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Digging in the megaproject's graveyard: Why do megaprojects die, and how to check their health?

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ABSTRACT

The pressure to complete Infrastructure Megaprojects (IMs) is enormous; once started, IMs are commonly considered too costly to be stopped. Still, despite this widespread belief, several IMs are terminated during delivery/construction. Notwithstanding its empirical and theoretical relevance, few studies investigate IMs termination during delivery/construction. This paper aims to develop further the "reverse escalation of commitment" theory which sense-makes the termination of IMs. We take a critical confrontation of the existing literature addressing two questions: (1) Why are IMs terminated during delivery/construction? and (2) How does the project termination process occur in IMs? By analysing 30 unfinished IMs, we identified the six determinants for IMs termination, contributing to the development of reverse-escalation of commitment theory by providing a processual perspective of the four most common patterns leading to IMs termination. Finally, we provide a checklist for identifying key elements leading to IMs termination.

1. Introduction

Infrastructure Megaprojects (IMs) are large-scale and complex capital investments from the public and private sectors, usually costing USD 1 billion or more (Denicol, Davies, & Krystallis, 2020). IMs are usually considered risky ventures with high political exposure and sensitiveness (Flyvbjerg, 2014; Van Marrewijk, Clegg, Pitsis, & Veenswijk, 2008), transformational and controversial (Flyvbjerg & Turner, 2018; Locatelli, Invernizzi, & Brookes, 2014; Van Marrewijk, Ybema, Smits, Clegg, & Pitsis, 2016). IMs often struggle to meet their initial performance targets (Denicol et al., 2020; Gil & Fu, 2021) and frequently need to acquire legitimacy and support from their broader institutional context to become viable and locally embedded as they shape the economics, society, and the environment (Aaltonen, 2013; Li, Lu, Cui, & Han, 2019; Williams, Vo, Samset, & Edkins, 2019). Merrow (2011) analysed 318 IMs, arguing that IMs are very good or bad, calling this the "Jemima principle". He shows that 35% of the IMs were excellent, while 65% did not perform as expected. We focus on the projects that have not performed as expected and, more specifically, on the limited number of IMs terminated during the delivery stage. Research exploring the termination of IMs during the construction stage is limited and discussed in Section 2.1.

There is a rich body of literature that investigates IMs' underperforming nature and fragility (Denicol et al., 2020; Merrow, 2011; Zarei, Sharifi, & Chaghouee, 2018), which includes varying and detailed explanatory narratives ranging from corruption (Harvey & Knox, 2015; Locatelli, Mariani, Sainati, & Greco, 2017), scope changes and reworks (Love & Ika, 2021; Love, Ika, Ahiaga-Dagbui, Locatelli, & Sing, 2019), optimism bias and strategic misrepresentation (Flyvbjerg, 2006; McCray, Purvis, & McCray, 2002), interaction with complex and fragmented institutional environments, varied interests, norms, rules, and practices (Van den Ende & Van Marrewijk, 2019) or inadequate planning (Lerche et al., 2022), to mention a few. Nevertheless, the literature is biased towards projects that have been completed or delivered (Söderlund, 2004) and scarcely discusses the termination of IMs, particularly during the delivery stage.

Literature discussing project termination is rich but focused on the natural closeout process of projects (Spirer, 1984; Meredith & Mantel, 2009; Pinto, 2022a). Project termination occurs in two ways: (i) when all project closeout activities have been completed, and (ii) when the project is terminated outright and prematurely (Pinto, 2022a; Spirer, 1984), the latter one being the central topic of this paper. In this paper, we refer to project termination as the *"withdrawal of resources from projects without the original objectives/purpose having been fully met"*

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(Tadisina, 1986, p. 97).

Paradoxically, in management in general, and project studies in particular, there is the "Escalation of Commitment" (EoC) theory sense-making of the tendency of decision-makers to keep investing resources in a project, despite evidence suggesting that they should not (Cantarelli & Flyvbjerg, 2013; Drummond, 2014; Ross & Staw, 1987; Sleesman, Lennard, McNamara, & Conlon, 2018; Winch, 2013). The sense-making of IMs termination has been investigated only by (Juarez Cornelio, Sainati, & Locatelli, 2021), which introduced the reverse-EoC theory, a development of the EoC theory (Locatelli et al., 2023; Pinto, 2022b). Therefore, considering the theoretical and empirical relevance of IMs termination, this paper aims to develop further the reverse-EoC theory addressing two research questions:

RQ1. Why are IMs terminated during delivery/construction?

RQ2. How does the project termination process occur in IMs?

Pinto (2022b) mentions that expanding and modifying existing theories is relevant to generating additional knowledge, which stimulates exploratory thinking and theorising for the development of project studies (Geraldi, Söderlund, & Van Marrewijk, 2020; Svejvig, 2021). To further develop reverse-EoC theory and address the research questions, we investigated 30 IMs terminated during the delivery/construction stage.

Following this introduction, the rest of the paper is structured as follows. Section 2 presents the literature review concerning project termination in the delivery/construction stage and the theoretical perspective based on the reverse-EoC. Section 3 describes the research method based on a multiple-case study approach. In Section 4, we present our findings, followed by Section 5, in which we discuss the main contributions of the research and include further areas of study.

2. Background

2.1. The termination of projects during the delivery

Project termination during the delivery stage has been studied for Research and Development (R&D) projects (Balachandra, Brockhoff, & Pearson, 1996; Dean, 1968; Meredith & Mantel, 2009), Information Technology (IT) projects (Keil et al.; 2000; Keil & Mähring, 2010; Benschop, Nuijten, Keil, Wilmink, & Commandeur, 2023) and NPD (Cooper, 1994; Griffin, 1997; Schmidt & Calantone, 1998; Biyalogorsky, Boulding, & Staelin, 2006; Steffens, Martinsuo, & Artto, 2007; Cooper, 2008; Eliëns, Eling, Gelper, & Langerak, 2018), but scarcely in construction projects (Pinto, 2022a). Some relevant examples of project termination from the NPD sector include the case of the Amazon Fire phone, which had to be cancelled outright. Amazon wrote off USD 170 million in losses (Pinto, 2022a), or the collapse of the Taurus project, a £500 million IT venture considered one of the major fiascos of business history (Drummond, 1999).

Despite the rich literature regarding project termination, the empirical context of construction projects in general, and IMs in particular, still needs to be discussed. IMs termination before commissioning is one of the toughest managerial challenges, as it concerns situations where either internal or external forces cause the project to become either irrelevant, unsuitable, unprofitable, or even harmful (Staw & Ross, 1987; Schmidt, Montoya-Weiss, & Massey, 2001; Calantone, Garcia, & Dröge, 2003; Steffens et al., 2007; Sambasivan & Soon, 2007; Unger, Kock, Gemünden, & Jonas, 2012; Martinsuo, 2013; Pinto, 2022a). The decision to terminate an IM should consider if the projects no longer meet strategic fit criteria, an analysis of whether costs exceed business benefits, a sensible consideration on whether deadlines are continuously missed, or when the technology evolves beyond the scope of the IMs. An example of an IM in which technology failed is the Amsterdam Metro North-South line construction, which was stopped for several months due to technical mishaps, significant cost overruns, and time delays. Leakages in the concrete dam walls spilt into the excavation site, causing the submergence of roads, railways, and buildings. The ground-freezing technique failed, and citizens in the surrounding areas had to be evacuated. Because of this, the construction of the North-South line was temporarily shut down while political discussions were held on whether to continue or permanently terminate the project. The ultimate decision was that, despite the major delays and significant cost increase, project termination was no longer an option, as they were too deep in the project (Van den Ende & Van Marrewijk, 2019).

The literature argues that existing infrastructure can be categorised as unbuilt or unfinished due to varying reasons, such as planned, blocked, delayed, or (long-term), typically because the organisation runs out of resources and projects lie suspended until further resources are approved or the project is permanently terminated or abandoned (Howe et al., 2015; Baumgardt, 2017; Gupta, 2018; Carse & Kneas, 2019; Davies, MacAulay, & Brady, 2019). An example of unfinished infrastructure includes the New Jersey Hudson River Tunnel Project, which was cancelled after one year of construction due to increased cost escalation and over 500 million USD invested (Pinto, 2022a).

The decision to terminate IMs is not easy, as the decision-making process involves behavioural uncertainty where decision-makers' risk-taking, collaboration, and preferences come into play (Steffens et al., 2007). The later the project is terminated, the more complex the decision is due to "sunk costs'' and commitments made (Schmidt et al., 2001; Calantone et al., 2003). The escalating behaviour has been vastly explored in project studies under the escalation of commitment theory (EoC), as per Section 2.2. However, project termination has been scarcely discussed in the context of IMs and is not explained under any theory in project studies apart from reverse-EoC. For this, we use reverse-EoC as our theoretical lens to explain how despite significant investments made, IMs are still terminated, which we explain in Section 2.2.

2.2. Theoretical framing: escalation of commitment (EoC) and reverse-EoC in projects

EoC, also known as the "commitment bias" or "sunk cost fallacy", has been explored under different narratives and perspectives as it applies to individuals, groups, and whole organisations (Staw, 1976; Staw, 1981; Arkes & Blumer, 1985; Ross & Staw, 1986; Brockner, 1992; Keil & Mähring, 2010; Sleesman, Conlon, McNamara, & Miles, 2012; Sleesman et al., 2018; Cantarelli, Flyvbjerg, van Wee, & Molin, 2010b; Winch, 2013; Drummond, 2014; 2017). According to Brockner (1992), two main conditions define EoC: (i) the tendency for decision-makers to persist with the project and (2) a failing course of action. EoC explains why decision-makers tend to continue investing in a particular endeavour (projects or products), based on the cumulative prior investment, despite counting evidence suggesting that the expected benefits will not offset the investment of additional resources. It shows how once the decision on an investment is made, particularly in terms of time and money, individuals, groups, and organisations opt to continue with the initial decision with the potential hope for project success rather than the sure opposed loss of the investment once they decide to quit (Keil & Mähring, 2010; Winch, 2013; Cantarelli & Flyvbjerg, 2013; Drummond, 2014; Harvey & Knox, 2015; Love et al., 2018). The solutions selected are inefficient and lead to EoC and lock-in situations (Sydow, Schreyögg, & Koch, 2009; Cantarelli & Flyvbjerg, 2013), and it is considered one of the top behavioural biases in project management (Flyvbjerg, 2021).

IMs scholars argue that the preparation process they go through upfront, known as the front-end process, is problematic (Merrow, 2011; Barshop, 2016; Babaei, Locatelli, & Sainati, 2021). Cooper (2008) mentions that projects are often plagued by missing steps and activities, poor organisational design and leadership, inadequate quality of execution, unreliable data, and missed timelines, and gate reviews are critical for decision-making (Eitan, Itay Fischhendler, & Van Marrewijk,

2023). IMs are subject to meticulous due diligence and experience a thorough gate review process. Each point in the development process allows decision-makers to stop, recycle, resubmit, abandon, or proceed before the executives authorise the final investment decision to deliver the project (Merrow, 2011; Barshop, 2016).

Decision-makers expect to maximise value from every project funded and direct capital to the most attractive and relevant investment opportunities to reduce the risk of monetary loss or reputational damage (Barshop, 2016). The gate reviews are the "*project review points where continuation or termination decisions are made, and critical resource commitments are made*" (Schmidt & Calantone, 2002; p. 104) to determine whether to continue investing in the project or terminate it before commercialisation. This stage lets decision-makers know whether the project is ready to be executed (Biyalogorsky et al., 2006; Steffens et al., 2007; Cooper, 2008; Eliëns et al., 2018). Merrow (2011) mentions that the gates serve not an engineering purpose but a business one, to identify whether the project is profitable and has the potential of success.

While EoC explains why IMs are driven to completion by assessing determinants (Staw & Fox, 1977; Ross & Staw, 1987; 1993; Drummond, 2017), it does not explain why IMs get terminated, which the reverse-EoC does (Juarez Cornelio et al., 2021). Reverse-EoC in literature is defined as *"the tendency for decision-makers to abandon a meritorious course of action"* (Juarez Cornelio et al., 2021; p. 784). So, while EoC focuses on assessing the escalation process for failed projects with negative feedback, reverse-EoC, on the contrary, does not judge whether the project is succeeding or failing. However, instead, it explains the dynamic process of termination and the determinants that lead to it.

3. Methodology

3.1. Research design

This paper is based on a multiple case study. Investigating case studies is relevant due to their possibilities in elaborating on a real-world context in which a particular phenomenon occurs (Eisenhardt, 1989; Eisenhardt & Graebner, 2007). Yin (2014) argues that the use of case studies relies on the logic that each case must be carefully selected to either predict similar results or contrasting results and that it is possible to examine how a particular phenomenon performs in different environments when conducting a comparative analysis between the cases explored. For this research, the selection of the individual cases is critical (George & Bennett, 2005), as the cases studied must share common characteristics and should be categorically bounded in a "quintain", which is the phenomenon to be studied (Stake, 2006).

We collected information from 30 IMs cases within different complex contexts. We studied IMs from 7 different sectors: Nuclear Power (18); Oil and Gas (6); Transportation (2); Cities and Smart Cities (1); Industrial (1); Hydroelectric Power (1); and Cross-Border Infrastructure (1). The complete list of cases is included in Appendix 2. In our sampling, we exclude IMs suspended and resumed. This is, for instance, the construction of the Narita Airport in Japan, which was suspended for almost 20 years (Gupta, 2018). Second, we excluded IMs terminated before construction started, i.e., during the stage gate process.

Although we did study a variety of sectors, our sample includes 18 nuclear power projects. Including nuclear power plants is relevant for our study as it provides rich content for analysing the termination of IMs. To mitigate the possible disbalance, we individually studied each case, elaborated a summary and description of the complex context in which they have been developed, and identified the reasons for termination and the process that every IM went through until the eventual termination. This allowed us to collect a similar level of information for every case, identify how each case is different from the others and validate that not every nuclear plant was terminated for the same reason, which provided an adequate variation in our analysis that is worth exploring.

3.2. Data collection

Data collection is based on publicly available secondary data, as it adds the plausibility or generalizability of qualitative findings (Heaton, 2004; Andrews, Higgins, Waring Andrews, & Lalor, 2012; Dufour & Richard, 2019).

As per Appendix 1, the type of documentation used for data collection considers:

- Online resources, including local and international newspapers from the countries of each IM studied, political and infrastructure magazines, and blog sites (66 entries).
- Websites, including publicly available information from official Government websites, local and international organisations, political parties, and multilateral entities (82 entries).
- Industry reports and academic publications, including press releases, official communications issued by Governments (for publicly funded projects) or the Project Organisation (for privately funded projects), and any public communication made by external stakeholders in every project (17 entries).

The total coverage of information corresponds to projects terminated between 1960–2022. Data triangulation was applied for all findings in the cases studied, particularly concerning the identification of the determinants for termination and their dynamic evolution over time (Langley, 1999). In addition, the authors defined a set of acceptance or rejection criteria for the data collected to ensure the consistency of analysis and mitigation of the potential issues that the use of secondary data has (Yardley, Watts, Pearson, & Richardson, 2014; Rubin & Babbie, 2008), which is included in Appendix 3.

3.3. Data analysis

Our data analysis was conducted in two stages: (i) a thematic analysis and (ii) the application of the reverse-EoC model.

To address RQ1, we conducted an inductive thematic analysis (Braun & Clarke, 2006) to identify the main determinants for termination for the 30 IMs studied. Our coding generated a three-level classification. The level three determinants are the most general descriptions of the reasons that lead to the termination of each project. These are expressed as words or generic statements of causes. In this initial coding, we found 23 sub-categories. The level two determinants were derived from the general statements of level 3 to create a concise categorisation. The secondary coding resulted in 13 sub-categories. Finally, level one is the broader category of the determinant. We grouped each of the sub-categories into six main determinants, namely (1) Socio-Political, (2) Environmental, (3) Financial distress, (4) Regulatory, (5) Force majeure, and (6) Technological. An overview of the thematic analysis is included in Appendix 4.

To explain how project termination occurs (RQ2), which is not discussed in project studies under the existing theories, we use the reverse-EoC theory by adopting abductive reasoning (Sætre & Van de Ven, 2021). According to Hansen (2008), abduction is a process we engage in when the existing mental models do not explain the observed experiences. Abductive research has three primary purposes in theory building: (i) Moving from the unexplained anomalies toward plausible explanations, (ii) Generative process of creating and evaluating explanations that would render the anomaly understandable, and (iii) Plausibility as a criterion (Sætre & Van de Ven, 2021). Similar approaches have been used in project studies, for instance, the three dimensions of a governance framework for major public projects (Brunet & Aubry, 2016).

As reverse-EoC derives from the EoC theory, we use the reverse-EoC model based on Staw and Ross's (1987) original temporal escalation model. For this, we selected 4 cases out of our sample to apply the model, namely (i) The Virgil C. Summer Nuclear Generating Station

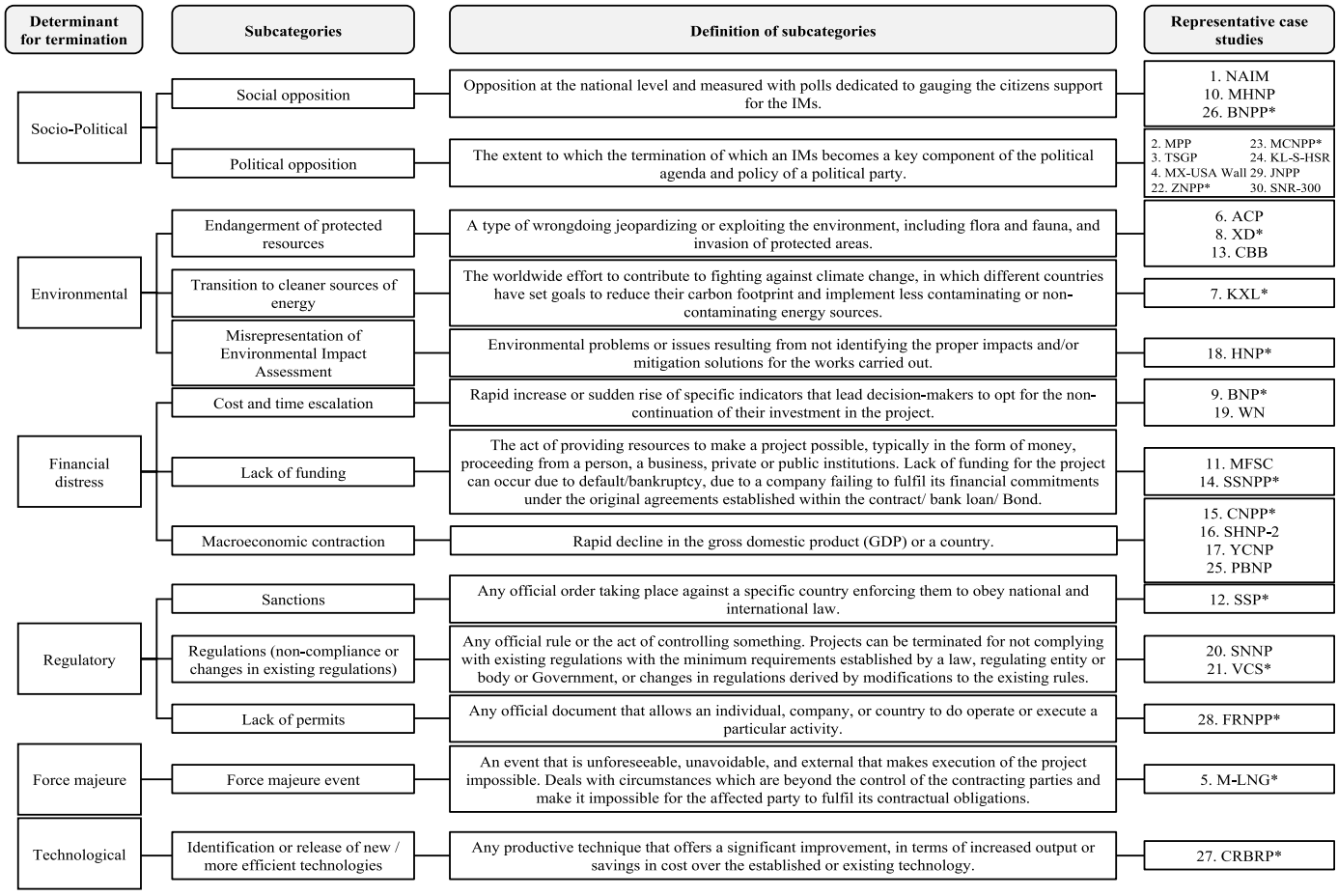

Fig. 1. Determinants and subcategories of project termination.

(Units 2 and 3), (ii) Keystone XL Pipeline, (iii) Xiaonanhai Dam, and (iv) the Mozambique LNG-project. We selected each case from different sectors by applying abductive reasoning, as it relies on specific cases to identify more general rules that can explain other observed situations (Kovacs & Spens, 2005; Floricel, Ben Abdallah, Hudon, Petit, & Brunet, 2023). We often have different dynamics in the termination process; we look at each case's different events, decisions, situations, or problems (Eisenhardt & Graebner, 2007). The model proposes that reverse-EoC evolves along four phases, namely:

(i) "Project initiation" refers to the beginning of a given course of action and the promise of future outcomes.
(ii) "Receipt of poor results" refers to the initial presence of actions that gradually affect performance.
(iii) "Receipt of worsening results" refers to the repeated presence of actions that lead to negative outcomes.
(iv) "Project termination" refers to cancelling the course of action, typically with substantial negative results.

We identified four termination patterns by applying the model and provided an explanatory setting for relevant cases from our sample, detailed in the following section. We adopted a longitudinal perspective to compare the patterns of termination for each of the cases. This allowed us to capture the dynamics, similarities and differences in the trajectories and the sequence of events until the point of termination and assign each project to the corresponding patterns (Floricel et al., 2023).

4. Findings

4.1. Why are IMs terminated?

By studying 30 IMs that have been terminated, we identified six determinants: (1) Socio-Political, (2) Environmental, (3) Financial distress, (4) Regulatory, (5) Force majeure, and (6) Technological, as well as the subcategories for each determinant. Fig. 1 includes a summary of the determinants and forms of termination in which they are present and their definitions. The table includes the respective IMs associated with the determinant, which permitted us to construct the table. The most significant case study for each category is marked with an *.

Termination almost always occurs due to the combination of determinants, and it can be explained as a process that occurs gradually in different stages and with different patterns. Out of the 30 cases studied, we found that the most common reasons for termination are (i) Socio-Political, (ii) Financial distress, and (iii) Environmental. For instance, in our sample, 17 out of 30 IMs presented the Socio-political determinant as the most prevalent reason for termination, and 11 out of 30 included the financial determinant as the second most prevalent.

The determinants for termination allowed us to classify the different problems that become present in the IM and gradually evolve until it became impossible to ignore due to their magnitude in the project's development, gradually leading to termination.

4.2. The termination process of "unhealthy" IMs

IMs are entities that can be very "healthy" or, on the contrary, "unhealthy". To explain the termination process for "unhealthy" IMs, we use

Table 1
Stages of reverse-escalation to project termination.

Case	Phase 1: project initiation	Phase 2: receipt of poor results	Phase 3: receipt of worsening results	Phase 4: project termination
Virgil C. Summer Nuclear Generating Station (Units 2 and 3)	March 2008, South Carolina Electric and Gas applied for a Combined Construction and Operating License to the Nuclear Regulatory Commission (NRC). March 2012, NRC approves the construction license.	Construction of Unit 2 begins in March 2013. Unit 2: first reactor built in the United States in 30 years. Technological and technical novelties not used before. Additional cost and time overruns announced. Fabrication and delivery delays of structural modules for the reactors increase costs by over USD 1.2 billion.	Company files for Chapter 11 Bankruptcy. Suggestions to complete only Unit 2 and abandon Unit 3 were made with no success. Extensive reviews of construction costs lead to a petition for approval of abandonment.	July 2017, Units 2 and 3 are officially cancelled.
Keystone XL Pipeline	The National Energy Board approved TransCanada`s (TC) application for KXL. Authorization under the U.S. Corps of Engineers nationwide permit was given to TC. April 2010, U.S. Department released a draft environmental impact, highlighting the limited effects on the environment.	Significant adverse effects on cultural resources. Volume and cost overruns are expected not to contribute to upstream and downstream oil distribution. Environmental and economic concerns. President Obamaś administration rejects the project.	President Trumpś administration granted the presidential permit, which Bidenś administration further reversed. Further requests for supplemental EIA. Violation of endangered species act.	June 2021, the Keystone XL project is officially cancelled.
Xianonanhai Dam	Construction of the Xiaonanhai Dam has been discussed for several years. January 2009, Chongqing Municipal Government seeks support from the central government. March 2012, construction of the project officially stats.	Politically motivated project to foster rapid industrialisation of Chonqing. Strong social opposition against the project. High environmental impact, endangering over 70 species of endemic fish. Chonqing Municipal Government requests a readjustment of the natural protected areas of the Yangtze River Natural Reserve to proceed with the project. Unremarkable economic returns (cost per MW triple compared to other similar projects).	Environmental and ecological experts are not included in Natural Reserve Review Committees voting to adjust the project. The Ministry of Environmental Protection instructs that no water-related projects can be built under reserved areas.	March 2016, Xianonahai Dam is officially cancelled.
Mozambique LNG project	June 2014, the Mozambican Ministry of Coordination of Environmental Affairs approves the Environmental Impact Assessment. The final investment decision of USD 20 billion was made in June 2019.	The project is the largest private investment in Africa. Construction of the project begins in August 2019. April 2020, non-critical activities at the project site were paused due to COVID-19. TOTAL reduces workforce due to fights linked to Islamic State raids in nearby towns.	March 2021, militants attacked Palma, 6 km from Afungi (Project site). An estimated dozen of people were killed. April 2, 2021, TOTAL withdraws all the staff from the Afungi site.	April 26, 2021, TOTAL declares Force Majeure on the Mozambique LNG project, indefinitely cancelling construction activities.

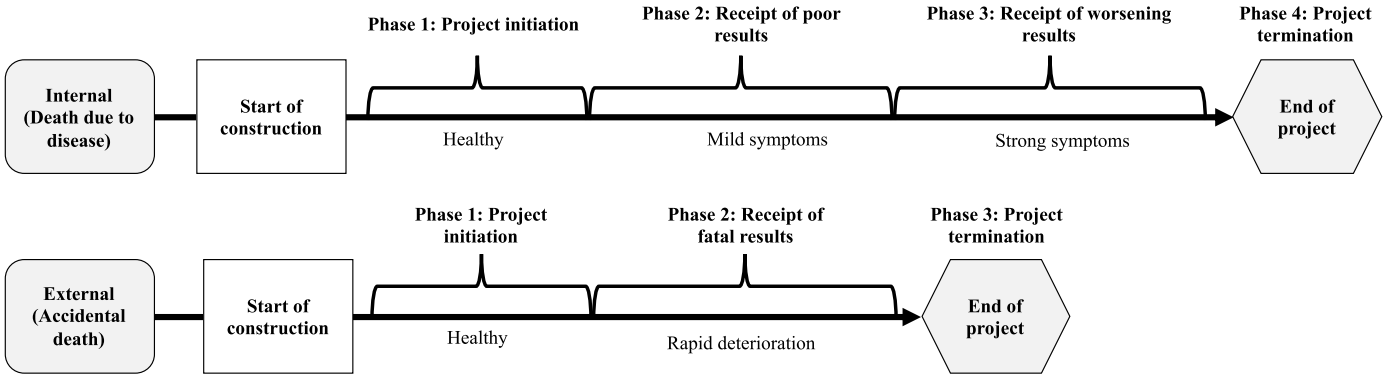

Fig. 2. Project Health Model.

reverse-EoC as our theoretical lens. Table 1 shows the stages of reverse-escalation to termination for four cases. We consider the determinants for termination (described in Section 4.1) to be the symptoms of the disease, which, if not treated or identified and managed timely, leads to IM termination.

4.2.1. *The "Project Health Model"*

As a further stage of our analysis to provide an overview of the termination process, we developed a "Project Health Model," as per Fig. 2. We use the concept of "healthy" and "unhealthy" as an analogy to explain that IMs can be healthy and become unhealthy, regardless of how "good" or how "bad" they are. We argue that IMs become

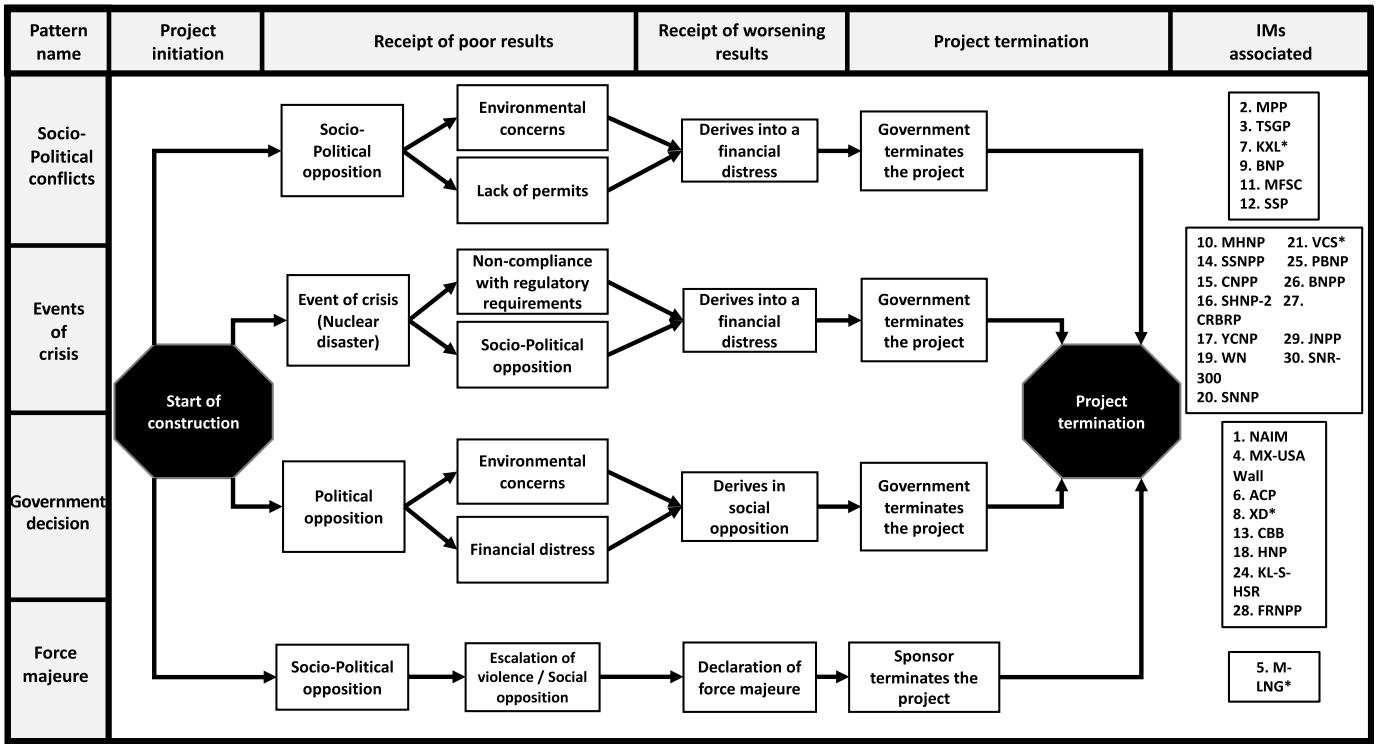

Fig. 3. Patterns in the termination of IMs.

Table 2
The reverse-EoC theory.

Theory	EoC	Reverse-EoC
Definition of theory	"*The continued commitment to a previously chosen course of action in spite of negative feedback concerning the viability of that course of action*" (Keil et al., 2000: 634)	The inclination of decision-makers for the termination or cancellation of a project during the delivery stage.
To explain	Why organisations and individuals (mostly decision-makers) continue to invest additional resources in a (mega)project despite continuous negative feedback.	Why organisations and individuals (mostly decision-makers) terminate projects during the delivery stage.
What (variables, concepts, etc.)	Determinants of escalation, namely: (1) Project; (2) Psychological, (3) Social, (4) Organisational, and (5) Contextual.	Determinants for termination, namely: (1) Socio-Political, (2) Environmental, (3) Financial distress, (4) Regulatory, (5) Force majeure, and (6) Technological.
How (relationships between variables)	Interplay of sets of forces over time described in a four-stage temporal model of escalation, namely: (1) Promise of future outcomes, (2) Receipt of questionable outcomes, (3) Receipt of negative outcomes, and (4) Receipt of highly negative outcomes.	Interplay of sets of forces over time, described through the stages of the stages of reverse-escalation to project termination, through the Project Health Model (Internal to the project, and external to the project). Internal to the project: (1) Project initiation, (2) Receipt of poor results, (3) Receipt of worsening results, and (4) Project termination. External to the project: (1) Project initiation, (2) Receipt of fatal results, and (3) Project termination.
Why (reasons behind the relationships)	The reasons that lead to escalation consider subcategories, such as: Ambiguity of economic data, Sequencing of projects costs and benefits, Categorisation as a long-term investment, Salvage Value, Closing costs, Optimism and illusion of control, Self-justification, Sunk-costs effects, External Justification, Social binding, Technical side-bets, Political support, Institutionalisation, and External Government support.	The reasons that lead to termination consider subcategories such as: Social opposition, Political opposition, Endangerment of protected resources, Transition to cleaner sources of energy, Misrepresentation of Environmental Impact Assessment, Cost and time escalation, Lack of funding, Macroeconomic contraction, Sanctions, Regulations (non-compliance or changes in existing regulations), Lack of permits, Force majeure event, and Identification or release of new/more efficient technologies.

"unhealthy" like good and bad people get sick. Being healthy or unhealthy does not imply any moral judgement as being "good or bad." Good projects can start in good shape, and as problems or issues arise during the construction process, they become unhealthy until there is no further remedy, leading to the termination of IMs. We argue that when IMs have continuous problems during their execution, they fall into a crisis or "critical condition" (Homer-Dixon et al., 2015; Unterhitzenberger, Naderpajouh, Hällgren, & Huemann, 2021; Clegg, Loosemore, Walker, Van Marrewijk, & Sankaran, 2023) from which the IM is hardly able to get back on track, and the decision of termination is the final thrust. The termination of IMs is a dynamic process that exacerbates due to issues or determinants that appear over time. The model includes two scenarios of termination, namely (i) internal and (ii) external, which are explained below.

The internal model (death due to disease) considers the four stages of reverse-escalation. IMs are generally healthy when the delivery stage begins (Phase 1: Project initiation) once the investment decision is made. In the following stage, initial problems or mild symptoms appear (Phase 2: Receipt of poor results). We consider these to be issues that are not a significant threat, whose impact can be minimised by decision-

Table 3
Overview of sectors, countries, and IMs studied.

No.	Project	Country	Year	Project cost USD (Billions)	Sector	Determinants for termination
1	Mexico City New International Airport (NAIM)	Mexico	2014–2018	13	Transportation - Aviation	Socio-Political, Financial distress, Environmental
2	Multi-product pipeline (MPP)	Malaysia	2016–2019	1.35	Oil and Gas	Socio-Political, Financial distress, Force majeure
3	Trans-Sabah Gas Pipeline (TSGP)	Malaysia	2016–2019	1.05	Oil and Gas	Socio-Political, Financial distress, Force majeure
4	Mexico - USA Border Wall	USA - Mexico	2017–2021	21.6	Cross-border infrastructure	Socio-Political, Financial distress, Regulatory
5	Mozambique LNG Project (M-LNG)	Mozambique	2019–2024	20	Oil and Gas	Force Majeure, Socio-Political, Financial distress
6	Atlantic Coast Pipeline (ACP)	USA	2018–2020	5.1	Oil and Gas	Environmental, Financial distress, Socio-Political
7	Keystone XL Pipeline (KXL)	USA	2020–2021	5.2	Oil and Gas	Socio-Political, Environmental, Technological
8	Xiaonanhai Dam (XD)	China	2012–2015	4	Hydroelectric power	Socio-Political, Environmental, Financial distress
9	Bellefonte Nuclear Plant (BNP)	USA	1975	6	Nuclear Power	Socio-Political, Technological, Financial distress
10	Marble Hill Nuclear Power Plant (MHNP)	USA	1977–1984	2.5	Nuclear Power	Socio-Political, Financial distress, Regulatory
11	Modderfontein Smart City (MFSC)	South Africa	2015	8	Cities / Smart City	Socio-Political, Financial distress, Regulatory
12	South Stream Pipeline (SSP)	Russia/ Bulgaria /Serbia/ Hungary /Slovenia/Austria/ Italy	2012–2014	10	Oil and Gas	Socio-Political, Regulatory, Financial distress
13	Mexicali Brewery - Constellation Brands (CBB)	Mexico	2016–2020	1.4	Industrial / Food and Beverage	Socio-Political, Environmental, Financial distress
14	Seabrook Station Nuclear Power Plant - Unit 2 (SSNPP)	USA	1976–1984	0.8	Nuclear Power	Financial distress, Regulatory, Socio-Political
15	Cherokee Nuclear Power Plant (CNPP)	USA	1970–1980	1.39	Nuclear Power	Financial distress, Regulatory, Socio-Political
16	Shearon Harris Nuclear Power Plant - Units 2 (SHNP-2)	USA	1978–1983	3.9	Nuclear Power	Financial distress, Regulatory, Socio-Political
17	Yellow Creek Nuclear Plant (YCNP)	USA	1978–1984	1.5	Nuclear Power	Financial distress, Socio-Political, Regulatory
18	Hartsville Nuclear Plant (HNP)	USA	1975–1984	0.72	Nuclear Power	Financial distress, Environmental, Socio-Political
19	Washington Nuclear 4 and 5 (WN)	USA	1982	2.2	Nuclear Power	Financial distress, Regulatory, Socio-Political
20	Shoreham Nuclear Power Plant (SNPP)*	USA	1973–1988	6	Nuclear Power	Regulatory, Financial distress, Socio-Political
21	Virgil C. Summer Nuclear Generating Station - Units 2 and 3 (VCS)	USA	2013–2017	9	Nuclear Power	Regulatory, Financial distress, Socio-Political
22	Zwentendorf Nuclear Power Plant (ZNPP)	Austria	1972–1976	1.4	Nuclear Power	Socio-Political, Regulatory, Force majeure
23	Montalto di Castro Nuclear Power Station (MCNPP)	Italy	1982–1988	3.5	Nuclear Power	Socio-Political, Regulatory, Force majeure
24	Kuala Lumpur - Singapore HSR Project (KL-S-HSR)	Malaysia - Singapore	2018–2020	15	Transportation - Rail infrastructure	Financial distress, Socio-Political, Environmental
25	Phipps Bend Nuclear Power Plant (PBNP)	USA	1977–1981	1.6	Nuclear Power	Financial distress, Regulatory, Socio-Political
26	Bailly Nuclear Power Plant (BNPP)	USA	1974–1981	1.8	Nuclear Power	Socio-Political, Environmental, Regulatory
27	Clinch River Breeder Reactor Project (CRBRP)	USA	1980–1983	8	Nuclear Power	Socio-Political, Financial distress, Regulatory
28	Forked River Nuclear Power Plant (FRNPP)	USA	1969–1980	0.488	Nuclear Power	Environmental, Financial distress, Socio-Political
29	Juragua Nuclear Power Plant (JNPP)	Cuba	1983–1992	1.1	Nuclear Power	Socio-Political, Financial distress, Regulatory
30	SNR-300 Fast Breeder Nuclear Reactor (SN-300)	Germany	1972–1985	5.3	Nuclear Power	Socio-Political, Financial distress, Regulatory

makers by acting timely. In stage 3, we argue that the problems evolve and are manifested through strong symptoms (Phase 3: Receipt of worsening results) during the execution of the project. We consider these to be issues that require immediate attention. The model's final stage refers to the project's end (Phase 4: Project termination). We argue that this stage is when the symptoms are so evident that they can no longer be ignored, and the project dies.

The external model (accidental death) considers three stages. The delivery of the IMs initiates at a healthy stage (Phase 1: Project initiation) once the investment decision is made. In the following stage, an accident or uncontrollable event external to the project occurs (Phase 2: Receipt of fatal results), leading to the project's rapid deterioration. The model's final stage refers to the project's end (Phase 3: Project termination). We argue that this stage is when it is impossible to recover from uncontrollable events, and the project dies. Examples of this include changes in government due to electoral cycles that rapidly change the

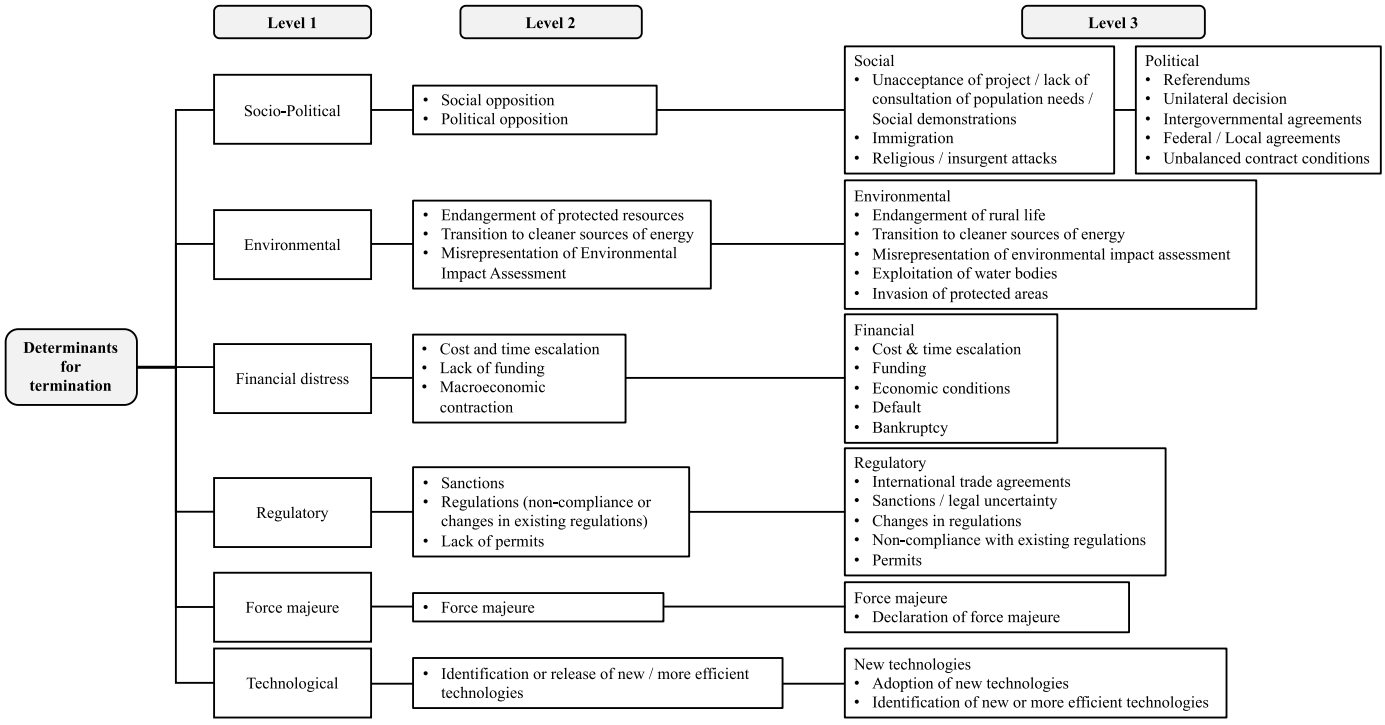

Fig. 4. Overview of the thematic analysis.

attitude towards the project (Juarez Cornelio et al., 2021; Locatelli et al., 2023) or nuclear disasters such as the Chernobyl disaster in 1986, which led to the 1987 Italian referendum against nuclear energy in Italy.

Furthermore, the "Project Health Model" allows us to identify four patterns for the termination of IMs, which provides an exploratory setting of the cases studied in Section 4.3. Furthermore, as a final stage of our analysis, we elaborated an "IMs health assessment", which can support decision-makers in assessing how "unhealthy" an IM is. For this, we elaborated a checklist of IMs problems to assess a project's health, which is included in Appendix 5.

4.3. How does the termination process occur in IMs?

Based on the cases studied, Fig. 3 shows the four main patterns for the termination of IMs identified. Our results show that project termination is a process that occurs in different stages, and the reasons for termination evolve over the project's lifecycle.

The identified patterns highlight the relevance of the Socio-Political opposition and financial distress towards the termination decision. Consistently, in three out of the four identified patterns, the Government plays a substantial role in the "kill decision". This is not surprising due to their significant role in the development of IMs. However, the findings suggest that a private stakeholder only makes the final termination decision in the last pattern.

5. Discussion and conclusion

This research deals with the questions, "(1) Why are IMs terminated during delivery/construction? and (2) How does the project termination process occur in IMs?". To answer these questions, we investigated 30 IMs, identifying three relevant insights for project studies, which are the basis for the contribution of knowledge of this investigation: (1) Literature on IMs failure literature, (2) Reverse-EoC as a theoretical perspective, and (3) Implications for practice.

5.1. Contributions to IMs failure literature

The first element of the contribution of this research relies on the identification of six determinants leading to the termination of IMs, namely (1) Socio-Political, (2) Environmental, (3) Financial distress, (4) Regulatory, (5) Force majeure, and (6) Technological.

The literature concerning the under-performance of IMs is vast and well-established (Locatelli et al., 2017; Denicol et al., 2020; Love & Ika, 2021; Flyvbjerg, 2021) and often discusses project failure in terms of optimism bias and strategic misrepresentation (Flyvbjerg, 2008) severe overbudget and extensive delays (Flyvbjerg, 2014), poor quality infrastructure (Drummond, 2017), lack of satisfaction of stakeholders (Zhai, Xin, & Cheng, 2009; Cuppen, Bosch-Rekveldt, Pikaar, & Mehos, 2016) or unsustainable outcomes (Sankaran, Müller, & Drouin, 2020), but mainly in IMs that have been completed. However, limited studies focus on the termination of IMs during delivery. Our research contributes mainly to the projects that fail to be completed due to the determinants for termination.

Megaproject failure literature explores the impacts and interplay of determinants in escalating behaviours, namely project, psychological, social, organisational, and contextual (Staw & Ross, 1987). Further research proposes forces for persistence (overconfidence, sunk costs, perceived need for self-justification, denial, social costs of admitting failure, completion effects, and exit barriers/organisational entrenchment) versus forces for abandonment (aversion to loss, opportunity costs, perceived risk of persistence, intolerance of failure, publicly stated limits, reluctance to renew budgets, shifting tides of organisation) (Drummond, 2014). However, project studies literature does not explain the termination of IMs during the delivery stage, which our research does.

In our sample of IMs, we found that the termination of IMs rarely occurs exclusively for one reason. There are prevalent determinants, but they always overlap with secondary ones, and their combination motivates the actual termination of IMs. Some of the reasons that lead to the termination of IMs are widely discussed in the other types of failure of IMs, for instance, the lack of Government or public support (Anand, Gupta, & Appel, 2018; Juarez Cornelio et al., 2021), herein described as

Table 4
Checklist for IMs problems.

Determinant	Questions	✓ / ×
Socio-Political		
Social opposition	Do the local communities accept the project?	
	Are there any communication plans for engagement with the local communities?	
	Have the needs of the local communities been considered?	
	Are there any policies for communication with the local communities?	
	Is there a periodic stakeholder analysis? (Individual, by groups and interdependencies)	
	Is there a Social Impact Assessment?	
Political opposition	Is the project accepted within the political environment?	
	Are there periodic meetings to deal with political issues?	
	Does the project require intergovernmental agreements/integration of multiple jurisdictions?	
	Is the project timeline being constantly adjusted to political times?	
	Are there periodic meetings with Government agencies?	
	Is the project organisation prepared to deal with Government changes?	
Environmental		
Endangerment of protected resources	Is the trace/footprint of the project clearly defined?	
	Does the project involve crossing or trespassing protected areas?	
	Are local flora, fauna, or water bodies any identified endangerment?	
	Is there any plan to deal with the findings of cultural heritage / archaeological remains?	
Transition to cleaner sources of energy	Is the project a strategic fit for the current organisation / Government?	
	Does the project consider the use of fossil fuels/production of unsustainable energy sources?	
	Is the project aligned with the Sustainable Development Goals (SDG)?	
	Does the project involve multiple jurisdictions/governments with different approaches to sustainability?	
Misrepresentation of Environmental Impact Assessment	Is there an Environmental Impact Assessment (EIA)?	
	Is there a dedicated team to follow up with the EIA? Is this communicated?	
	Is there a clear understanding of the existing utilities that will be impacted or required?	
Financial distress		
Cost and time escalation	Is the cost of the project too optimistic?	
	Is the schedule of the project too optimistic?	
	Is the cost of the project like projects with comparative characteristics?	
	Are there significant events that can delay the completion of the project?	
	Are deadlines constantly missed?	
	Do project forecasts vary frequently?	
	Is there any functional change management process in place?	
	Is value engineering or peer review used for cost optimisations?	
Lack of funding	Does the project count with stable sources of funding?	
	Does the project count with funding from Multilateral Development Banks?	
	Does the project count with funding from commercial banks?	
	Does the project rely exclusively on Government funding?	
	Does the project budget consider contingency funds?	
Macroeconomic contraction	Are there any macroeconomic instabilities that can deteriorate the Project Organisations' credit quality? (Default/Bankruptcy)	
	Is growth in the project's area of influence highly dependent on one source?	
Regulatory		
Sanctions	Is the project dependent on companies from countries facing sanctions?	
	Does the materials/supply chain dependent on sanctioned countries/companies?	
Regulations (non-compliance or changes in existing regulations)	Is the project compliant with the existing regulations?	
	Are there any recent changes in regulations?	
	Are the new regulations implementable or feasible?	
Lack of permits	Does the construction of the project count with the required permits?	
	Is the land required for the project in order?	
	Do the land-of-use permits allow for the project to be developed?	
Force Majeure		
Force majeure	Are there any disruptions in major economic activities? (i.e., Pandemic)	
	Are there any wars or other hostilities that prevent the execution of the project? (civil unrest, riots, revolutions, insurgent attacks)	
	Are there any exceptional weather conditions?	
	Are there any natural disasters?	
Technological		
Identification or release of new / more efficient technologies	The latest technologies are being considered?	
	The technology(ies) used are the most efficient?	
	The current technology(ies) used is(are) flexible/adaptable for technological changes?	

Socio-Political determinants. National governments have always had a pivotal role in the termination of IMs. Regardless of the occurring determinants, central governments almost always execute the actual termination. This is performed via different instruments, including implementing the result of a referendum, emitting unilateral decisions for political motivations, withdrawing the necessary funds, or enforcing regulatory requirements via its administration (Harris & Wynne, 1989). Examples include the termination of the Montalto Di Castro Nuclear Power Plant and the Zwentendorf Nuclear Power Plant, which were terminated due to national referendums. These insights emphasise the relevance of IMs for national policy, as it is not possible to terminate IMs without involving Governments. There is an exception to the central role of Government: force majeure termination. According to this research, this is the only instance where private sponsors can withdraw their support and terminate the IMs. To an extent, these side effects are also justified. In this case, the private sponsor manages the termination process through their internal procedures rather than the instruments used by Governments.

Other reasons for termination, such as financial distress, are often associated with IMs failure (Morer, Ansel, Michelik, & Girandola, 2017).

However, environmental motivations, for instance, are reasons for the failure of IMs that have attracted far less attention from project studies. To an extent, environmental determinants are related to projects' environmental sustainability (Kivilä, Martinsuo, & Vuorinen, 2017; Wang & Wu, 2019). However, the angle considered in the academic literature differs from ours because it assumes that the infrastructure is completed rather than a motivation that leads to unfinished projects. Compliance with statutory and regulatory requirements is an area that is not directly linked with IMs success. Typically, project studies consider legal and regulatory requirements as a contextual factor (Ochieng, Freeman Price, Zuofa, Egbu, & Ruan, 2016; Schwierking & Anantatmula, 2015), and compliance has received limited attention from project scholars until recently, as a growing group of scholars are considering the unethical and illegal practices characterising the so-called "dark side of projects" (Locatelli, Konstantinou, Geraldi, & Sainati, 2022).

IM termination is usually associated with failure and profound reputational damage to the organisations and institutions involved. The Governments involved are likely to be affected, and a lack of confidence in public institutions spreads quickly amongst the population and investors. IMs termination is perceived as a waste of resources and opportunities, and it is quite challenging to convince the population otherwise, despite them opposing the project's development. The general view persists that resources invested in termination could have been employed in other alternative projects (Novy & Peters, 2012; Lundrigan, Gil, & Puranam, 2015; Van den Ende & Van Marrewijk, 2019; Denicol et al., 2020).

5.2. Contributions to reverse-EoC as a theoretical perspective

The second element of the contribution of this research relies on the theoretical contribution to explain the termination of IMs. Our research advances the development of reverse-EoC as a theory by providing an improved definition and the processual perspective of the dynamics of the termination process of IMs, in which we identified the four most common patterns that lead to the termination of IMs. By doing this, we explain how project termination occurs, from the beginning of the delivery stage, until the final decision of termination (Pinto, 2022a).

Theories are made up of three essential elements: (i) What, (ii) How, and (iii) Why. The first element refers to the variables or concepts. The second element refers to the relationship between variables. The third element refers to the reasons behind the relationships. These three elements describe and explain the phenomenon under study to provide a theory (Whetten, 1989; 2002). Müller and Klein (2018) mention that contributions to Project Management theories should go beyond just describing the *What* and *How* but also provide explanations that include the *Why* component of the theory. Table 2 explains the main elements of the reverse-EoC theory and compares them with the existing EoC theory to highlight the theoretical contributions of this research.

Our research focuses on explaining the opposite behaviour of escalation, namely the reverse-EoC, which is not discussed in the EoC literature (Brockner, 1992; Ross & Staw, 1993; Drummond, 2014; Sleesman et al., 2018; Eitan et al., 2023). The use of reverse-EoC as a theory relies on the idea that under the existing EoC theory, project termination would typically not occur, and IMs would be completed at any cost, despite evidence suggesting otherwise (Ross & Staw, 1987; Simonson & Staw, 1992; Winch, 2013; Cantarelli & Flyvbjerg, 2013; Drummond, 2014; 2017). Therefore, to contribute to developing reverse-EoC as a theory in project studies, we adopted an abductive approach (Sætre & Van de Ven, 2021) for theory building to sense-make the project termination process in the context of IMs.

Our research suggests that reverse-EoC does not assess whether a project is failing, which EoC does, but describes the process until the termination without any moral judgement on the project's performance. This is why we employ the analogy of "unhealthy" projects, as it is not the case that only bad projects underperform, but also good projects can.

Furthermore, our findings suggest that termination is not necessarily a success or failure and depends on "the eyes of the beholder" (Ika & Pinto, 2022). Success and failure in the context of projects are often conflicting and different for the stakeholders involved (Davis, 2017) and goes beyond the factors that hinder the project's performance (Pinto & Slevin, 1987; Pinto, 2014; Locatelli, Littau, Brookes, & Mancini, 2014). Terminating a project can be considered a failure or a success in the short, medium, and long term (Zwikael & Meredith, 2021). For instance, the termination of Keystone XL, Constellation Brands Brewery or the Xiaonanhai dam was due to a series of events (such as the endangerment or exploitation of protected resources or the misrepresentation of Environmental Impact Assessment), which can be argued whether they were consciously or unconsciously ignored, but ultimately terminated due to the environmental impact they were generating. It can be seen as an environmental and sustainability "victory" in the eyes of society but a failure from the project owner.

5.3. Contributions to practice – diagnosis technique for decision-makers

The third element of the contribution of this research relies on developing a "Project Health Model" and a "Checklist for IMs problems". These tools provide decision-makers with a diagnosis technique for assessing how "unhealthy" an IM is. While these tools are not meant to be definitive in deciding if terminate an IM or proceed with the investment decision, the practical value of these tools leverages the availability of information that decision-makers have during the due diligence and before the commencement of the delivery stage of the project. Both tools are based on information that decision-makers can access easily to have an overview of the IMs to concentrate efforts on identifying issues that can become critical if left unresolved.

Furthermore, our research suggests that no decision is "final" and invites us to revisit what the "final investment decision" means. Project studies literature typically presents the dichotomy of whether to persist or desist with the continuation of a project (Biyalogorsky et al., 2006; Steffens et al., 2007; Cooper, 2008; Eliëns et al., 2018). While the common belief is that once started, IMs should be completed at any cost; our research suggests that the final investment decision is not definitive (Merrow, 2011; Barshop, 2016; Denicol et al., 2020), and it is a construct defined as a justification to continue with the selected course of action, to justify the point of no return to the investment made. However, our research shows that this is not always the case, and further research on the potential "exits" and gate reviews is necessary before and during the construction stage in the context of IMs (Eitan et al., 2023).

5.4. Limitations and further areas of study

Finally, this research presents two main limitations. Firstly methodological. The research did not include primary data, such as interviews with relevant stakeholders. However, the information relies on publicly available information, and none of the information used for this research is confidential; therefore, it is open for consultation in the links provided by the authors—secondly, the generalisation of results. The research studies multiple cases from different contexts and sectors and identifies problems, but it does not aim to provide definitive solutions for terminating all construction projects. However, we acknowledge that this research paves the way further for investigating project termination for smaller projects.

As project termination and unfinished IMs are still under-researched topics in project studies, the authors envisage that this research could lead to further research areas. The authors suggest additional research questions that can continue with this research topic:

- Are exit doors possible for sponsors to escape from potentially failed projects at the beginning of the construction stage? This challenging question requires further research to know the conditions and particularities that would allow sponsors to withdraw their commitment to failing projects during construction.

- Which characteristics influence the decision to terminate or deliver IMs? Further research is required to understand the factors that lead to the decision to persist with a project or terminate it (permanently or temporally), depending on conditions or circumstances in a specific environment.
- What is the value of terminating IMs at advanced stages of construction? Further research is required to investigate the value of termination from a stakeholder perspective and who is responsible for the termination of IMs.

Declaration of Competing Interest

No potential conflict of interest was reported by the author(s).

Appendix 1. – Selected publicly available data used in the research

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Appendix 2. - Overview of sectors, countries, and IMs studied

Table 3

Appendix 3. – Acceptance or rejection criteria

To select the most appropriate information for the Case Studies, the following rejection criteria and filters for data sources were employed:

1. The research considers projects from 1960 until 2022. This is due to the availability of publicly available information.
2. We consider projects that have been abandoned or terminated only during the construction stage and before going into operation. We do not consider projects terminated during the design or planning stages.
3. Cross-fact reference between multiple online resources, websites, reports, and journals was critical for gathering the same level of detailed information from each case.
4. To validate the information collected, we conducted a data triangulation to verify the information obtained for every case to avoid misinformation.
5. Any fact that appoints an official institution has been corroborated in their official websites, and no information that is not publicly available on their website has been included in the document.
6. The information available is published in English.
7. Documents, reports, websites, and any other source of information are not confidential or require permission to be accessed by any individual organisation.

Appendix 4. - Overview of the thematic analysis

Fig. 4

Appendix 5. – IMs health assessment

The "IMs health assessment" does not aim to be definitive or exhaustive for all the problems that IMs have but serves the purpose of recognising critical issues. This checklist supports decision-makers to assess if the project is "unhealthy" and identify potential areas of action that, if not acted upon, can have detrimental effects on the overall project performance.

The checklist includes the six determinants for termination and each subcategory, for which we elaborated 53 questions, allowing us to operationalise the problems that IMs have. This checklist includes frequent problems in IMs since the early stages of planning, which exacerbate during the development stage if not treated in advance. We propose the following assessment criteria:

- Healthy: The project is considered healthy if all the problems are covered.
- Mild symptoms: The project is considered to have mild symptoms if up to 15–20 problems are identified.
- Strong symptoms: The project is considered to show strong symptoms if more than 20 of the identified problems are present.

The earlier these problems are identified; the more likely decision-makers can avoid investing resources in projects that are not solid and focus on implementing those that are well-prepared or with a better understanding of the problems that are present. We consider the checklist most useful before the project's construction begins. The checklist is included below in Table 4.

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