more comprehensive understanding of the relationships between environmental factors and project performance. By embracing a critical realist perspective and employing mixed-method research, project management scholars can pave the way for more contextually-relevant and explanatory studies in this multifaceted field.

Keywords: project management; PM; research philosophy; critical realism; CR; mixed-method research.

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Biographical notes: Bijan Jamshid-Nejad is an accomplished academic and researcher in the field of project management. He currently serves as a Lecturer of Project Management at the School of Engineering and Technology at Central Queensland University. He received his Bachelor's degree from Sharif University of Technology and his master's degree from the University of Tehran, both in industrial engineering. After gaining extensive professional experience in the oil and gas and automotive industries for over a decade, he pursued his doctoral studies at the University of Melbourne, Australia. His PhD research focused on agent-based modelling and simulation of quality management systems. Through his research, he has explored the application of agent-based modelling techniques to the study of complex systems, particularly in the context of project management.

1 Introduction

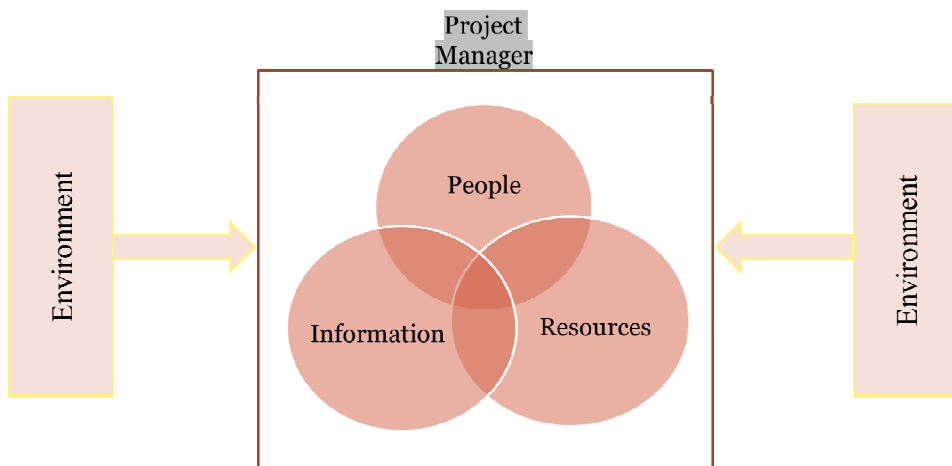
For the past 70 years, project and program management have been used increasingly to achieve strategic objectives. Modern project management (PM) started as the offshoot of operations research (Rakade, 2020). Critical path method (CPM), resource-constrained

scheduling, and resource levelling algorithms are examples of early techniques of PM developed by operation research scholars. In the 1980s, professional associations like PMI, APM, AIPM, and IPMA advanced PM by developing bodies of knowledge and certification programs (Rakade, 2020) followed by the 1990s, when universities and research institutes took the lead by incorporating PM in their programs and promoting it as a branch of management. In addition to engineering and construction management, interest in PM grew from other disciplines like business and IT (Rakade, 2020; Turner et al., 2013).

PM has undergone some changes in theory and practice afterwards. In theory, the single life cycle theory of projects has been replaced by theories about project complexity, social interaction, and stakeholder relations (Shane et al., 2014). In practice, life-cycle image of projects based on a sequence of tasks like a production process is changing towards framing projects “within an array of social agenda, practices, stakeholder relations, politics, and power” (Shane et al., 2014; Transportation Research et al., 2014). Also, the focus has shifted from ‘product creation’ to ‘value creation’. The changes in theory and practice necessitate an in-depth analysis of PM research methodologies and their underpinning philosophical standpoints. The aim of this paper is to address this need.

The emergence of PM as an individual discipline would facilitate knowledge development. However, as we have yet to reach that point, it would be helpful methodologically to clarify PM’s disciplinary position, i.e., whether it is a multidisciplinary or interdisciplinary field. To draw a demarcation line between multidisciplinary and interdisciplinary research, the definitions, cited in Farrow et al. (2020) are used in which, multidisciplinary research is conducted on several disciplines in parallel but interdisciplinary research synthesises methods from different disciplines to integrate knowledge in a new, coherent model; so the difference is in the need for meta-analysis in interdisciplinary fields. Having said this, PM research is deemed to be more multidisciplinary than interdisciplinary.

Figure 1 Projects as systems (see online version for colours)



Adopting a socio-technical system viewpoint, projects as systems are comprised of people, resources, and information as shown in Figure 1. Scholars of each subsystem have their own ‘way of thinking’ and ‘way of working’. The interconnected nature of projects justifies the need for multidisciplinary and interdisciplinary knowledge. There are ontological and epistemological incompatibilities between these subsystems based on which different schools of thought have been emerged gradually. Some of important PM schools of thought are optimisation, governance, behaviour, decision, and contingency (Söderlund, 2002; Kwak and Anbari, 2009; Turner et al., 2013). The metaphors used by these schools for theory building are different as shown in Table 1. The conceptual frameworks and the metaphors used, and their relationships constitute PM’s disciplinary identity. In other words, predominant models show the essence of PM.

Table 1 Metaphors used in PM

<i>School of thought</i>	<i>Metaphor</i>
Optimisation School	Project as machine
Governance School	Project as a legal entity (i.e., organisation)
Behaviour School	Project as a social system
Decision School	Project as an information processor
Contingency School	Project as a complex adaptive system

Different schools of thought show how prevalent the concept of PM is among different disciplines and emphasises the importance of having a solid theoretical foundation of PM to establish it as an independent discipline. But it also raises questions about integration of knowledge due to inadequate justification of integration and dominance of disciplinary specialisation.

In PM, unlike organisation science, the emphasis is on the ‘way of working’ rather than ‘way of thinking’ that is mostly inherited from engineering science. In other words, the focus in PM practitioners has been more on ‘how to’ rather than ‘what is’ or ‘why’. Put another way, project practitioners are concerned with forming new artefacts by synthesis rather than studying artefacts by analysis. In academia, analysis is preferred, because academics are more interested in knowing ‘why’ for theory building. Theorising PM is lagging behind other management areas probably because of its multi-disciplinary nature, novelty of project-based approach to organisations, and traditional engineer-led development of PM.

Our critical analysis of PM research is inductive in nature, i.e., drawing general conclusions from specific observations. That is why we start our critique about PM research by a general review of current PM research followed by its associated issues, which are grouped into three categories: research design, definitions and measurements, and analysis. Next, we suggest a mixed-method research based on critical realism (CR) philosophy which ameliorates some existing issues. Mixed methods research is defined by Tashakkori and Creswell (2007, p.4) as “research in which the investigator collects and analyses data, integrates the findings, and draws inferences using both qualitative and quantitative approaches or methods in a single study or a program of inquiry”. Then, we envisage the possibility of applying the suggested research method for the topic of project complexity before we sum up our findings at the end.

2 PM research at a glance

Traditionally most PM research has been underpinned by a logical positivism philosophy. The objective of this philosophy is to identify regularities as general laws and then to predict specific outcomes by these laws. The ontological assumption of this philosophy is that there are real objects, social structures, and forces that are independent of human observation. Another assumption is unbiased observation which is questioned as all observations are theory dependent (Mingers, 2004).

A taxonomy based on modelling purpose and type has been developed to structure our analysis of PM research, shown in Table 2. As regards modelling purpose, descriptive models are used for describing behaviours of their referent subjects. Sometimes also called input-output models, these models describe what outputs are expected from different inputs. However, the internal mechanisms and structures of systems are considered as a black box, and they are not included in descriptive models. Explanatory/prediction models explain how events are unfolded or what are the mechanisms of converting inputs to outputs in the system.

Types of models are identified based on their method of representing reality. Verbal/conceptual models embody language to represent entities, variables, and events/processes/mechanisms, whereas mathematical and computation models use equations for this purpose (Zacharias et al., 2008). In PM, PMBOK and PRINCE2 are examples of verbal/conceptual models and scheduling techniques like CPM and program evaluation and review technique (PERT) are examples of mathematical models.

While a thorough literature review is not the objective of this study, Table 3 contains a selection of relevant papers, published in *International Journal of Project Organization and Management*, *International Journal of Project Management*, and *Project Management Journal*, which are analysed using the provided taxonomy.

Table 2 Taxonomy of models in PM with examples

		Type of modelling		
Purpose of modelling	Description	Conceptual/verbal	Computational	Mathematical
		PMBOK and Prince2	Agent-based models, discrete-event simulation	Statistical models
	Explanation/prediction	Team formation models	Discrete-event simulation models, system dynamics models, scenario-based analysis	Statistical models, Empirical models for estimation, CPM, PERT, operation research models

Most studies listed in Table 3 have been aimed at finding a simple theory to explain complex interrelationships between PM practices and their success factors, where success factors have broad definitions here. We have inherited this kind of research from positivism era and success of classic, Newtonian mechanics. The main characteristics of positivism (Farrow et al., 2020), that are followed by PM scholars are:

- universality of theories and law-like generalisations
- triviality of context

- transferability of knowledge
- distinguishability and separability of cause and effect
- application of the Scientific Method of investigation.

Despite the prevalence and success of positivism, projects are complex entities and “in the social world, outcomes often reflect very complex underlying relationships that include the interaction of several potentially chaotic systems” [MacIntosh, (2006), p.12] which limits the application of reductionist approach embedded in positivism. In the system view of projects (shown in Figure 1), there are fundamentally different elements interacting in an uncertain environment and therefore, the search for a simple set of equations to explain such complex phenomena may have been a futile attempt. As a result, alternative modelling paradigms like agent-based modelling and network analysis have emerged as new research methods.

Table 3 Analysis of selected PM papers based on the taxonomy

<i>Paper</i>	<i>Purpose of modelling</i>	<i>Type of modelling</i>	<i>Research philosophy</i>	<i>Research methodology (quantitative/qualitative/mixed)</i>
Bing et al. (2005)	Description	Mathematical	Positivist	Quantitative
Garcia et al. (2005)	Description, Prediction	Conceptual/verbal, mathematical	Interpretive, positivist	Mixed
Partington et al (2005)	Description	Conceptual/verbal	Interpretive	Qualitative
Van Donk and Riezebos (2005)	Description	Conceptual/verbal, mathematical	Positivist	Mixed
Xu et al. (2005)	Description	Conceptual/verbal	Positivist	Qualitative
Xu et al. (2021)	Description	Conceptual/verbal	Interpretive	Qualitative
Song et al. (2022)	Description	Conceptual/verbal	Interpretive	Qualitative
Tam et al. (2020)	Description	Conceptual/verbal, mathematical	Positivist	Mixed
Geraldi and Söderlund (2018)	Description	Conceptual/verbal	Interpretive	Qualitative
Von Danwitz (2018)	Description	Conceptual/verbal	Interpretive	Qualitative
Cerić et al. (2021)	Description	Conceptual/verbal	Interpretive	Qualitative
Leiringer and Zhang (2021)	Description	Conceptual/verbal	Interpretive	Qualitative
Maylor et al. (2023)	Description	Conceptual/verbal, mathematical	Interpretive, Positivist	Mixed
Khan et al. (2022)	Description	Conceptual/verbal, mathematical	Positivist	Quantitative
Nauman et al. (2022)	Description	Conceptual/verbal, mathematical	Positivist	Quantitative
Usher (2021)	Description	Conceptual/verbal	Interpretive	Qualitative
Sospeter et al. (2021)	Description	Conceptual/verbal, mathematical	Positivist	Quantitative

Table 3 Analysis of selected PM papers based on the taxonomy (continued)

<i>Paper</i>	<i>Purpose of modelling</i>	<i>Type of modelling</i>	<i>Research philosophy</i>	<i>Research methodology (quantitative/qualitative/mixed)</i>
Cao et al. (2021)	Description	Conceptual/verbal	Interpretive	Qualitative
Einhorn et al. (2022)	Description	Conceptual/verbal, mathematical	Positivist	Quantitative
Ali and Haapasalo (2023)	Description	Conceptual/verbal	Interpretive	Qualitative
Ayat et al. (2022)	Description	Conceptual/verbal	Interpretive	Qualitative
Ellis et al. (2022)	Description	Conceptual/verbal, mathematical	Positivist	Quantitative
Larsen et al. (2022)	Description	Conceptual/verbal, mathematical	Interpretive, Positivist	Mixed
Lindhult and Axelsson (2021)	Description	Conceptual/verbal	Interpretive	Qualitative
Podgórska and Pichlak (2019)	Description	Conceptual/verbal, mathematical	Interpretive, Positivist	Mixed
Fossum et al. (2019)	Description	Conceptual/verbal, mathematical	Positivist	Quantitative
Haaskjold et al. (2020)	Description	Conceptual/verbal	Interpretive	Qualitative
Rasool et al. (2023)	Description	Conceptual/verbal, mathematical	Positivist	Quantitative
Ayub et al. (2019)	Prediction	Conceptual/verbal, mathematical	Interpretive, Positivist	Mixed
Benítez-Ávila et al. (2019)	Description	Conceptual/verbal	Interpretive	Qualitative
Denicol et al. (2020)	Description	Conceptual/verbal	Interpretive	Qualitative
Sergeeva and Winch (2021)	Description	Conceptual/verbal	Interpretive	Qualitative
Sydow (2021)	Description	Conceptual/verbal	Interpretive	Qualitative
Wang et al. (2021)	Description	Conceptual/verbal	Interpretive	Qualitative
Wang et al. (2022)	Description	Conceptual/verbal	Interpretive	Qualitative
Khoza and Marnewick (2023)	Description	Conceptual/verbal	Interpretive	Qualitative
Ershadi et al. (2021)	Description	Conceptual/verbal	Interpretive	Qualitative
Ghalenoei et al. (2018)	Description	Conceptual/verbal	Interpretive	Qualitative
Mignerat et al. (2022)	Prediction	Conceptual/verbal	Interpretive	Qualitative
Zighan (2020)	Description	Conceptual/verbal	Interpretive	Qualitative
Bohnstedt and Wandahl (2019)	Description	Conceptual/verbal, mathematical	Positivist	Quantitative

Table 3 Analysis of selected PM papers based on the taxonomy (continued)

<i>Paper</i>	<i>Purpose of modelling</i>	<i>Type of modelling</i>	<i>Research philosophy</i>	<i>Research methodology (quantitative/qualitative/mixed)</i>
Steen et al. (2018)	Description	Conceptual/verbal	Interpretive	Qualitative
Khoso et al. (2022)	Prediction	Conceptual/verbal, mathematical	Positivist	Quantitative
Buvik and Tvedt (2017)	Description	Conceptual/verbal, mathematical	Positivist	Quantitative
Pakdaman et al. (2021)	Prediction	Conceptual/verbal, mathematical	Positivist	Quantitative
Leiringer and Zhang (2021)	Description	Conceptual/verbal	Interpretive	Qualitative
Jamshid-Nejad and Alvandi (2023)	Explanation	Computational	Interpretive, positivist	Quantitative

Conduction research for identifying causal arguments is fundamentally inductive (Vaughn, 2010). The reason is that we try to build theories from evidence in induction unlike deduction in which we look for evidence for our theories (Bowell and Kemp, 2002). Even for deduction, the researcher starts with some evidence (i.e., experiences in empiricism) before formulating a model. In an inductive argument, given the premises are true, it would be more reasonable to accept the conclusions as true than false. In other words, it is a probabilistic conclusion in which the probability of conclusion being true is more than 50% but less than one (Bowell and Kemp, 2002). Therefore, to judge an inductive argument, we need to investigate its premises and their relationship to conclusions. By the same token, we need to evaluate the premises of PM research and their conclusions and for this purpose PM research has been analysed in three categories, namely research design, definitions and measurements, and analysis. The details of each category are explained herein.

3 Drawbacks of research methods in PM

As shown in Table 3, logical positivism is an important research philosophy in PM. The cornerstones of this philosophy are definition, measurement, developing hypotheses, and testing them with data. The conception of causality in positivism is linear based on Humean laws of causality which leads to closed cause and effect models (Smyth and Morris, 2007; Mingers, 2006). Positivism prefers a reductionist approach in which a system behaviour is explained based on its constituent elements. It was mentioned before that there are different school of thoughts in PM and each follow their preferable methods. Engineers, the proponents of optimisation school of thought, like mathematical modelling for prediction purposes, whereas social scientists prefer inductive reasoning which is mostly used to develop descriptive models. Coming from a positivist philosophy, predictive models like operation research models require closed form analysis which is challenging in projects because of contextual factors. Therefore, positivism does not seem to be an appropriate research philosophy for PM except cases that closed system assumption is valid. As a result, to build explanatory/prediction

models we need to adopt new philosophies for research inquiries and CR could be one of them. We will discuss this matter later in this paper.

3.1 *Research method*

Our review of literature in Table 3 and other older studies like Smyth and Morris (2007) show that PM-related research is mostly done by applying inductive reasoning, where different statistical methods like regression analysis, factor analysis, and structural equation modelling are used to analyse the data, mainly collected by questionnaires as the research instrument. The outcome of induction in PM could be variance theories (Edmondson and McManus, 2007) indicating an increase in X leads to an increase in Y (which are mostly descriptive) or less common process theories (Edmondson and McManus, 2007) (which are mostly explanatory/predictive) pointing out how a phenomenon works, or how a process unfolds. Process models are built to represent behaviours of an object and relevant processes and are usually dynamic. Components of a process model could be arranged to allow for a two-way analysis of the system response to a disturbance (based on a scenario) (Zacharias et al., 2008). Due to the amount of detail needed to represent processes and behaviours, developing process models takes much time and effort and thus they are few.

It is claimed that inductive reasoning falls short of providing an explanation for the effects of PM practices on project success and leads to propositions that specify a statistical relationship (e.g., linear) between variables of a model (Argyris, 1999). The prevalent statistical models generally are applied to model the relationship between outputs and inputs of a project and that is why they seem to be inappropriate for explaining or understanding the behaviour of a project, because they lack sufficient details of the structure, context, and interacting mechanisms. In other words, they do not provide the mechanisms underlying the micro-macro level linkages in PM.

Research method involves planning the overall research. In PM literature, the application of inductive reasoning based on statistics has several issues. The first issue relates to modelling strategy: it is difficult to match the problem modelled to the realities of projects. It could be due to lack of attention to details or unrealistic expectations about research outcomes. Induction is applied when deduction is arduous (sometimes even impossible). Its main weakness is that causal inductive arguments can provide us only probable conclusions (Vaughn, 2005). Therefore, inductive conclusions must be viewed with caution (Powell, 1995). Despite this weakness, it is still a useful tool in doing research in many fields because there is no other equally efficient alternative. There are major difficulties in modelling synergies and interactions through statistical methods (Stahl, 1999). These interactions should be reflected in nonlinear relationship between dependent variable and independent variables. Designing the internal structure of models is problematic because of unrealistic assumptions about projects. For instance, the relationship between organisational culture on project performance is nonlinear and thus difficult to be modelled with statistical models.

The second issue relates to ontological and epistemological problems. In the subsystems of projects (see Figure 1), different categories of objects, concepts, or social structures exist. As regards epistemology, methods of inquiry in these subsystems are different. For example, for resource subsystem, deduction is used (e.g., mathematical modelling for resource allocation), whereas in information and people subsystems the inquiry method is mostly induction (e.g., analysis of effects of IT adoption on project

success). This leads to interface incompatibilities of models developed in PM field for people, resources, and information subsystems because of ontology incompatibilities, different levels of resolution and purpose of modelling. Furthermore, expectations about verification, validation, and accreditation of modelling in social systems (i.e., people subsystem) in general are high due to comparison to physical systems (i.e., resource subsystem), which cannot be achieved (Zacharias et al., 2008).

In building statistical models, it is assumed the effects of two or more causes are equal to the sum of effects of each individual cause. Known as additivity, this assumption results in linearity of system behaviour because in an additive function the effects of two different causes are equivalent to the sum of the effects of each one individually and there is no synergistic impact among causes. In modelling human behaviours, maintaining additivity is difficult due to adaptation and change. Non-stationary behaviours are common in social systems like projects and can trigger new behaviours or change performance landscape.

The third issue is the lack of universally accepted theoretical foundation for PM. Based on a positivist viewpoint, every model has two components: a general theory and an object (Hartmann, 1996). The general theory provides the framework under which specific features/properties of an object are represented in the model. In model development, the purpose of the model, modelling object, computational and data constraints, and verification and validation methods should be considered. The success of model development depends on not only data availability, but also on model assessment, analysis methods, and tools for interpretation and understanding (Zacharias et al., 2008). As mentioned before, PM is a multidisciplinary field which makes theory development difficult, because each discipline has its own approach. In PM literature, a considerable number of papers deal with PM standards and frameworks like PMBOK, Prince2, ISO21500, and Agile methods, which is argued to be because of a dearth of well-founded theory of PM. In fact, PM looks more like a collection of different methods and tools without any meta theory to integrate knowledge. This per se is not a disadvantage, only if they provide new insights, which is not the case.

The fourth problem is lack of originality in PM research based on statistical models. There are many studies in this area already done albeit with various methods and depth of research. On the one hand, similar studies may test the falsifiability of conclusions, which is a criterion for demarcation in Popperian philosophy (see Popper, 2005). Therefore, similar research could be interpreted as a tool for strengthening evidence for relatively similar hypotheses. For instance, the effects of communication, information flow, and measurement are conceptualised differently in PM research, each addressing relatively a similar notion (see for example, Bashir et al., 2022; Parraguez et al., 2015). On the other hand, there has yet to be a universal theoretical foundation for PM, as it has been explained before in this paper, without which falsifiability or verification makes no sense. Consequently, each author defines his/her own conceptual model first and then tries to test some relevant hypotheses to prove the validity of the conceptual model. Therefore, similar research projects with different conceptual models provide little evidence for a hoped-for general theory of PM.

The existence of external disturbance obscuring the links between different factors and PM is the fifth drawback. The hoped-for theory for PM, includes supposedly a set of cause-effect propositions but they cannot be deduced without deliberately controlling different variables that is very difficult in inductive reasoning. Existence of some

important contextual parameters like organisation culture or governance structure exacerbates the situation.

Finally, the last problem is the existence of tangible and intangible (sometimes behavioural) factors of success in projects. Like organisation performance, project success is a multi-faceted concept that may be interpreted as a combination of output/outcome quantity and quality, flexibility, benefits, and service-related indicators. These behavioural factors cannot be captured and modelled within mathematical/statistical frameworks. This provides fresh impetus for application of mixed-method research. Mixed research methods are being used in PM as examples shown in Table 3. However, we will discuss how the rigor can be improved.

3.2 Definitions and measurements

The first requirement of efficient research is basic definitions. Without definitions, appropriate measures cannot be defined. Both project success and PM suffer from fuzziness of definitions and measures. Lack of exact definitions of basic concepts like trust, power, project success, etc. is ubiquitous in the PM literature. This vagueness of definitions hinders developing a consistent mental model among managers, consultants as well as academics, resulting in inconsistent responses to different surveys.

There are several difficulties in data collection. Data collection methods vary from online survey and direct observation to in-depth interview. The danger of biased data always exists; survey respondents are mainly project managers and practitioners and they, like case studies, report positive results; furthermore, direct observation and in-depth interview are time-consuming and produce qualitative data. The tendency to try 'to give the 'right answers' not the 'actual answers' and to exaggerate project success by managers are other sources of bias. Data accuracy, sample size, and measurements are other challenges in data gathering. Firstly, data inaccuracy does exist, because project managers cannot consider all variables and assess all causal linkage in PM. Secondly, the sample size is of paramount importance in obtaining reliable results but a review of previous research shows that respondent rates are low (often less than 25%). Consequently, sample sizes are usually small. Thirdly, serious measurement problems exist in PM. The fuzziness of definitions makes it hard to develop an appropriate, measurement yardstick. Most surveys lack operational definition of the terms they use and thus are ambiguous.

Despite these problems, researchers struggle to minimise data bias as much as possible for improving exploratory power of statistical models they apply. Measurements prepare inputs for estimating statistical models' parameters and thus affect the precision of results. In the next section, issues associated with data analysis are discussed.

3.3 Analysis

Analysis is deemed to be the final stage of research in which the hypotheses are tested, or research questions are answered. Some of the most important pitfalls in this category are explained in this section.

Because of its importance in companies surviving international competition, PM as a discipline has attracted the attention of both practitioners and academics. However, there is no consensus about the reasons for project failures. It can be argued that the success or failure of PM relates to the gap between its perceived and expected results, where

perceived results are related to PM effectiveness and expected results are formulated by managers based on their individual framework or benchmarking of others' success stories. Advocates of PM practices assert that failure cases are due to misunderstanding of the basic theories or incomplete implementation initiatives and lack of management commitment. Conversely, opponents of PM point to flawed theoretical foundations. Problems in finding success/failure factors could, in part, be attributed to difficulties in building causal models between PM practices and project success.

Temporal issues between short-term and long-term results are another difficulty in PM. As it was explained before, PM methodologies includes some benefits which do not happen easily in a short time but evolve over a lengthy time span. In other words, researching in this area needs longitudinal analysis. Finally, sometimes PM tools and techniques are implemented just in a section of a company and the performance data are not available or cannot be compared with other companies.

The issues discussed in this section necessitate reviewing current research methods and to find new solutions. In the following section, some possible solutions are proposed.

4 Areas of improvement in PM research

So far, we have categorised the issues of current PM research in three categories. They are used here again to classify the possible solutions in each category. Improving current research methods comes out as a potential solution, but it is a rocky road.

The main issues associated with research design, discussed in Section 3.1, are related to positivism and induction. Without ignoring the importance of induction, deductive reasoning, wherever possible, seems to be a better option because it is purely objective based on a logical analysis. In fact, the validity of deductive models rests on mathematics or logic laws. Also, it is somewhat possible to control effects of external disturbances in such models by making necessary assumptions. However, like induction, it is difficult to mathematically model interactions and synergies among variables. In the recent PM literature, deductive analysis is hardly seen, because it is difficult to capture the dynamics of projects by mathematical models. Methodologically, mixed research methods can help to bypass many of the issues. Also, quantitative models like network analysis, agent-based modelling, and text mining would offer new insights.

In Section 3.2, the second category 'definitions and measurements' has been discussed. The main rooms for improvement are reducing data bias and collecting in-depth qualitative data, which in turn is highly related to basic definitions of concepts like trust, complexity, or governance. To enhance credibility of results, selecting large samples is theoretically very desirable, but even if possible, it is practically strenuous. Also, providing operational definitions of constructs used in surveys would be helpful.

The analysis issues, discussed in Section 3.3, are mainly an outcome of previous stages, namely, research designs and definitions and measurements; therefore, to avoid them or ameliorate their negative effects, it is better to focus on research design and definition and measurements. To eliminate temporal issues involved in the analysis stage, the capability of computer simulation models in compressing time could be helpful. The classic study of project organisations (Jin and Levitt, 1996) or the recent simulation study of project uncertainty management (Jamshid-Nejad and Alvandi, 2023) are examples of simulation studies in PM.

So far, we have discussed the issues associated with PM research and possible solutions, but these solutions fall short of eliminating fundamental issues like uncontrollable external factors or the existence of complex interactions. It seems that to ameliorate these issues, research in PM needs fresh insights. Joslin and Müller (2016) suggest philosophical triangulation to identify interesting phenomena and to gain richer insights about PM. Their definition of this type of triangularity is the application of multiple philosophical perspectives on a complex research problem. Attempts to ameliorate PM research issues can also be directed towards ontological consistency and use of computer advancement for improving data collection and analysis. In the rest of this paper, we analyse the potentials which CR and mixed-method research methodology offer in this regard.

5 Outlooks of CR

CR as a new philosophy eliminates tensions and reconciles between traditionally used constructionist and positivist approaches. It sits in the middle way between positivism and interpretivism (Zachariadis et al., 2013). This makes it a suitable philosophy for PM which is mostly a multi-disciplinary, practice-driven field consisting of aspects of natural and social science. The three building block of CR are ontological realism, epistemological relativism, and judgmental rationality (Holland, 2014). As shown in Figure 2, based on CR there is a 'real domain' ontologically, but the knowledge is epistemologically relative and is conditioned on the actors, their viewpoints, and histories (Archer et al., 2013). CR is based on a stratified domain of ontologies (see Figure 2) in which there are objects in 'real domain', and social structures and forces and causal laws/mechanisms may or may not be active depending on contextual factors. The next level is 'actual events', the result of some triggered causal laws/mechanisms that exist whether there are perceived by an observer or not and the last level, the 'empirical', which is a subset of actual events and perceived and experienced by the observer. The causal power/mechanism, creating events in the actual domain, rests on powers or tendencies of entities [physical, social, conceptual (Bhaskar, 1997)] and their interactions, observed or not, to act in certain ways in some contexts.

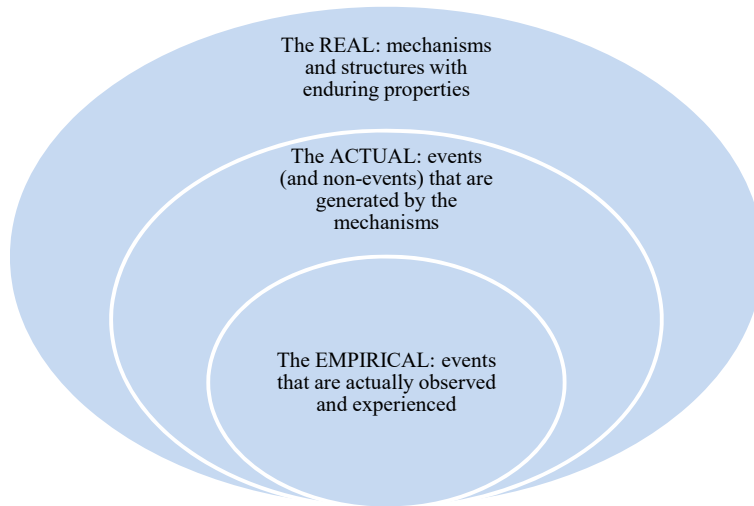
For analysis, CR leans towards abduction, namely explaining a phenomenon or event based on the possible mechanisms that creates it. However, structures, powers, and liabilities create mechanisms under a set of conditions and this makes analysis difficult because context is also important in an open and complex system view (Zachariadis et al., 2013). Because of this, causal relationships are not linear in CR and that makes analysis (no matter based on abduction, deduction, or induction) difficult. This is the feature that disadvantages statistical models as explained before.

In CR, objects can embody concrete and abstract elements and internal mechanisms or processes with causal powers like physical and social relations and language (Smyth and Morris, 2007). Furthermore, CR's transitive, constructivist viewpoint on epistemology promotes different modelling approaches and paves the way for multi-perspective understanding of PM practices.

CR's standpoint on ontology and epistemology suits the hybrid nature of projects as mixed, real, and social artefacts. With a CR philosophical approach, the existence of projects as real, external objects is recognised which eliminates issues of objectivity associated with constructivism. Casual powers are embedded in structures and

mechanisms or processes of project and they are triggered based on contextual conditions (Smyth and Morris, 2007).

Figure 2 The three domains of CR (see online version for colours)



Source: Adopted and modified from Mingers (2004)

Based on a CR philosophy empirical verification can be bypassed, because causal powers may be present but not triggered (Mingers, 2004). Some statistical models like structural equation modelling are of interest, because they help to recognise underlying structures and mechanisms in projects.

Under CR, descriptive models are not enough to unravel hidden structures and mechanisms of a phenomenon; rather the objective is to develop explanatory, mechanism-based models to explain why the world is the way it is. And the plurality embedded in CR necessitates a mixed-method research approach. The logic of scientific inquiry in CR is neither deduction nor induction, because there is no law in the stratified domains of reality and observed phenomena are partial snapshots of reality. Rather, it is reproductive (i.e., abduction) to explain the mechanisms (Holland, 2014).

The concept of stratified ontology with a 'real' domain where objects, structures, powers, and liabilities exist implies new methodologies by which empirical observed events should be analysed to identify relevant mechanisms (i.e., liabilities and powers) (Zachariadis et al., 2013). Therefore, causal explanation of events goes beyond the mere regularities of constant conjunctions and include the generating process and conditions like the context under which 'A' causes 'B' (Zachariadis et al., 2013, Mingers, 2004). This conception of causality makes single-method analysis and generalisation difficult and justifies applying mixed-method approach. When contextual factors are playing roles in phenomena, we can use qualitative research methods to unravel underlying mechanisms. Quantitative methods like statistical modelling on the other hand can be used to explain certain characteristics of an object or structure (Zachariadis et al., 2013) or explore particular patterns within the data for future research or validation purposes (Mingers, 2004). Having said all of these, it seems mixed-method research is appropriate for PM, because qualitative and quantitative methods would complement each other. The

potential of mixed-method research based on CR philosophy for PM are discussed in the next section.

6 Mixed research methodology in PM

Despite the benefits of methodological pluralism advocated in CR, mixed-method research in PM is rarely seen (refer to Table 3 for some examples). Guidelines for conducting mixed-method researches like what has been developed for information systems research (Venkatesh et al., 2013) are needed to facilitate its application in PM. If challenges of mixed-method approach can be handled and it provides a plausible explanation for research questions, it is always preferable because of in-depth, rich insights it offers. The decision should be made based on the research question, purpose, and context (Venkatesh et al., 2013). Harrison et al. (2020) characterise the elements of rigorous mixed-method research. They emphasise the importance of rationale of using mixed methods and having a mixed-method research question. In some mixed-method studies listed in Table 3 (for example, see Tam et al., 2020), these factors are not clearly outlined. Mixed-method researches can be categorised based on research objectives/questions [for example, triangulation, explanatory, exploratory, and embedded (Venkatesh et al., 2013)].

Based on CR, there could be mechanisms in social structures like projects which are not manifest in actual events and observable data, and therefore, pluralistic application of mixed-method methodologies is deemed to be an advantage in PM. The main reason is that quantitative methods individually are not capable of explaining social phenomena due to contextual factors and, consequently they should be combined with qualitative methods which are more valid for explaining complex, intertwined mechanisms of an open system like a project.

CR can analyse both the general and the particular (with context) and mixed-method approach is a potential methodology to fulfil this requirement. There are different types of the mixed-method approach based on the sequence of qualitative and quantitative methods in data collection and analysis. Whether qualitative or quantitative methods should precede depends on the objective of the inquiry. Sometimes application of quantitative research reveals some regularities which should be further researched by qualitative methods to analyse contextual factors and build a valid explanation. In other cases, quantitative methods may need to follow qualitative methods to test a theory or for validation purposes. It is also possible to conduct concurrent quantitative and qualitative research to have better understanding and triangulation.

Qualitative analysis falls short of analysing different aspects of an inquiry due to data collection constraints, whereas quantitative analysis is weak in providing a deep insight due to simplified assumptions (like linearity in statistical models). These limitations make a mixed-method approach more attractive, where quantitative and qualitative methods complement each other.

Joslin and Müller (2016) identify several types of multi-paradigm research to characterise how to manage tensions between different methods: bracketing, bridging, parallel, sequential, meta-theorising, and interplay. Paradigm bracketing entails ignoring certain aspects of a phenomenon to focus on specific aspects/issues. Bridging involves focusing on the grey zones of conflicts between paradigms. In parallel and sequential multi paradigms, we maintain different viewpoints of each paradigm. In meta-theorising,

we build a meta model to unify different viewpoints and finally in interplay we welcome conflicting outcomes to promote innovative methods. These scenarios can be considered when designing research. For instance, bridging paradigm can be used to link research about team-level and project-level decision-making. Another example is project complexity management which is discussed in the following section.

7 Application of mixed-method research based on CR: the example of uncertainty effects on projects

In this section, the process of conducting research based on CR is explained with an example. Based on a system view of projects, the effects of environmental uncertainty on projects are of utmost importance for project managers. More research is required for understanding effects of uncertainty theoretically and empirically (Florice et al., 2016) because project uncertainty studies are mostly theoretical (Chapman, 2016) and descriptive. Further, mechanism-based, explanatory studies are needed to enrich uncertainty management practices. Potential areas of interest for research could be describing effects of uncertain environments on projects or understanding mechanisms of dealing with uncertainty or prescribing a set of guidelines to handle uncertainty (Pich et al., 2002). To our knowledge, despite the fact that mixed-method research is being applied increasingly in PM (Cameron et al., 2015) there is no such research about project uncertainty management. We envision such research in the following steps no matter what the sequence qualitative and quantitative research is:

Step 1 Identifying research topic and purpose.

Step 2 Using different data (interviews, historical documents, surveys, etc.) to hypothesise the situation which has been observed, measured, or experienced in a qualitative study or using data for hypothesis testing.

Step 3 Data analysis and drawing conclusions about the situation.

It is noteworthy that the definition of complexity in projects depends on the philosophical standpoint of the researcher. Based on a logical positivist viewpoint, project complexity is ontologically objective and external, whereas it is subjective and context-dependent in the constructivist approach which depends on the knowledge of researcher and available data.

Regarding uncertainty effects on projects, descriptive models are mostly seen in the literature like Antoniadis et al. (2011), Bjorvatn and Wald (2018) and Botchkarev and Finnigan (2014) but explanatory studies like Jamshid-Nejad and Alvandi (2023) are few. The question is how we can conduct mixed-method research to gain more insight about project complexity management. Here is where a mixed method approach based on CR philosophy is useful to understand not only the effects of project complexity on project success but also its underlying events and further mechanisms. Following the aforementioned steps, we need to evaluate alternative explanations of the phenomenon (i.e., project complexity) and select the most plausible account of the observed effects.

For step three, we need to define a metanalysis method to combine results from quantitative and qualitative methods. Venkatesh et al. (2013) define metanalysis as “theoretical statements, narratives, or a story inferred from an integration of findings from quantitative and qualitative strands of mixed methods research”. Metanalysis

depends on how research questions are framed (for example whether a holistic explanation is required or not), and the sequence of quantitative and qualitative methods. Quantitative methods are usually efficient for breadth of analysis, whereas qualitative methods help us scrutinise a problem in depth.

One of key research questions about project uncertainty is about positive or negative effects of uncertainty on project performance. It is generally believed that uncertainty is detrimental to project performance (Antoniadis et al., 2011). The reason is that uncertainty makes project planning inaccurate and therefore diminishes the chance of project success. However, a quantitative, explanatory analysis done by Jamshid-Nejad and Alvandi (2023) showed that uncertainty provide opportunities for learning and growth which smart project managers can take advantage of. Therefore, a logical question would be raised about the best guidelines for taming and benefiting from uncertainty. A qualitative, case study research from Shane et al. (2014) about project complexity answers this question; some of the recommended tools to manage project uncertainty are:

- 1 Define project success for each dimension of complexity as required.
- 2 Project contracting method based on project outcomes.
- 3 Incentivise critical project outcomes.
- 4 Perform comprehensive risk analysis.
- 5 Design to budget.

The example reveals that a combination of qualitative and quantitative methods (although they have done independently in a multimethod fashion (see Venkatesh et al., 2013) provide richer insights about project complexity management.

8 Conclusions

PM research suffers from lack of a sound theoretical foundation. It is argued that current research methods based on inductive reasoning cannot capture the complexities of projects that are mostly because of behaviour of people, units, processes, and departments of an organisation. In addition, it is difficult to model synergies, learning and working culture changes with mathematical/statistical models, which are currently prevalent modelling methods in PM studies. The characteristics of CR like methodological plurality make it an appropriate research philosophy for PM research. It is argued that there is room for improving research efforts by applying mixed-method research methodology, because they can accommodate fundamental characteristics of projects as complex adaptive systems and can ameliorate many issues involved in research design, measurements, and analysis of current PM research. As an example, analysing the potentials of applying mixed-method methodology for researching project uncertainty management demonstrates that PM scholars can do more insightful studies by employing CR and mixed-method methodology.

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