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Under pressure: A qualitative comparative analysis on the factors contributing to the success and failure of cross-border gas pipeline construction in Europe and Turkey

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ABSTRACT

Around 60% of internationally traded gas is shipped through pipelines. In Europe alone, there are around twenty cross-border gas transmission pipelines and new pipelines continue to be proposed. Yet, proposed pipelines often do not make it past the planning stage. Existing research has been unable to find a framework for determining success and failure in cross-border gas pipeline projects' construction. In this study, a six condition explanatory framework is developed based on an extensive literature review to explain the success or failure of gas pipelines in Europe. These conditions include: support from the involved states, powerful states, the Commission and the US, as well as the number of stakeholders and the technical difficulties (length and onshore/offshore). The study then conducts a Qualitative Comparative Analysis on 21 European gas pipeline projects and finds that support from those involved, powerful member states and the Commission is imperative for the successful construction of gas pipelines in Europe. The absence of these conditions has the opposite effect.

1. Introduction

International gas trade is still dominated by pipelines (60%), despite the rapid growth of LNG [1]. Gas pipelines have maintained a broad allure amongst governments and companies because of their (geo)political and economic benefits [2]. Despite the existing twenty cross-border pipelines to Europe and Turkey,[1] new pipeline projects continue to be proposed, such as the EastMed and Trans-Caspian pipeline [3]. In the European Union (EU), EUR 25 billion worth of gas pipeline projects are currently under construction or being considered, and if commissioned, they would add 150 bcm per year to the existing 725 bcm import capacity [1,4]. History teaches us, however, that many of the proposed pipelines are abandoned and only a small number of these projects will be constructed. This begs the question which factors contribute to the successful construction of pipelines and which factors to its failure.

[5,6] have developed a 5-dimension framework for energy project success. However, the dimensions are broad and hence open to take different directions. In order to understand the success and failure of gas pipeline projects a more specific framework is needed, that allows for cross-case comparison. More recently, [7] has created an index to assess the construction of Nord Stream 2 and TurkStream, despite their counter productivity on European diversification efforts. This index, although relevant, does not assist in explaining the success of non-Russian pipelines or the failure of the South Stream project. This study aims to mitigate this gap by developing a novel six factor explanatory framework to determine the factors that contribute to a pipeline's construction or failure. The conditions are derived from the existing literature on the success and failure of energy (mega)projects and gas pipelines in particular. Subsequently, these conditions are analyzed using Qualitative Comparative Analysis (QCA) in 21 gas pipeline projects to Europe and Turkey. QCA allows for the comparison of a larger number of cases. The 21 gas pipeline projects are cross-border gas pipeline projects[2] proposed in the last twenty years and therefore allows for an initial testing of our framework. The results of the QCA indicate that different combinations of the conditions results in construction; yet, only the presence or absence of three conditions (support from involved states, powerful states and the Commission) contribute to pipeline construction

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[1] The pipelines are Blue Stream, Urengoy-Pomary-Uzhhorod pipeline, Europipe I, Europipe II, Franpipe, Green Stream, Kipi-Komotini, Langeled, MedGaz, Magreb-Europe Gas, Nord Stream 1, Norpipe, Tabriz –Ankara, TANAP, TAP, Transmed, TurkStream, Vesterled, Yamal, Zeepipe (based on [3]).

[2] Pipelines between two member states are excluded.

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or failure.

This paper is organized as follows: first, a literature review of studies on energy and pipeline projects success and failure is conducted and based on this literature a six factor conceptual framework is created. Second, the research design is introduced. Third, the QCA is conducted using this framework in 21 gas pipeline projects. Fourth, an interpretation of the outcomes is presented. Finally, the conclusion summarize the findings of this study.

2. Literature review

The literature on the success or failure of energy projects and gas pipelines is comprehensive. In this literature review, we predominantly focus on European projects. From this literature multiple conditions can be deduced. First and second, the importance of support from countries involved in the project and powerful states is frequently found in multiple case studies. An extensive study by [8] of 55 projects found that state support is the most important when trying to avoid delays or cancellations of pipeline projects. [9] found that Italian, German and French (all powerful states in Europe) desire for increased gas competition trumped other issues in the case of the Urengoy-Pomary-Uzhhorod pipeline (or the Brotherhood pipeline). [10] highlighted that these countries also tend to favor individual relations with gas suppliers and organize infrastructure projects. Additionally, synergies between private companies and national governments' objectives strengthened pipeline success in the South Gas Corridor and other Italian pipelines, as governments are able to negotiate with other countries and EU institutions to obtain political support for a specific project [11,12]. [13] indicates the use of a government-to-government mechanism in the energy sector to promote projects. This is also found in the Nord Stream 2 project as economic and supply benefits attributed to political support from Germany and Austria, tied to economic and supply benefits [14], and the Green Stream pipeline that benefited from close diplomatic relations between Libya and Italy [15]. This support extends to transit countries, as found by [16]. Conversely, an unstable political climate between stakeholders can negatively impact pipelines, as found in Indian pipeline projects [17–19] and the Galsi project [15]. A study by [6] found that 'the Nabucco consortium's biggest failure probably was that it drew up a gas pipeline infrastructure without the participation of key producer countries'.

A third condition can be found in the role of the European Commission. In the past, the planned Galsi project was hampered by a misalignment between the objectives of the European Commission and Algeria [15]. [11] also addressed the EU's (the Commission) growing political, regulatory and financial support in the Trans Adriatic Pipeline (TAP) and Nabucco projects, that might contribute to the successful completion of these projects [11]. In the case of Nord Stream 2, the Commission tried to prevent the completion of the project, but failed because of its limited competences in the external energy dimension [20]. [21] argued that the Commission cannot prevent a projects realization if 'important countries (like Germany) want to continue with an international gas project, and if this project complies fully with EU rules'. The Commission's objectives in the external energy domain are constrained, because companies are financing projects and have used market principles to keep in control of energy supplies [22].

Fourth, multiple studies have addressed United States' (US) involvement in the success or failure of pipeline projects. The US appears to have hindered the development of the Iran-Pakistan-India (IPI) pipeline because of Iranian involvement [17,18]. In the past, the US unsuccessfully attempted to stop the construction of the Brotherhood pipeline using sanctions [9], one of the risks to pipeline completion according to [8]. More recently, the US imposed sanctions against the Nord Stream 2 and TurkStream pipeline projects [23]. Although US opposition might hamper construction, its support does not guarantee construction, as is evident by the Turkmenistan-Afghanistan-Pakistan-India (TAPI) pipeline [17].

A fifth condition is the large number of stakeholders that can complicate energy projects, as suggested by [5,6,24,25]. [6] found that fragmented objectives of stakeholders can result in clashes that provide hurdles to the construction of the project, as this can dilute the efficiency of the project. For example, different legal regimes can require the need to creation of an intergovernmental agreement (IGA). For companies, involvement in a pipeline project can be driven by different commercial objectives, such as profitability and access to gas supply.

Sixth, technological complexities have been found to play a role in pipeline success and failure. In the case of the IPI pipeline, [17] found that more technologically challenging pipelines, for example underwater and underground pipelines, can hamper construction, as they can result in more expensive projects or higher investment risk. [25] (based on [26]) found that onshore pipelines tend to be technologically easier to complete than offshore ones. [5] also examined the technological complexity of energy projects and found they are more difficult to complete. In addition, they are more costly and tend to run over budget.

This literature review leads to six possible explanatory conditions for pipeline success and failure. These conditions and their expected impact are shown in Table 1.

The literature on conditions for success and failure highlighted three shortcomings. First, research is done either on a single case study or on different types of projects (nuclear, oil, renewables and gas). A single case study limits the universality of the outcomes. A notable exception is [8], who has included multiple gas pipeline projects, but does not propose success factors. Instead, he focuses on the commercial and political risks that these projects can encounter. A second shortcoming is the different political and legal landscapes in different regions that do not allow for comparative analysis across regions. It is therefore important to focus on a specific region, before probing outcomes in other areas. Third, not all the conditions are examined in the same case, as the conducted studies are aimed at explaining individual projects.

This study aims to overcome these shortcomings by analyzing multiple gas pipeline projects in Europe and Turkey, and is able to provide some generalizable outcomes. The novelty of this research lays in comparing these 21 European pipeline projects in a systematic manner using QCA, which has not been done before. Instead, existing research has been done on either a more limited number of pipelines or pipelines from different regions. Additionally, combining the research outcomes of the literature review has not been done and would help push this research field to a new, more overarching area, instead of the continued focus on individual projects.

3. Research design

3.1. Method

Methodologically, this paper builds on the original crisp set version of QCA (csQCA) [27]. This configurational comparative method allows to draw conclusions on the causal relationship between three to seven explanatory conditions and an outcome of interest, i.e. pipeline

Table 1
Possible explanations for pipeline project success and failure.

Explanatory condition	Expectation
States	Support from the involved states results in pipeline success
Powerful state(s)	Support from powerful states increases the likelihood of the project success
Commission	Support from the Commission leads to successful construction of projects
US	US support contributes to the successful completion of pipelines
# of stakeholders	Less stakeholders result in pipeline success
Technology	Onshore and shorter projects are more likely to be constructed

construction success. More specifically, QCA's analytical techniques allow to systematically compare an intermediate to large number of cases and, hereby, uncover a complex form of causality, generally referred to as multiple conjunctural causation [28,29]. Conjunctural causation implies that the impact of a causally relevant condition depends on the presence (or absence of other conditions). In other words, it indicates that a condition might only play a causal role in combination with other conditions. Multiple causation or equifinality, in turn, indicates that there are different combinations of conditions that produce the same outcome; in other words, that there can be multiple causal pathways towards an outcome. QCA constitutes an appropriate method for examining pipeline construction success because we expect different (multiple) combinations (conjunctural) of conditions to result (causation) in the outcome. The study applies the original crisp set version of QCA because the outcome of interest, successful pipeline construction, presents itself in binary form [29].

3.2. Case selection and data

For this comparison, 21 cross-border European and Turkish projects are examined, see Table 2 for a list of the projects. In the appendix, the main characteristics of these 21 pipelines are introduced. The projects are all gas pipelines to the European and Turkish market and were found using different sources [3,8,11,30,31]. They do not include intra-European projects, for example pipelines between Poland and Lithuania, or Bulgaria and Greece. The inclusion of Turkish projects (Blue Stream, South Caucasus Pipeline, TANAP and TurkStream) can be debated, as they can be considered to break-up the uniformity of pipelines directed to the internal European market. However, the analysis was also conducted with solely pipelines to the EU and the same results were found (cf. appendix). Consequently, we deem the inclusion of Turkish pipelines is acceptable and non-distortive to our analysis.

All pipelines have been proposed or constructed in the last twenty years; this time limitation is selected for two reasons. First, it is important to have a comparable level of competences for the Commission, as the Commission has obtained more competences in the (external) energy market in the past two decades [32]. Second, to account for differences in gas market design and gas demand (e.g. the more developed Gas Directive that stipulate the operational rules of the European gas market), we have limited the period to the last twenty years. Gas pipelines such as Norpipe, Yamal and Magreb-Europe Gas are therefore not included. In addition, only projects on which a final decision has been made are included in the analysis, excluding proposed projects, like EastMed, Galsi, Nigeria Morocco Gas Pipeline and White Stream. The Interconnector Turkey-Greece-Italy (ITGI) pipeline has only partially been constructed (the Turkish-Greek section), yet we have placed the project in the completed section. Nord Stream 2 is included as a completed project as this study examines the success and failure in pipeline construction and Nord Stream 2 was fully constructed from a technical perspective; it was physically able to export gas to the EU. However, the Russian invasion of Ukraine, the current political situation, and the sabotage of the Nord Stream 2 (and Nord Stream) pipeline has rendered the chances of the project ever becoming operational highly unlikely.

Table 2
Pipeline projects and their outcome.

Pipeline	Outcome	Pipeline	Outcome
AMBER	Abandoned	Nord Stream 1	Completed
Baltic Pipe	Completed	Nord Stream 2	Completed
Blue Stream	Completed	Skanled	Abandoned
Green Stream	Completed	South Caucasus Pipeline	Completed
Interconnector Turkey-Greece-Italy (Poseidon)	Completed	South Stream	Abandoned
Interconnector Strandzha 2 – Malkoclar	Completed	Tampen	Completed
Langeled (Britpipe)	Completed	Trans Adriatic Pipeline (TAP)	Completed
MedGaz	Completed	Trans-Anatolian Natural Gas Pipeline (TANAP)	Completed
Mid-Nordic Gas pipeline	Abandoned	TurkStream (Turkish Stream)	Completed
Nabucco	Abandoned	Yamal 2	Abandoned
Nabucco-West	Abandoned		

The data for the cases is derived from different sources (cf. online appendix). We predominantly use secondary sources, such as academic publications, government and pipeline project websites, and international media reports. In some cases, specific internet searches were conducted in order to check whether information on a specific project and condition was available.

3.3. Conditions and operationalization

Based on the literature, six conditions that can contribute to pipeline success or failure are identified, see Table 1. The operationalization and dichotomization of the conditions is discussed in this section. Dichotomization refers to the assignment of a score of 1 or 0 to the cases on the conditions and outcome. A score of 1 is assigned if a condition or an outcome is present in a given case, a score of 0 if it is absent. The raw data and dichotomized values for the six conditions can be found in the appendix.

First, the *support of the states connected to the project* is crucial for pipeline success. The producer, transit and consumer countries, for example, need to issue permits [8]. The case of Nabucco highlighted that support from a producer is important, as the Nabucco consortium did not include a production company or country [6]. Additionally, the connected countries can provide support for companies headquartered on their territories through their diplomatic connections [11], this can increase the success rate of the pipeline. For this condition, we examine whether all involved states are supportive of the project. For this condition, we looked at media reports and scholarly publications for information on the individual projects.

Second, we will examine whether *support of powerful states*, such as Germany, France, Italy, the United Kingdom (UK) and Turkey, have a positive impact on pipeline completion.[3] Specifically, the economic and supply benefits for powerful states are analyzed, as they seem to play an important role [9,14–16,19,21]. A physical (a more direct supply benefit) or an economic (company headquartered in powerful state) connection to one of these powerful states results in a "1" score. This information was retrieved from project websites and secondary sources.

Third, *the role of the Commission* is examined, based on studies by [11,15,20]. Specifically, the placement of cases on the Project of Common Interest (PCI) list and the EU funding are considered indicators of support. The PCI list is a suitable measure, as the list is draw-up by the Commission based on the positive influence on the EU market. Subsequently, the list is submitted for approval by the European Parliament and the European Council. Both institutions can only approve or reject the list, they cannot amend or request amendments to the list [33]. Only cases on the PCI list and receiving EU funding are scored "1". Cases that are not placed on the PCI list, did not receive funding, or where the Commission has not taken an explicit position are scored "0". Data for this condition was found on the PCI-lists [34,35], and specific internet searches.

A fourth condition is the *position of the US* in supporting or opposing a pipeline project. In the past, the US has attempted to influence the construction of pipeline projects [17,18] and even imposed sanctions against some projects [9,23]. The position of the US is operationalized through public statements and actions. If the US has not taken an explicit

[3] These countries represent larger gas markets and are larger economies in the EU. The UK was included as for the majority of this period it was a part of the EU.

position on my project, we assume that the absence of statements and actions indicate a neutral or implicit support (scored "1").

The *number of stakeholders* is the fifth condition. This condition is supported by [5,6,25], who found that a high number of stakeholders can have a negative impact on project success. Stakeholders can be either companies or countries connected to the pipeline. More countries means more permitting procedures and different legal frameworks that need to be aligned for the pipeline, while companies might have different commercial objectives they wish to obtain from the project. Five or more stakeholders (states and companies) is considered a negative impact and cases are scored "0". Information for this condition was found on project websites or open sources.

Sixth, *technological* issues can complicate the construction of a pipeline project [5,17]. Offshore projects tend to be technologically more complex than onshore pipelines [25] and lengthy projects will in general need more compressor stations and encounter more obstacles. This condition is operationalized based on two characteristics: length and onshore/offshore. Cases that are longer than 1000 km or offshore are scored "1" and cases that are shorter than 1000 km and onshore are scored "0". Data for this condition was retrieved from project websites or open sources.

4. Analytical results

The csQCA procedure proceeds in two main steps, which were carried out with the QCA package for R [36]. The first step of an analysis of QCA is the construction of a truth table. A truth table lists all logically possible combinations of conditions, with each row corresponding to a specific combinations of conditions [28]. A value of 1 in a row indicates that a condition is present, a value of 0 indicates that a condition is absent. Table 3 presents the truth table of the present study. Row 1 of this truth table corresponds to the combination of the presence of STATESUP (1), the absence of POWSTATE (0), the presence of COM (1), the presence of US (1), the absence of STAKE (0) and the presence of TECH (1). Each case is assigned to the truth table row that corresponds to the combination of conditions that characterizes this case. An outcome value is assigned to every truth table row with empirical cases. Truth table rows that only include cases in which the outcome is present are assigned a score of "1", because they correspond to combinations of conditions that are sufficient for the outcome; rows that only include cases of the absence of the outcome are assigned a value of "0", indicating that they correspond to combinations of conditions that are sufficient for the outcome's absence. Truth table rows without empirical cases are called logical remainders, logically possible combinations of conditions that do not correspond to empirical cases.

Subsequently, Boolean minimization is used to minimize the truth table and find out which combinations of causally relevant conditions produce the outcome. Minimization can result in different solution types, depending on the remainders included in the minimization process. Given that we aim to identify causally relevant conditions, we focus on the parsimonious solution [37]. Table 4 presents the solution for the presence and absence of the outcome: construction completion.

The results indicate that two combinations of conditions consistently lead to pipeline construction completion and two combinations consistently result in abandonment. Success is found in cases that have support from the involved states (STATESUP) in combination with support of powerful states (POWSTATE) or the Commission (COM). The failure of gas project is traced to two combinations of conditions: first, the absence of state support (~STATESUP) results in abandonment. Second, the absence of powerful state (~POWSTATE) and Commission support (~COM) also results in the abandonment of a gas pipeline project.

5. Interpretation

The results of the QCA provide support for the causal relevance of three conditions that were includes in our theoretical framework: support of involved states, support of the European Commission and support of powerful member states. In contrast, our analyses does not suggest that US support, the number of stakeholders are technological difficulties are relevant.

The influence of support from states involved in the project is crucial for the completion of pipeline projects. Not only is this condition part of every pathways towards completion, its absence suffices for the abandonment of pipeline projects. Hereby, our results support the conclusions of previous studies [8]. Case-based evidence further supports the importance of this condition. For South Stream, the temporary drop of Bulgarian support, led to demise of the project, despite support from powerful member states. Bulgaria experienced increased pressure from the Commission and the US to retract its support for the project after Russia annexed Crimea and Russian continued support for East-Ukrainian rebels [39,40]. These events triggered the cancellation of South Stream, as EU sanctions were imposed against Russia and the urgency of diversification efforts grew in Brussels. Likewise, the short withdrawal of a Danish environmental permit lead to a three month delay in the construction of Baltic Pipe, but not to the project's cancellation. The difference between South Stream and Baltic Pipe is the fact that the Danish government did not terminate its support, but that further examination was needed to assess the environmental impact of the pipeline construction [41,42]. The support of a gas producer is also crucial for pipeline completion, as is evident in the cases of Nabucco, Nabucco-West, AMBER and Yamal 2. Both Nabucco projects did not include a producer and Azerbaijan was the only possible supplier for both projects, as Iranian gas imports were under sanctions and Turkmen gas could not cross the Caspian Sea due to territorial disputes. However, issues with Azerbaijani gas were that they were insufficient to deliver the volumes to fill-up Nabucco and that other projects (e.g. TANAP and TAP) included state company SOCAR.[4] Additionally, AMBER and Yamal 2 also lacked a gas supplier, as Russia had clearly favoured a subsea pipeline without any transit countries.

The results, however, indicate that support of the involved states only results in pipeline completion if either the Commission or a powerful state also support the project. Conversely, the solution of the absence of the outcome show that abandonment requires both the absence of the support of the commission and powerful states, indicating that powerful states still hold competences that can overshadow the preferences of the Commission in the gas sector. The case of Nord Stream 2 is evidence of this. The Commission displayed extremely public opposition, but was unable to halt its construction, as powerful member states and states involved supported the project's construction. This also shows a dichotomy between the powerful states and less powerful states. In the South Stream project, Bulgaria was susceptible for pressure from Brussels, while Germany is not (or at least less). Additionally, powerful states are able to generate the synergies between companies, that the Commission cannot recreate. The powerful states are also larger consumers of gas.[5] Hence, their support might persuade investors to

[4] The gas supply came from Azerbaijan, but the decision to construct other projects was made by the Shah Deniz consortium. This consortium consists of BP, TPAO, Petronas, AzSD, SGC Upstream, Lukoil and Nico.

[5] Multiple models fared equally well in accounting for the data - see Baumgartner, M. and A. Thiem, Model ambiguities in configurational comparative research. Sociological Methods & Research, 2017.46(4): p. 954–987. The presented model for the presence of the outcome was selected because it is the only model that does not include the presence of "technological difficulties", which is highly unlikely to be linked to the success of pipeline construction. The presented model for the absence of the outcome was selected because it is the only model that does not include the absence of "technological difficulties", which is highly unlikely to be lined to the abandonment of a pipeline construction project. In 2019, gas consumption in these countries was Germany 95 bcm, France 42 bcm, Italy 74 bcm, UK 79 bcm and Turkey 45 bcm - see Eurostat. Supply, transformation and consumption of gas (2021), https://ec.europa.eu/eurostat/databrowser/view/NRG_CB_GAS_custom_1203353/default/table?lang%20=%20en.

Table 3
Truth table.

	STATESUP	POWSTATE	COM	US	STAKE	TECH	Outcome	Cases
1	1	0	1	1	0	1	1	Baltic pipe, MedGaz
2	1	1	0	0	0	1	1	Nord Stream 1
3	1	1	0	0	1	1	1	Nord Stream 2, TurkStream
4	1	1	0	1	0	0	1	South Caucasus Pipeline
5	1	1	0	1	0	1	1	Blue Stream Tampen
6	1	1	0	1	1	1	1	Green Stream, Langeled
7	1	1	1	1	0	1	1	ITGI, TAP
8	1	1	1	1	1	0	1	Strandzha 2 - Malkoclar
9	1	1	1	1	1	1	1	TANAP
10	0	0	0	1	0	0	0	AMBER
11	0	0	0	1	0	1	0	Yamal 2
12	0	0	1	1	0	1	0	Nabucco-West
13	0	1	0	0	0	1	0	South Stream
14	0	1	1	1	0	1	0	Nabucco
15	1	0	0	1	0	0	0	Skanled
16	1	0	0	1	1	0	0	Mid-Nordic Gas pipeline

STATESUP: support of involved states; POWSTATE: support of powerful states; COM: European Commission support; US: US support; STAKE: number of stakeholders; TECH: technological difficulty.

Table 4
QCA solutions.[a]

			Coverage		Consis-tency	Cases
			Raw	Unique		
Comp-letion	1	STATESUP* POWSTATE	0.857	0.571	1	Nord Stream 1, Nord Stream 2, TurkStream, South Caucasus Pipeline, Blue Stream, Tampen, Green Stream, Langeled, ITGI, TAP, Strandzha 2 - Malkoclar, TANAP
	2	STATESUP*COM	0.429	0.143	1	Baltic pipe, MedGaz; ITGI, TAP, Strandzha 2 -Malkoclar, TANAP
		Solution	1		1	
Abandonment	1	~STATESUP	0.714	0.429	1	AMBER, Yamal 2, Nabucco-West, South Stream, Nabucco
	2	~POWSTATE* ~COM	0.571	0.286	1	AMBER, Yamal 2, Skanled, Mid-Nordic Gas pipeline
		Solution	1		1	

STATESUP: support of involved states; POWSTATE: support of powerful states; COM: European Commission support; "~" indicates the absence of a condition; multiplication "*" refers to the conjunction of conditions.

[a] Multiple models fared equally well in accounting for the data - see Baumgartner, M. and A. Thiem, *Model ambiguities in configurational comparative research*. Sociological Methods & Research 46: 4 (2017) 954–987. The presented model for the presence of the outcome was selected because it is the only model that does not include the presence of "technological difficulties", which is highly unlikely to be linked to the success of pipeline construction. The presented model for the absence of the outcome was selected because it is the only model that does not include the absence of "technological difficulties", which is highly unlikely to be lined to the abandonment of a pipeline construction project.

approve the project, while the support of the Commission does not ensure there is a market for a specific pipeline project. In the majority of cases, the Commission provides no explicit support for projects.

Our results do not provide evidence for the importance of US support, the number of stakeholders and the distinction between technical difficult and 'easier' pipelines. The absence of the role of the US is not that surprising, considering that in the past sanctions were unable to stop the Urengoy-Pomary-Uzhhorod project and the US′ position on Indian pipelines has not led to the completion or abandonment of pipelines. Past studies [5,6] did indicate the importance of the number of stakeholders. It is possible that the operationalization of this condition contributed to its absence; although changing the threshold to six or more stakeholders does not change the outcome of our analysis (cf. appendix). Another reason might be that QCA aims to find minimal solutions and therefore the stakeholders condition is not found. This entails that the number of stakeholders could still play a role, but is not necessary to reach the outcome. Of the seven abandoned projects only the Mid-Nordic Gas pipeline has four or less stakeholders. However, for the completed projects less evidence is found, as only eight of the fourteen completed projects has more than four stakeholders.

The absence of technically difficult condition is interesting, as more risky or organizational difficult pipelines might provide obstacles for companies to invest in them. The operationalization of this condition might have contributed to its absence. Including cost might have yielded a different outcome.

Besides the six conditions included in the QCA, we have also examined two additional conditions – Russian gas and volume of gas supply. The QCA and the raw data can be found in the appendix. First, we substituted the technical condition with the condition Russian gas. We expected this condition to either result in pipeline success or in pipeline failure. Success was expected as Russian gas projects represent a clear synergy between partly state-owned Gazprom and the Russian state. Additionally, Gazprom is the largest supplier of gas to the European and Turkish market (34.7 and 33.4% respectively in 2019 [44]). Alternatively, the role of Russian gas in the EU has become controversial since the 2006 and 2009 gas supply disruptions and the Commission and Eastern European countries favor diversification projects, instead of new Russian pipelines. Russian gas pipelines are often associated with methane leakages as methane is known for its potency in speeding up climate change [45]. Therefore, the presence of Russian gas might lead to unsuccessful projects. Pipelines that are supplied by Russia are scored "1" and all other projects "0". However, our analysis found no evidence for this condition.

A second condition that we analyzed was the volume of supply. Again, this condition substituted the technical condition. Volume of supply (annual pipeline capacity) was used by Dubský, Tichý [7] in their method to assess pipeline options. They apply their model, which includes price, political stability of producer and transit country, and long-term volume, to Nord Stream 2 and TurkStream and use it to explain their construction. Larger pipeline projects entail more risk for investors, as a gas producer needs to be able to fill the pipeline (higher responsibility) and gas consumption needs to be significant in order to recuperate the investment. Hence, we expected larger pipeline projects to be less successful. All pipeline projects with a capacity of >30 bcm are scored "1". However, our analysis also found no support.

6. Conclusion

This study examined the conditions that contribute to pipeline success or failure, using QCA. Our analysis found that the presence or absence of state support, powerful state support or the Commission in different combinations is sufficient for success or failure. We did not find an important role of US support, the number of stakeholders or technical difficulties. Although we do not deny the role their absence or presence might have played in individual projects, such as US pressure on the Bulgarian government to drop South Stream after the annexation of Crimea, the downing of flight MH-17 and Russian support for eastern Ukrainian rebels.

The novel contributions of this analysis are (1) overcoming the limitations of the single case study analyses conducted on individual projects and (2) allowing for generalization on European and Turkish cross-border gas pipelines success, such as the need for support from powerful member states and the Commission. Furthermore, this research has allowed for (3) the comparing of multiple pipeline projects through a systematic framework using QCA. Still, the uniqueness of each project complicates generalization efforts. If you look at Nord Stream 1 and 2, they share many basic characteristics (location, length, volume, offshore, involved countries) and their outcome (completed); yet, upon closer examination both pipelines have experienced different influences based on unique geopolitical circumstances.

This study can be used by policy-makers and investors to save time and money when dealing with planned gas pipeline projects, like EastMed or White Stream. Also, the European pivot away from Russian gas, following the Russian invasion of Ukraine, has made the expansion or new gas (pipeline) infrastructure highly topical, especially considering the urgency of acquiring Russian gas substitutions. This study might also have implications for other energy projects, like hydrogen trade. Hydrogen trade through pipelines is expected to have similar geopolitical impacts as gas pipeline [46] and their successful construction, or successful refurbishment of gas pipelines might depend on the similar factors. Furthermore, this framework has provided a starting point for probing pipeline projects outside of Europe and Turkey. Future research can also reassess or refine the conditions examined in the cases. For example, competition between projects has possibly influenced pipeline success. Nabucco experienced competition from South Stream, TANAP and TAP, while Yamal 2 and AMBER were proposed as an alternative to Nord Stream 1. Also, efforts by social movements might negatively impact pipeline construction [47,48]. In the US, the halting of pipeline construction (such as the Atlantic Coast Pipeline) has in recent years been predominately dominated by social movements opposing pipeline construction [49]. Inclusion of these conditions can provide further insights into pipeline success and failure. Additionally, a more in-depth analysis of the role of interest groups (companies) might provide new insights into governmental processes that contribute to project success and failure, as suggested by [10].

Credit author statement

Moniek de Jong: Conceptualization, Writing- Original draft preparation and Reviewing and Editing, Formal analysis, Resources, Project administration **Tim Haesebrouck**: Conceptualization, Methodology, Formal analysis, Data Curation, Project administration.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.esr.2022.101033.

References

[1] BP, Statistical Review of World Energy 2020, 2020. Available from: https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/energy-economics/statistical-review/bp-stats-review-2020-full-report.pdf.
[2] F. Proedrou, Revisiting pipeline politics and diplomacy: from energy security to domestic politics explanations, Probl. Post-Communism 65 (6) (2018) 409–418.
[3] ENTSO-G., The European natural gas network 2019, 2019 [cited 2012; Available from: https://www.entsog.eu/sites/default/files/2020-01/ENTSOG_CAP_2019_A0_1189x841_FULL_401.pdf.
[4] M. Inman, G. Aitken, S. Zimmerman, Europe Gas Tracker Report, Global Energy Monitor, 2021.
[5] B.K. Sovacool, C.J. Cooper, The Governance of Energy Megaprojects: Politics, Hubris and Energy Security, Edward Elgar Publishing, London, 2013.
[6] T. Van de Graaf, B.K. Sovacool, Thinking big: politics, progress, and security in the management of Asian and European energy megaprojects, Energy Pol. 74 (2014) 16–27.
[7] Z. Dubský, L. Tichý, D. Pavliňák, A quantifiable approach to the selection of criteria and indexation for comparison of the gas pipeline projects leading to the EU: diversification rationality against securitisation? Energy 225 (2021), 120238.
[8] T.J. Dimitroff, Cross-border oil and gas pipeline risk and sustainable mitigations, J. World Energy Law Bus. 7 (4) (2014) 287–339.
[9] P. Högselius, Red Gas: Russia and the Origins of European Energy Dependence, Palgrave Macmillan, New York, 2013.
[10] I. Nesterenko, European energy governance: the pursuit of a Common external energy policy and the domestic politics of EU member states preferences, in: M. Rewizorski, K. Jedrzejowska, A. Wróbel (Eds.), The Future of Global Economic Governance, Springer, Cham, 2020, pp. 141–160.
[11] A. Prontera, Beyond the regulatory state: rethinking energy security governance and politics in the European Union, Comp. Eur. Polit. 18 (2019) 330–362.
[12] A. Prontera, Italian energy security, the Southern Gas Corridor and the new pipeline politics in Western Europe: from the partner state to the catalytic state, J. Int. Relat. Dev. 21 (2) (2018) 464–494.
[13] A. Goldthau, Energy diplomacy in trade and investment of oil and gas, in: A. Goldthau, J.M. Witte (Eds.), Global Energy Governance: the New Rules of the Game, Brookings Institution Press, Washington DC, 2010, pp. 25–47.
[14] M. de Jong, T. Van de Graaf, T. Haesebrouck, A matter of preference: taking sides on the Nord Stream 2 gas pipeline project, J. Contemp. Eur. Stud. (2020) 1–14.
[15] R. Cardinale, The profitability of transnational energy infrastructure: a comparative analysis of the Greenstream and Galsi gas pipelines, Energy Pol. 131 (2019) 347–357.
[16] K. Öge, Understanding pipeline politics in eurasia: Turkey's transit security in natural gas, Geopolitics 26 (5) (2019) 1510–1532.
[17] H.S.K. Nathan, S.S. Kulkarni, D.R. Ahuja, Pipeline politics—a study of India' s proposed cross border gas projects, Energy Pol. 62 (2013) 145–156.
[18] M. Lall, India's gas pipeline efforts: an analysis of the problems that have prevented success, in: B. Kong, et al. (Eds.), Pipeline Politics in Asia: the Intersection of Demand, Energy Markets, and Supply Routes, 2010 (NBR Special Report).
[19] M.S. Huda, S.H. Ali, Energy diplomacy in South Asia: beyond the security paradigm in accessing the TAPI pipeline project, Energy Res. Social Sci. 34 (2017) 202–213.
[20] M. de Jong, T. Van de Graaf, Lost in regulation: Nord Stream 2 and the limits of the European commission's geo-economic power, J. Eur. Integrat. 43 (4) (2021) 495–510.
[21] A. Prontera, P. Plenta, Catalytic Power Europe and gas infrastructural policy in the Visegrad countries, Energy Pol. 137 (2020), 111189.
[22] A. Herranz-Surrallés, An emerging EU energy diplomacy? Discursive shifts, enduring practices, J. Eur. Publ. Pol. 23 (9) (2016) 1386–1405.
[23] M. de Jong, Too little, too late? US sanctions against Nord Stream 2 and the transatlantic relationship, J. Transatl. Stud. 20 (2022) 213–229.
[24] J. Gregory, Governance, scale, scope: a review of six South African electricity generation infrastructure megaprojects, Util. Pol. 66 (2020), 101103.
[25] G. Locatelli, et al., The successful delivery of megaprojects: a novel research method, Proj. Manag. J. 48 (5) (2017) 78–94.
[26] E.W. Merrow, Industrial Megaprojects: Concepts, Strategies, and Practices for Success, John Wiley & Sons, Hoboken, 2011.

[27] C. Ragin, The Comparative Method: Moving beyond Qualitative and Quantitative Strategies xvii, University of California Press, Berkeley, 1987, p. 185.
[28] Oana, I.-E., C.Q. Schneider, and E. Thomann, *Qualitative Comparative Analysis (QCA) Using R: A Gentle Introduction*. 2021, Cambridge: Cambridge University Press.
[29] C.Q. Schneider, C. Wagemann, Set-Theoretic Methods for the Social Sciences: A Guide to Qualitative Comparative Analysis (QCA), Cambridge University Press, Cambridge, 2012.
[30] S. Nies, Oil and Gas Delivery to Europe: an Overview of Existing and Planned Infrastructures, 2011 (Ifri).
[31] European Commission, Projects of Common Interest, 2019.
[32] T. Maltby, European Union energy policy integration: a case of European Commission policy entrepreneurship and increasing supranationalism, Energy Pol. 55 (2013) 435–444.
[33] European Commission, Key cross border infrastructure projects, 2019, 7 April 2021 [cited 2021 31 August]; Available from: https://ec.europa.eu/energy/topics/infrastructure/projects-common-interest/key-cross-border-infrastructure-projects_en#who-can-become-a-pci-.
[34] European Commission, DECISION No 1229/2003/EC of the European Parliament and of the Council of 26 June 2003 Laying Down a Series of Guidelines for Trans-European Energy Networks and Repealing Decision No 1254/96/EC, 2003.
[35] European Commission, COMMISSION DELEGATED REGULATION (EU) 2016/86 of 18 November 2015 amending Regulation (EU) No 347/2013 of the European Parliament and of the Council as regards rge Union lists of projects of common interests, 2016. Available from: https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32016R0089&from=EN.
[36] A. Duşa, QCA with R: A Comprehensive Resource, Springer, Cham, 2018.
[37] T. Haesebrouck, Relevant, Irrelevant or Ambiguous? towards a Correct Interpretation of QCA's Solution Types, Conditionally Accepted at Sociological methods & research, 2021.
[39] J. Yardley, J. Becker, How Putin forged a pipeline deal that derailed, in: The New York Times, 2014.
[40] A. Vihma, U. Turksen, The geoeconomics of the South Stream pipeline project, J. Int. Aff. 69 (1) (2015) 34–53.
[41] Reuters, Baltic Pipe Gas Link Work Resumes but Faces 3-month Delay, Reuters, 2021.
[42] Reuters, Concern over Wildlife Halts Building of Norway-Poland Gas Link, Reuters, 2021.
[44] Eurostat, Imports of natural gas by partner country, 2020. Available from: https://appsso.eurostat.ec.europa.eu/nui/submitViewTableAction.do.
[45] S. Nasralla, Satellites Reveal Major New Gas Industry Methane Leaks, Reuters, 2020.
[46] T. Van de Graaf, et al., The new oil? The geopolitics and international governance of hydrogen, Energy Res. Social Sci. 70 (2020), 101667.
[47] D. McAdam, et al., Site fights": explaining Opposition to pipeline Projects in the developing world 1, in: Sociological Forum, Wiley Online Library, 2010.
[48] McAdam, D. and H. Boudet, *Putting Social Movements in Their Place: Explaining Opposition to Energy Projects in the United States, 2000–2005*. 2012, Cambridge: Cambridge University Press.
[49] Financial Times, End of the Road for America's Oil and Gas Pipelines? Financial Times, 2021.