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Türkiye in International Energy Trade: Implementation of Social Network Analysis

Mustafa YÜCEL [1] **Erol TURAN** [2]

Abstract

Energy resources are fundamental inputs in almost every sector and play a crucial role in development and economic stability. This situation has increased the importance of keeping energy costs low, becoming a significant factor in attaining global superiority. In the contemporary era, where states represent the highest level of the organization, the strategic importance of these resources has been further exposed. The strategic value of energy resources, predominantly encompassing fossil fuels such as oil, natural gas, and coal, has precipitated intense global competition. The dynamics of energy resource trade have transcended mere profit-driven motives, transforming into a tool wielded by governments for various political objectives. This paradigm shifts underscores the vitality of energy supply security, prompting the formulation of energy trade networks guided by policies and national strategies. Within these networks, participating actors exhibit diverse traits shaped by distinct circumstances, assuming varied roles through pre-existing relationships. The purpose of the research is to examine the energy trade network of Türkiye, implementing the social network analysis method that integrates empirical data and mathematical approaches. The study aims to unveil pivotal aspects of the network, including its size within the global energy trade landscape, density, relational ties among actors, centrality, and brokerage degrees. The research aims to contribute valuable insights to understanding Türkiye's positioning in the global energy trade through these analyses. The results indicate that the volume of Türkiye's energy trade network accounts for around 1/3 of the global energy trade. While no single dominant actor exists in the network, specific entities demonstrate significant brokerage power. The analysis highlights the impact of global energy players, including Russia, the United States, and some European countries. Finally, the study involves recommendations for future research, anticipating a continued exploration of the complicated dynamics shaping energy trade networks on a global scale.

Keywords: Strategic Management, Social Network Analysis, Sustainable Energy Trade, Energy Security, International Business

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Uluslararası Enerji Ticaretinde Türkiye: Sosyal Ağ Analizi Uygulaması

Mustafa YÜCEL [1] **Erol TURAN** [2]

Öz

Enerji kaynaklarının hemen her sektörde temel girdi özelliğinde olması, kalkınma ve ekonomik istikrarın en temel gerekliliklerinden biri haline gelmesine yol açmıştır. Bu durum, enerji maliyetini düşük tutabilmenin önemini artırmış, küresel mecrada üstünlük sahibi olmada önemli bir etken haline getirmiştir. Dolayısıyla söz konusu kaynakların günümüzün en üst düzey örgütlenme boyutu olarak kabul edilen devletler açısından da stratejik önem kazanmasına sebep olmuştur. Bahsi geçen stratejik değer, başta petrol, doğal gaz ve kömür olmak üzere halen yüksek oranda fosil yakıtlardan oluşan enerji kaynakları ticaretinde sıra dışı bir rekabetin oluşmasında etkili olmuştur. Nitekim enerji kaynaklarının ticareti, sadece kâr amacı taşıyan bir ticaret olmanın ötesinde, hükümetlerin çeşitli politik amaçlarında koz olarak kullandıkları bir araç haline gelmiştir. Bahsi geçen konu, enerji arz güvenliği ve sürdürülebilir enerji ticareti meselelerinin önemini artırmış, enerji ticaret ağlarının ülkelerin geliştirdikleri politikalar doğrultusunda şekillenmesine sebep olmuştur. Ticaret ağlarında yer alan aktörler, kendilerine has koşulların etkisinde çeşitli özelliklere sahip olmakta ve kurdukları ilişkiler ile ağ içerisinde farklı roller üstlenmektedirler. Sosyal ağ analizi bu noktada ağ içerisindeki ilişki bağlarının aktörlerin sahip olduğu konum ve özelliklerine tesir etmesinden yola çıkmaktadır. Bu çalışma, Türkiye'nin enerji ticaret ağını ampirik verilerin ve matematiksel yöntemlerin kullanımını esas alan sosyal ağ analizi yöntemi ile incelemeyi amaçlamaktadır. Bu amaç kapsamında, öncelikle ağın küresel enerji ticareti içerisindeki büyüklüğü ve ağ yoğunluğu özellikleri tespit edilmiştir. Ayrıca, ağdaki aktörlerin ilişkisel bağları, merkezilik ve aracılık dereceleri ortaya çıkarılmıştır. Sonuçlar, Türkiye'nin enerji ticaret ağındaki hacmin küresel enerji ticaretinin yaklaşık 1/3'ünü oluşturduğunu göstermektedir. Ağda tek bir baskın aktör bulunmamakla birlikte, belirli yapıların önemli aracılık gücü görülmüştür. Analiz, Rusya, ABD ve bazı Avrupa ülkeleri gibi küresel enerji aktörlerinin Türkiye'nin ticaret ağında da etkinliğini öne çıkarmıştır. Çalışma, konuya yönelik ileriki incelemeler için önerilerde bulunmaktadır.

Anahtar Kelimeler: Stratejik Yönetim, Sosyal Ağ Analizi, Sürdürülebilir Enerji Ticareti, Enerji Güvenliği, Uluslararası İşletme

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Introduction

The demand for energy, a key input in various aspects of economic and social life, such as production, health, security, tourism, and education, continues to rise, making reliable and sustainable energy a focal point globally (Yücel, 2022, p.62). Since ensuring economic stability and development is one of the primary goals of policymakers (Kesgingöz & Dilek, 2016, p.180), energy resources have become a crucial factor in international strategies due to geopolitical features. An inadequate energy supply threatens economic and political stability, jeopardizing firms' sustainability. The situation intensifies the competition between countries for a share of energy resources. Countries that effectively manage energy costs gain a significant competitive advantage in global energy trade, shaping today's competitive landscape. Nations actively seeking dominant power positions strive to control rich fossil energy sources, especially in the Middle East and North Africa, as seen in the efforts of the United States. On the other hand, some fossil-energy-poor countries, specifically in the European Union, focus on energy conservation and efficiency strategies and prioritize renewable energy investments. The EU aims to reduce carbon emissions and encourage other non-member countries in these efforts.

Despite its geopolitical advantage as a bridge between energy-exporting and importing countries, Türkiye remains a net energy importer due to the need for more utilization of its resources and geopolitical position. It is crucial for Türkiye to ensure energy security and reduce its current account deficit by planning sustainable future projections in the energy sector. In the context of increasing global interactions, the trade of energy resources holds vital importance for Türkiye, considering factors such as population, industrialization, and geopolitical positioning.

Social network analysis, examining relationships through relational connections (Freeman, 2004, p.2) is employed to explore Türkiye's energy trade network, revealing its size, density, and critical actors within global energy trade. The study focuses on identifying the conditions in the energy trade of Türkiye by utilizing social network analysis. In this line, social network analysis is implemented in the energy trade network of Türkiye to determine the key features of the network, such as the network's density, central actors, and position of Türkiye in the network. This analysis will help to clarify the contemporary circumstances in the energy trade of Türkiye amid various conflicts for energy resources.

The conceptual part introduces energy resource types, current usage rates, and the significance of energy in the contemporary world. The study delves into the importance of energy trade for states, distinguishing it strategically from the trade of other goods and services. The dynamics shaping energy trade, including issues arising from intensive energy use and international agreements, are explained. The empirical section explains social network analysis in line with the literature. The study employs secondary data sources, utilizing World Bank data on fuel categories like oil, natural gas, and coal. Using UCINET software, the study reveals Türkiye's energy trade network through an adjacency matrix, conducting calculations to examine its size, density, dominance, centrality, and brokerage levels of involved actors.

The study, unique in its approach to the energy trade network of Türkiye, fills a gap in comprehending the roles and positions of actors by implementing the social network analysis. Considering the findings and existing literature alike, the study provides conclusions regarding Türkiye's energy trade network and recommends strategies, aiming to contribute valuable insights to the field.

Energy Supply, Distribution and Consumption

In addition to the rising global electricity and gasoil demand, the sourcing of materials such as steel, aluminum, concrete, and similar construction materials extensively used in urbanization projects, including road construction, mass transit projects, and the construction of residential and commercial buildings is a significant factor influencing energy consumption (Zhou et al., 2012, p.202-220). Furthermore, the increase in individuals' use of personal vehicles and the transportation of agricultural products from rural areas to cities are among the factors that significantly affect the increase in energy consumption within the scope of urbanization (Jones, 1989, p.29-44). The involvement of energy trade in such crucial aspects of energy production and circulation goes beyond profit motives; it plays a pivotal role in determining countries' strategic positions on the international stage and holds a substantial place in development plans.

Energy trade is not merely a for-profit but also a sector that governments continuously intervene in as part of their national strategies (Zehir, et al., 2023, p.2). When we refer to energy trade, we are essentially discussing the trade of "primary energy sources carrying production value," encompassing various raw materials with this particular characteristic. However, three dominate the entire market among these raw materials: oil, natural gas, and coal. Among these three energy sources, the dominance of crude oil derivatives in the energy markets (Zhong et al., 2016, p. 868-877). Figure 1 represents the global consumption rates of primary energy sources in 2022 according to the most recent data from the 2023 World Energy Outlook by IEA (International Energy Agency). (IEA, 2023a):

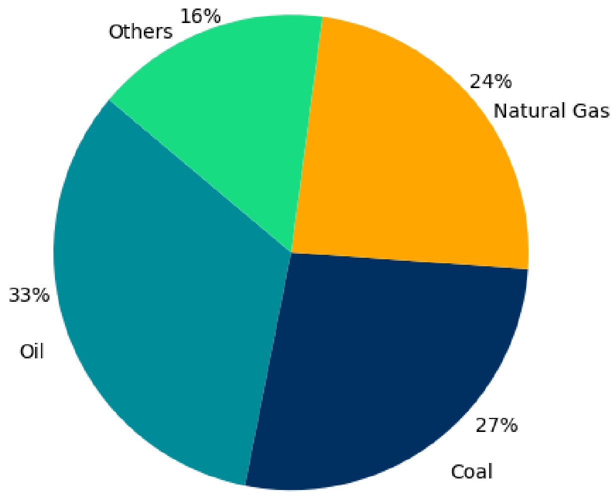

Figure 1: Consumption Rates of Primary Energy Sources in the Global Markets (2022).

The pie chart illustrates the global primary energy consumption by source. According to the data, oil accounts for approximately 33% of the total consumption, coal for 27%, and natural gas for 24%. Renewables and other energy sources, including nuclear, make up the remaining 16%. Despite progress in renewable energy adoption, fossil fuels continue to dominate the global energy landscape. This persistent reliance underscores the challenges in transitioning to cleaner energy sources to meet global climate goals. Significant efforts are required to enhance energy policies, increase renewable investments, and develop innovative technologies to reduce carbon emissions and achieve a sustainable energy future.

Currently, four significant blocks form the energy trade network. The first block consists of the countries led by the United States (US), including Canada, Mexico, Brazil, Venezuela, etc. The other blocks include Europe-Russia countries, East-Southeast Asia countries, and Australia-India-Africa countries (Guifeng et al., 2019, p.5).

Another key factor shaping the energy supply, demand, and trade network has been the significant progress made by the US in shale gas extraction technology since 2009. As a result, the US has transitioned from a net energy importer to a net exporter, taking historic steps to ensure its energy security. Under the influence of all these factors, reshaping occurs in the international energy network, and old behavioral patterns of countries are replaced by new ones (Hua, 2021, p.1-4)

Energy Resources and Classifications

Various resources are used worldwide to meet the energy needs required to benefit from today's technological tools, which have replaced human and animal energy that was intensively used before industrialization. These resources, referred to as primary energy sources, allow the obtainment of energy that can be used in final consumption, such as heat or electricity, or can be reconverted for use in another process. The crucial concept expressed by the terms “energy production” or “energy consumption” is the process of transforming energy (EIA [US Energy Information Administration], 2020). Factors such as the impossibility of the energy conversion process under all conditions and the high-cost investment it requires have led to the utilization of different energy sources at different times in history. With the replacement of human or animal power by machines in production and transportation methods, fossil energy sources, such as coal, oil, and natural gas, began to be used intensively. In addition to these fossil sources, various sources such as nuclear, wind, solar, and geothermal are also used to obtain energy today**.** Energy sources are classified in various ways. These classifications generally include (Akova, 2010, p. 8-9):

- Fossil Fuels (Non-renewable) and Renewable Resources
- Underground and Aboveground Resources
- Solid – Liquid – Gas Resources
- Organic and Inorganic Origin Resources
- Commercial and Non-Commercial Resources
- Primary and Secondary Resources

Proper and clear classification of primary and secondary energy sources is crucial for energy statistics. Distinguishing between newly entered (primary) energy into the system and energy obtained by transforming within the system (secondary) is necessary to prevent miscalculations in recording the transformations and losses experienced by the energy entering the system until its final consumption. In this context, the explanation considering the human factor shown in Figure 2 below summarizes this distinction (Øvergaard, 2008, p.5):

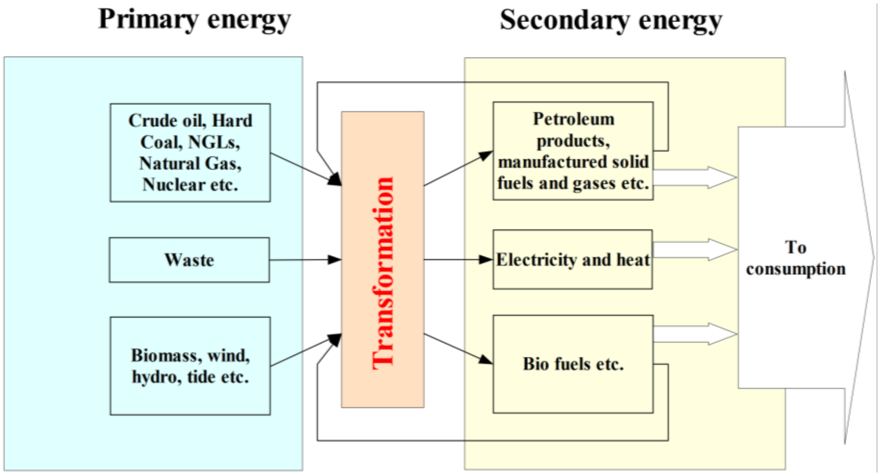

Figure 2: Primary and Secondary Energy Sources

Supply and Demand in Energy

Non-renewable primary sources, especially coal, oil, and natural gas, are widely used in electricity generation activities. Non-renewable primary sources, especially coal, oil, and natural gas, are widely used in electricity generation activities. Radioactivity-based nuclear energy is also prevalent in electricity production operations and poses significant environmental threats worldwide. Figure 3 shows the approximate usage rate of primary energy sources in electricity generation worldwide (IEA, 2023b):

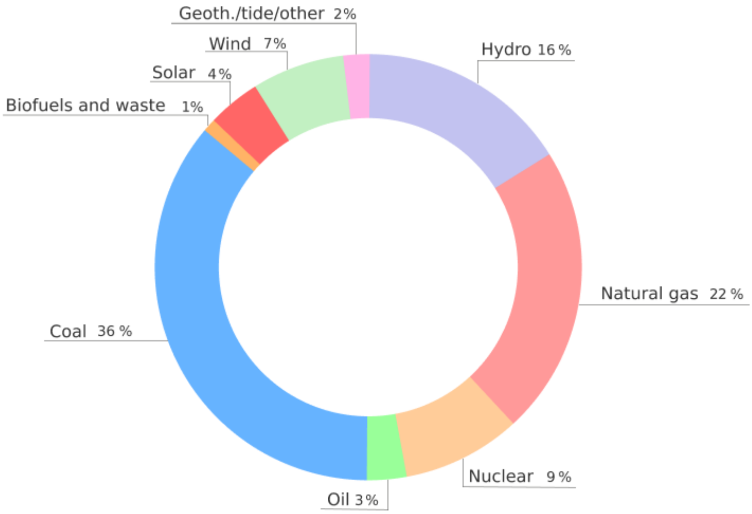

Figure 3: Global Electricity Generation Rates According to Primary Sources - 2023

According to the figure, coal usage constitutes 36% of the world's primary energy sources, while oil usage is 3%. In addition, nuclear energy accounts for 9% of the total consumed primary sources. The use of natural gas, known to pollute the environment less than coal and oil, has been steadily increasing, especially in recent years. As evident, all these mentioned types of resources in the non-renewable energy category collectively make up more than 70% of the total consumed sources. Therefore, it is apparent that the consumption of non-renewable energy sources, which still significantly contribute to disrupting the balance of nature, is relatively high today.

In the global electricity generation sector, coal holds a usage share of 38%, making it the most produced and traded commodity in terms of quantity (Zhong et al., 2016, p. 868-877). According to the International Energy Agency (IEA) data, coal is predominantly consumed for industrial activities but is also utilized in various sectors such as households, commercial services, public utilities, agriculture, forestry, and, to a lesser extent, in sectors like fishing and transportation (IEA, 2023c).

During the transition to industrial production, petroleum has assumed a significantly different role, becoming a vital component, particularly with advancements in the transportation sector (Black, 2020). Presently, petroleum is extensively used in sectors such as tourism, logistics, industry, agriculture, forestry, and fishing, besides being a primary energy source for transportation.

"The global consumption of crude oil reached 100 million barrels per day in 2019 but experienced a reduction to around 90 million barrels per day in 2020 due to the severe impact of the COVID-19 pandemic on various sectors, especially tourism (IEA, 2023d). With developments such as the production of vaccines against the disease in 2021, the gradual easing of quarantine and restriction measures has led to a resurgence in petroleum demand. According to the latest OPEC report, global oil demand is projected to average 102.2 million barrels per day in 2023, with a slowing growth of 1.1 million barrels per day in the first quarter of 2024 (OPEC, 2024, p.28).

Natural gas production has been increasing annually in response to rising consumer demand driven by household, commercial, industrial, and electricity generation needs (Henderson & Shahidehpour, 2014, p.12-19). Natural gas, with lower production costs and carbon emissions compared to coal and oil, witnessed consumption growth from approximately 44 million TJ (Terajoule) in 1990 to around 75 million TJ in 2018, according to the International Energy Agency (IEA, 2023d). Recent data from the IEA indicates that natural gas consumption reached approximately 4,036 billion TJ in 2022, with a projected 2.3% increase in 2023 driven by robust demand in Asian markets (IEA, 2023a; IEA, 2024).

Currently, nuclear power plants globally produce 2,710,430 GW/h of electricity, constituting approximately 10% of the total electricity generated worldwide (IEA, 2023b). As for the European Union, it supplies 25% of its total electricity from nuclear energy production (Zehir et al., 2023, p.2-12).

Finally, the renewable energy sector has grown substantially, adhering to the concept of meeting present needs without compromising the resources of future generations (Brundtland, 1987). As of 2018, the share of renewable energy sources (including hydro, solar, wind, geothermal, wave, biofuels, and other sources) in electricity generation reached approximately 25% (IEA, 2023e).

Global Actors of Energy Sector and Türkiye

The strong link between supply security and national security indicates that economic and political stability is highly dependent on energy supply. States compete intensely for a share of energy resources, with leaders seeking dominance in regions rich in fossil energy, particularly in the Middle East and North Africa (Erdoğan, 2017, p.10-26). This competition has led to worrisome developments driven by policies implemented by powerful actors (Kedikli & Çalağan, 2017, p.120-138). On the other hand, EU countries, susceptible to environmental issues, are committed to achieving zero greenhouse gas emissions in the long term. They actively work to reduce carbon emissions and encourage non-union countries to do the same (European Commission, 2018, p.2-76). Figure 4 displays the countries with the highest energy demand, along with their approximate consumption quantities in MTOE for the year 2019 (Enerdata, 2020a).

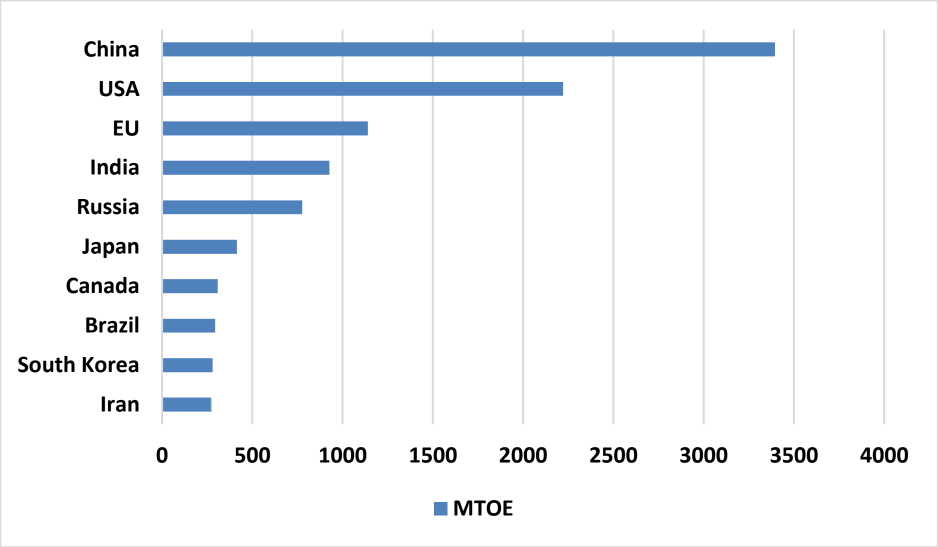

Figure 4: Global Electricity Consumption Rates Based on Primary Sources

Energy consumption rates alone can be misleading indicators of a country's industrial profile. For instance, despite China ranking first in energy consumption, the USA holds the top spot in GDP, as depicted in the figure. This disparity is also evident in the comparison between China and the EU (World Bank, 2020a). It becomes apparent that the USA or the EU generates more output while consuming less energy than China. Hence, considering a comprehensive set of data in the analysis is crucial for minimizing the margin of error. Figure 5 presents data on energy production, another pivotal factor in distinguishing oneself in the energy markets, alongside production amounts measured in MTOE (Enerdata, 2020b).

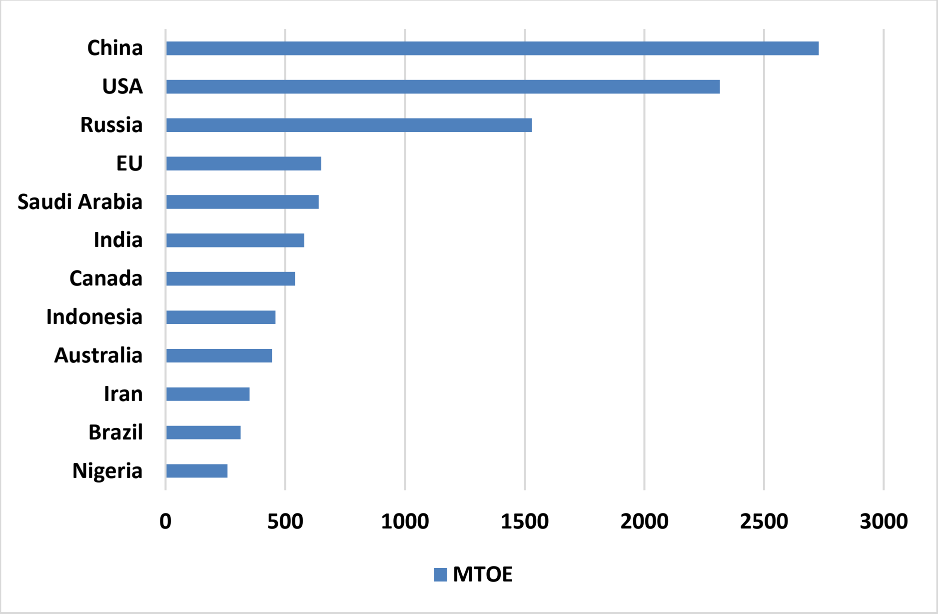

Figure 5: Global Electricity Production Rates Based on Primary Sources - 2020

One of the crucial points to note is that, when evaluating the graphs in Figures 4 and Figure 5 together, despite India and China ranking highest in global energy production, their energy production falls below the amount they consume. This is a significant indicator that they heavily rely on energy imports.

To better filter out the countries considered global powers and dominant in energy markets, it is essential to examine an important aspect beyond energy production and consumption. Analyzing how the volume of production-consumption reflects the country's level of development, particularly through examining the ratios of GDP and per capita GDP (PPP), is crucial. Table 1 illustrates the countries that rank in the top 10 in global energy production and consumption, as shown in the previous figures (Enerdata, 2020a, 2020b). Additionally, it highlights countries that also rank in the top 100 in terms of GDP and per capita GDP (PPP) ratios (World Bank, 2020a, 2020b).

Table 1: Dominant Actors in Energy Sector

Countries	Consumption	Production	GDP	GDP (PPP)
USA	2	2	1	15
China	1	1	3	108
EU	4	3	2	39
Russia	5	3	12	70
Canada	7	7	11	34

As a result, it can be stated that the dominant states in the energy market are actively involved in energy production and consumption activities. They have robust and diverse energy trade networks, and they hold influence in energy markets due to their economic and political strength. These countries are capable of making strategic moves in their own interest, influencing price increases or decreases. As seen in the table, notable organizations in this regard United States and China, EU (particularly leading countries), Russia, and to some extent, Canada.

Türkiye holds a strategically advantageous position for transmitting energy resources to markets, bordered by the resource-rich Caspian Region, Russia, and the Middle East on one side and serving as a crossroads for trade routes to energy-demanding European and Atlantic countries on the other. Since 2010, Türkiye has been among the OECD countries experiencing the highest growth in energy demand and has avoided prolonged economic stagnation witnessed by some European countries (EIA, 2017). As of 2023, Türkiye's gross domestic product is approximately 1.024 trillion US dollars at the current exchange rate (World Bank, 2023). With a population of about 85.8 million (TÜİK, 2023), Türkiye falls into the category of developing countries (UN, 2023), where the use of fossil fuels remains prevalent, as depicted in the graph illustrating Türkiye's primary energy sources consumption data as of 2019 (BP [British Petroleum], 2020).

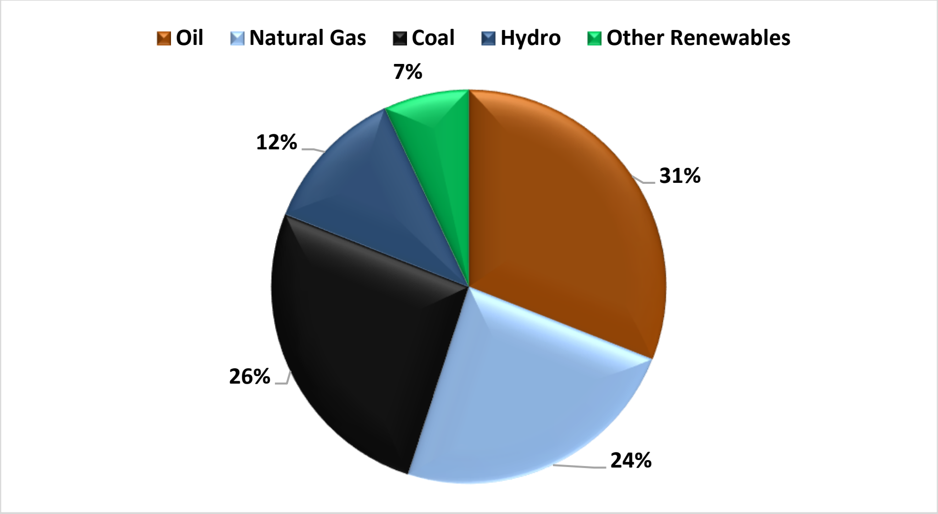

Figure 6: Primary Energy Consumption by Sources in Türkiye

As a net energy importer, Türkiye relies on imports for approximately 75% of its energy supply. This situation results in around 31% from oil, 24% from natural gas, 26% from coal, 12% from hydroelectric, and 7% from other renewable sources, forming only a quarter of the total imports. Factors such as insufficient production of oil and natural gas, inadequate investment in renewable energy sources, and the historical lack of emphasis on energy management contribute to the increasing dependence on external sources in the energy sector (Yılankıran & Doğan, 2020, p.77-92).

Energy policies in development plans are executed in connection with numerous issues. Particularly, global power struggles in geopolitical, economic, and military domains in the region that closely concerns Türkiye significantly impact matters such as energy investments and trade. Therefore, in the competitive environment, it is crucial for Türkiye to maximize the utilization of its advantageous elements. Within this context, the priority in the pursued policies has been to benefit from Türkiye's position as both an energy-producing country and a net energy importer. Efforts have been made to establish Türkiye as a significant actor at the regional level, considering the ongoing global power struggles in the geopolitical, economic, and military spheres within the geographic proximity.

In addition, the liberalization process in the energy market has increased the role of the private sector in electricity production. Investments in renewable energy sources have been incentivized, and there has been a focus on using local coal in electricity generation. Improvements have been made in areas related to the search and exploration of energy resources, and various projects have been carried out in different regions, including exploration activities for oil and natural gas in the license areas of the Turkish Republic of Northern Cyprus. Underground natural gas storage areas have been expanded, the foundation for an Energy Security Operation Center has been laid in Mersin province, and efforts have been initiated for the establishment of new nuclear power plants (TC Cumhurbaşkanlığı Strateji ve Bütçe Başkanlığı, 2019, p.4-21).

Türkiye in Energy Trade: Implementation of Social Network Analysis

The social network analysis method, which takes its starting point from the emergence of social relationships, focuses on examining the relationships between individuals or organizations, referred to as nodes, that have one or more relational connections. Social network analysis is known as a systematic and empirical method applied in the context of social actors' structured relationships, relying on mathematical computation models, primarily utilizing graphs and figures (Freeman, 2004, p. 3). The results obtained in social network analysis are essential to be presented visually through graphs, where actors are represented as nodes and relationships are depicted as lines (Hawe et al., 2004, p. 973).

In the context of energy trade volumes where factors other than the energy demand of countries are effective, the current situation of energy trade networks and the characteristics of Türkiye's energy trade network, as well as its position in global trade, can be revealed through social network analysis. This method relies on empirical data, systematic work methods, graphical representation of findings, and the use of mathematical methods (Freeman, 2004, p. 3).

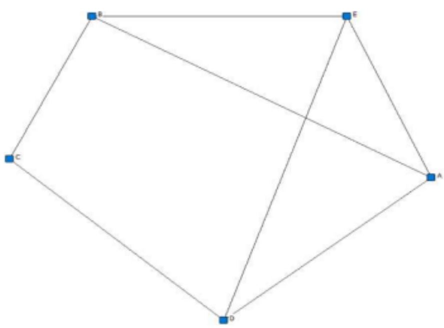

Figure 7: An Example Scheme for Social Network Analysis

Social network analysis, as a social science, enables the study of networks where individuals, species, teams, or organizations of various sizes and types can participate as actors (Borgatti et al., 2013, p.1-2). This methodology has been employed in various studies examining intergovernmental interactions and trade. The previous studies applied the method in various datasets and in different aspects.

One notable study among these endeavors applied network analysis to investigate international trade between 1965 and 2000. Using the Structural Equivalence criterion, the study revealed the hierarchical nature of the world economy's structure, exposing the hierarchical nature of the economic system. In a study exploring the impact of changes related to globalization and the New International Division of Labor on structural inequality in the world economy, it was concluded that these concepts benefited only a few countries, contributing to structural inequality on a global scale. The author, utilizing UCINET software for analysis, indicated that the trade volumes of South Korea, Singapore, and Türkiye showed promising upward trends. However, it was highlighted that the current system has impoverished many countries participating in the world economy (Mahutga, 2006, p.1863-1889).

Moreover, in another study focusing on the social network analysis of the West African trade network, traders with an annual trade volume above a certain threshold in five different border markets within Niger, Nigeria, and Benin were selected using the snowball sampling method. These selected traders were then queried about whom they perceived as their commercial collaborators. The study, exclusively aiming to measure relationships among traders, excluded trader-state commercial relationships. Through analyses based on betweenness centrality, the research identified significant trade hubs in West African countries, elucidating the points at which strong or weak ties come into play in the context of commercial activities in the region (Walther, 2014, p.179-203).

Furthermore, another study aiming to examine the relationship of conflicts worldwide through social network analysis, conflicts that occurred globally between 1978 and 2018 were obtained from the GDELT dataset (Global Data on Events, Location and Tone). These conflicts and their relevant countries were then entered into an adjacency matrix based on geographical proximity. Subsequently, social network analysis was conducted by applying Centrality (Betweenness, Closeness, Degree) criteria. The analysis revealed that the countries with the highest centrality level in global conflicts were identified as the United States, Russia, and Israel. Based on these findings, it was concluded that the United States is the most connected country with other nations and the primary actor in the occurrence of conflicts. Another notable point highlighted in the study is the observation that a few countries have connections with a large number of countries, while many countries have very few connections (Çelik, 2019).

Base Theories of Social Network Analysis

Within the scope of social network theory, which primarily focuses on examining relationships among actors rather than the actors themselves, one of the most crucial debates has revolved around determining the types of network relationships that provide benefits. While various opinions exist on this matter, three theories are generally accepted, namely strong ties, weak ties, and structural holes (Sayğan Tunçay, 2016, p.38). Thus, in addressing the research questions, these three theories, recognized as pivotal in social network analysis, have been considered.

Strong Ties (Closure) Theory: The Strong Ties Theory focuses on the closure feature of social networks. Emphasizing the positive impact of actors with close relationships, this theory (Gargiulo and Benassi, 2000, p.184; Burt, 2001, p.37-38) argues that relationships between actors are important when they are strong, implying that strong relationships indicate tight interaction among actors. In the context of energy trade relationships, having strong ties within the global network is considered a significant advantage. In other words, countries engaged in energy trade should have strong ties with at least some of the countries they trade with. A country without strong ties may not dominate the network.

Weak Ties Theory: The Weak Ties Theory refers to a situation where the intensity of relationships among actors in any social network is low. In energy trade, it is understood that having not only strong ties but also a significant number of weak ties is essential for a country. In other words, to strengthen and reinforce its position in energy trade, a country should not only strengthen its ties with existing actors but also emphasize increasing weak ties by collaborating with new actors.

Structural Holes Theory: Ronald Burt's theory of structural holes, proposed in 1997, expands and reorganizes the weak ties theory. While Granovetter's weak ties theory emphasizes the quality of ties, Burt's structural holes theory focuses on bridging different groups. Burt (2000, p.353-354; 2001, p.34) highlights the strategic advantage derived from actors establishing bridges, creating a brokerage position. He asserts that the presence of unconnected actors within a network reveals structural holes and that actors filling these structural holes through the bridges they create gain a competitive advantage (Burt, 1997, p.341-343; 2000, p.353-354; 2001, p.34-35).

The Purpose and Value of the Research

The strategic significance of energy resource trade lies in its distinction from many other products, as it is conducted not solely for profit but also involves continuous intervention within the national strategies of countries. It serves as a crucial tool for governments to achieve their political objectives. Despite Türkiye's position as a country situated between net-exporting and net-importing nations within the category of developing countries, various challenges, such as high dependence on fossil fuels, technological and economic inadequacies, and regional conflicts of interest, have led it to be a net energy importer.

The primary objective of this study is to examine Türkiye's energy trade network using social network analysis. The study delves into the network formed by countries involved in Türkiye's energy trade, employing social network analysis to calculate the network's density. Additionally, efforts are made to identify central (hub) and intermediary actors (countries) within the network using various centrality criteria. Furthermore, the study aims to reveal the strengths of dyadic relationships between actors through the use of network mappings in social network analysis. The specific objectives of the study include:

- Calculating the magnitude of energy trade within the social network formed by countries involved in Türkiye's energy trade and comparing to global energy trade.
- Determining the density of the network in question.
- Identifying the most central actors, hub, and intermediary countries within the network.
- Uncovering which dyadic relationships between actors exhibit significant levels of strong or weak ties.

- Investigating whether countries recognized as global energy actors, based on existing literature, dominate Türkiye's energy trade network.

The in-depth examination of the network comprising countries engaged in energy trade with Türkiye, along with the utilization of systematic and empirically-based data and visually interpretable social network maps, highlights the potential usefulness of employing social network analysis based on mathematical calculations for academics and practitioners interested in this field in the future.

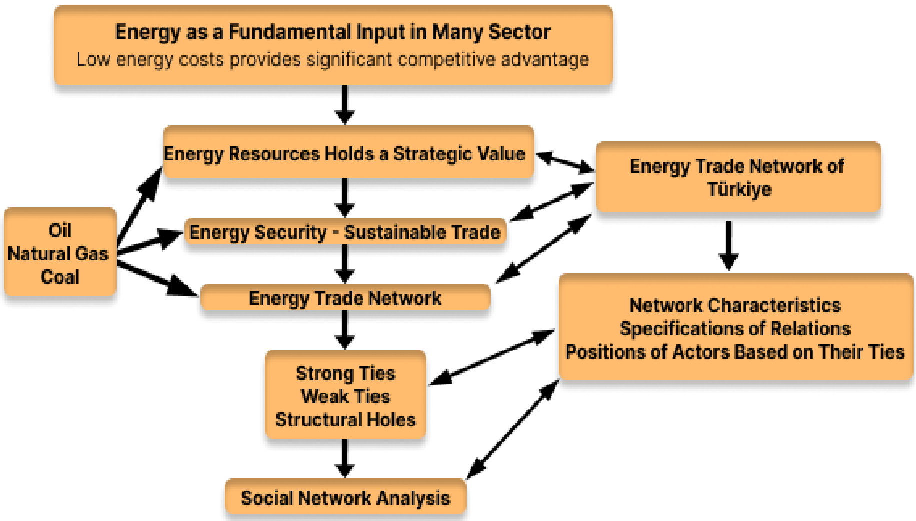

Figure 8: Subsequent Framework of the Study

The provided framework illustrates the comprehensive approach undertaken in the study to analyze Türkiye's energy trade network through social network analysis. At the core, the study recognizes energy as a fundamental input in many sectors, where low energy costs provide a significant competitive advantage. The strategic value of energy resources—such as oil, natural gas, and coal—is emphasized, highlighting their role in ensuring energy security and facilitating sustainable trade.

The central focus is on the "Energy Trade Network," which encompasses the relationships and trade flows between various countries. The framework further delves into the specifics of Türkiye's energy trade network, analyzing its characteristics, relational specifications, and the positions of actors based on their trade ties.

The study employs social network analysis to examine these dynamics, utilizing metrics such as strong ties, weak ties, and structural holes to understand the intricacies of the network. This analysis helps identify the centrality and importance of different countries within the network, providing insights into the connectivity and influence of Türkiye's energy trade relationships.

Overall, the framework encapsulates the study's objective to provide a detailed examination of the energy trade network, emphasizing the significance of strategic energy resources and the implications for energy security and sustainable trade practices.

Research Method

The study focuses on energy commodities traded under the "27" code, representing the "fuels" group according to the "HS 1988/92" customs product classification. Data on the trade volumes of countries in the selected product group are presented in US dollars on a yearly basis. Although both export and import data are available in the source, only import data is considered in the study since it is suggested that import data more accurately reflects reality. The data matrix prepared for input is entered as weighted and asymmetric. This is because the mutual import and export ratios of countries may not be equal, and they may not have an equal relationship within the total energy trade volumes.

Network density is calculated by dividing the number of existing connections in the network by the number of all potential connections that could exist (Wasserman & Faust, 1994, p.101-103). The total potential connections can be found in a symmetric matrix with the formula n(n-1)/2, where "n" is the number of actors, and in an asymmetric matrix, it can be found with the formula n(n-1) (Borgatti et al., 2018, p.216-217; Hanneman & Riddle, 2005, p.95). Therefore, network density is calculated by dividing the number of connections in the network by the number obtained with this formula. Figure 9 includes some drawings to explain the concept of network density.

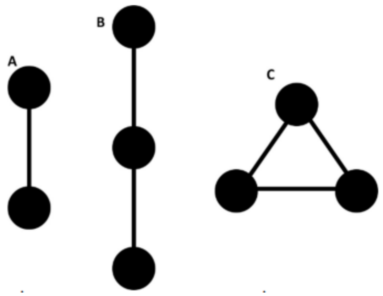

Figure 9: Examples for Network Density

From the drawn network examples, in system A, where the total possible number of connections is 1, the current number of connections is also 1. In other words, the current number of connections in the system is equal to the maximum possible number of connections. In system B, the total possible number of connections is 3, and the current number of connections is 2. Finally, in system C, the current number of connections is equal to the maximum possible number of connections, both being 3. Based on this, the network densities for these three systems can be calculated as follows: for A, it is 1/1=1; for B, it is 2/3≈0.667; and for C, it is 3/3=1. These calculations are valid for a symmetric network; however, in an asymmetric connection, where a relationship is two-way, meaning there are two relationship values on one connection, these numbers will vary depending on whether the relationships between actors are one-sided or reciprocal. As the connections between actors in the network increase, the increasing network density decreases, as seen in the given example, when approaching zero.

Upon revealing density value, the analysis calculated centrality degrees, indicating the importance of a node (country) based on its connections within the network. The centrality metrics classified under three major subheadings as inner centrality, outer centrality, and betweenness centrality.

Inner Centrality, also known as in-degree centrality, this measures the number of incoming connections a country has, indicating how much energy it imports from other countries. A higher inner centrality suggests a country is a significant importer in the network. On the other hand, outer Centrality is known as out-degree centrality. This metric measures the number of outgoing connections a country has, indicating how much energy it exports to other countries. A higher outer centrality suggests a country is a significant exporter in the network (Freeman, 1979, p.215-239). Furthermore, betweenness centrality measures the extent to which a country lies on the shortest paths between other countries, indicating its role as an intermediary or broker in the network. High betweenness centrality implies that a country is crucial for the connectivity and flow of energy trade between other countries (Freeman, 1977 p.39-40; Newman, 2005, p.39-54).

By employing social network analysis in UCINET, the study was able to visualize and quantify the complex relationships in the global energy trade network, thereby facilitating a deeper understanding of the trade dynamics, involving Türkiye.

Findings

The study aims to provide a comprehensive understanding of Türkiye's engagement in the trade of energy commodities. By examining the density values of the energy trade network, the quantities of energy trade between actors, and the centrality degrees of countries within the network, the significance of this network has been exposed in the context of the world's total trade volume.

The research focuses on reciprocal import values, interpreting import figures between actors as relationship weights, and includes countries with more than 0.15% of the total trade volume of Türkiye's energy products in the trade network. The countries in the network with Türkiye are Russia, Iran, India, Colombia, the United States, Israel, Algeria, Greece, Bulgaria, Australia, Italy, the United Arab Emirates, Kazakhstan, Egypt, Norway, Iraq, Spain, Canada, Romania, Belgium, the United Kingdom, South Africa, China, the Netherlands, and Germany. A literature review in the third section of the study highlighted Russia, Canada, the United States, China, and Germany, known as global energy actors, due to their leading positions in energy supply, demand, GDP, and per capita GDP. These countries, along with some European Union nations, are also prominent in the created network.

The analysis evaluates whether these countries, considered as global actors based on theories of strong ties, weak ties, and structural holes, play a dominant role in Türkiye's energy trade network. The study initially determines the share of Türkiye's transaction volume in the global energy trade by transferring energy import data to the matrix and calculating the ratio to the total global energy import figures.

The study highlights that Türkiye's energy trade network, with a total trade volume of $738.68 billion, holds approximately 32% of the total global energy trade volume of $2.306 trillion (World Bank, 2021). This indicates that Türkiye's energy trade network is significant in the context of global energy trade. The key point here is that the "network" refers to the trade relationships between Türkiye and other countries. The significance of this network is derived from the fact that it encompasses a substantial portion of the global energy trade. The ties within this network are crucial because they include all the countries that actively trade energy commodities with Türkiye. For instance, if Türkiye trades with major economies like the US and China, the trade between these countries is included in the network's trade volume. Conversely, if Türkiye does not trade with a particular country, such as North Korea, the trade between North Korea and other countries (e.g., China) is excluded from the network's numbers. Therefore, the network's significant value of 32% means that nearly one-third of the total global energy trade volume occurs between the countries that are part of Türkiye's energy trade network. This highlights the extensive reach and importance of Türkiye's trade ties in the global energy market.

In light of the information on density, the maximum number of possible connections in Türkiye's energy trade network for the year 2019, calculated according to the formula n(n-1) as 26x25=650. The existing number of connections is provided in the matrix table, considering trade amounts below 1 million USD as "0" or non-existent within import and export relationships.

As evident in the table presented in Table 2 the constructed network contains a total of 472 connections. Consequently, the density calculation for Türkiye's energy trade network is determined as 472/650=0.726 (approximately). While this figure suggests a dense network, it is crucial to note that the perception of density can be subjective based on the context of the research. For instance, in a study concerning the acquaintance among individuals working in a Faculty of Economics and Administrative Sciences department, this figure might be relatively low. However, in an investigation focusing on individuals who share their dinner every evening within the faculty, the density might appear considerably higher (Borgatti et al., 2018, p.216-217). Nevertheless, considering that the calculated figure representing the density of energy trade relationships exceeds 0.5 and is close to the maximum value of 1, it may be inferred that energy trade network of Türkiye is a dense network. Table 2 shows the trade matrix of top organizations in 2019. While "1" shows the trade is above $1 millon and "0" means the trade is below the specified amount:

Table 2: Energy Trade Matrix of Türkiye ($1 Million Threshold)

Country	TR	RU	IR	IN	CO	US	IL	DZ	GR	BG	AU	IT	AE	KZ	EG	NO	IQ	ES	CA	RO	BE	UK	ZA	CN	NL	DE	TOTAL
TR	0	1	1	1	1	1	1	1	1	1	0	1	1	1	1	0	1	1	0	1	1	1	1	1	1	1	22
RU	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
IR	1	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	1	1	0	6
IN	1	1	1	0	1	1	1	1	1	0	1	1	1	0	1	0	1	1	1	1	1	1	1	1	1	1	22
CO	1	1	0	1	0	1	0	0	0	0	1	1	0	0	1	1	0	1	1	0	1	1	1	1	1	1	16
US	1	1	0	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	24
IL	1	1	0	1	1	1	0	0	1	0	0	1	0	0	0	0	0	1	0	0	1	1	0	0	1	1	12
DZ	1	0	0	1	0	1	0	0	1	0	1	1	1	0	1	0	0	1	0	0	1	1	0	1	1	1	14
GR	1	0	0	1	0	1	1	1	0	1	0	1	1	0	1	0	1	1	1	1	1	1	0	1	1	1	18
BG	1	0	0	0	0	1	0	1	1	0	0	1	0	0	1	0	0	1	0	1	1	1	0	0	1	0	11
AU	1	0	0	1	0	1	0	0	0	0	0	1	1	0	0	0	0	1	0	0	1	1	1	1	1	1	12
IT	1	1	0	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	24
AE	1	0	1	1	0	1	0	1	0	0	1	1	0	0	1	0	1	1	1	0	1	1	1	1	1	0	16
KZ	1	1	0	1	0	1	0	1	1	1	0	1	0	0	0	0	0	1	1	1	1	1	0	1	0	1	15
EG	1	1	0	1	0	1	0	1	1	1	0	1	1	0	0	0	0	1	1	0	1	1	1	1	1	1	17
NO	1	0	0	1	0	1	0	0	1	0	0	1	1	0	0	0	0	1	1	0	1	1	1	1	1	1	14
IQ	1	0	0	1	0	1	0	0	1	1	0	1	1	0	1	0	0	1	0	1	0	0	0	1	1	1	13
ES	1	1	0	1	1	1	1	1	1	1	1	1	1	0	1	1	1	0	1	1	1	1	1	1	1	1	23

CA	1	1	0	1	1	1	1	0	1	0	1	1	1	1	1	1	0	1	0	1	1	1	1	1	1	1	21
RO	1	1	0	0	0	1	1	1	1	1	0	1	0	0	1	0	0	1	0	0	1	0	1	1	1	1	15
BE	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	24
UK	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	24
ZA	1	0	0	1	0	1	0	0	0	0	1	1	1	0	1	0	0	1	0	0	1	1	0	1	1	1	13
CN	1	1	0	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	0	1	1	1	0	1	1	22
NL	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	24
DE	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	25
TOTAL	**25**	**16**	**6**	**23**	**12**	**24**	**14**	**17**	**20**	**14**	**15**	**24**	**20**	**10**	**20**	**11**	**13**	**24**	**16**	**16**	**23**	**22**	**18**	**23**	**24**	**22**	**472**

In addition to the density features, the study employs centrality metrics, indicating the dominance of actors, and their ability to perform brokerage activities to measure the strength of relationships among actors within the network.

Centrality measures are criteria that help reveal the importance level of actors within a network. A high level of centrality indicates that the actor holds a strategic position in the network due to their position. Centrality is a widely used criterion in measuring sociological and economic aspects such as control over resources, degree of access to resources, and information transfer (Wasserman & Faust, 1994, p.169-174).

In the context of asymmetric data, distinguishing between the concepts of inner degree and outer degree centrality becomes crucial, as observed in Türkiye's energy trade network. Inner degree centrality denotes the number of connections incoming to an actor, whereas outer degree centrality indicates the number of connections going from the actor to others. Actors with high inner degree centrality, receiving numerous connections from others, are considered dominant or prestigious in the network. On the other hand, those with high outer degree centrality are suggested to have significant influence in the network, either in terms of information flow or economic trade, thus being influential (Hanneman & Riddle, 2005, p.147). The Tables 3 and 4 shows the inner and outer degree centralization values:

Table 3: Degree Centrality Metrics of Energy Trade Network of Türkiye

DEGREE CENTRALITY RESULTS			
Inner Degree		**Outer Degree**	
Country	**Percentage**	**Country**	**Percentage**
Russia	100%	Türkiye	100%
Germany	100%	USA	96%
USA	96%	Italy	96%
Italy	96%	Spain	96%
Belgium	96%	The Netherlands	96%
UK	96%	India	92%
The Netherlands	96%	Belgium	92%
Spain	92%	China	92%
Türkiye	88%	UK	88%
India	88%	Germany	88%
China	88%	Greece	80%
Canada	84%	UAE	80%
Greece	72%	Egypt	80%
Egypt	68%	S. Africa	72%

Colombia	64%	Algeria	68%
UAE	64%	Russia	64%
Kazakhstan	60%	Canada	64%
Romania	60%	Romania	64%
Algeria	56%	Australia	60%
Norway	56%	Israel	56%
Iraq	52%	Bulgaria	56%
S. Africa	52%	Iraq	52%
Israel	48%	Colombia	48%
Australia	48%	Norway	44%
Bulgaria	44%	Kazakhstan	40%
Iran	24%	Iran	24%

The external degree centrality in energy product exports indicates that globally recognized energy actors that dominate the network. In the trade network centered around Türkiye, Russia, Germany, and the United States exhibit higher centrality values in energy exports than Türkiye. Despite Türkiye's centrality not being meaningful in the context of a Türkiye-centered energy trade network, the noteworthy finding is that other countries have higher centrality in this network. Germany, a known net energy importer like Türkiye, ranks highest in export centrality, emphasizing Türkiye's underutilized potential. China and Canada, despite ranking lower than Türkiye, demonstrate strong external degree centrality, indicating a robust position in Türkiye's energy trade network. Notably, India, not classified as a global energy actor due to its low per capita GDP, holds a strong position with an 88% external degree centrality in Türkiye's energy trade network, suggesting its significant role despite global rankings. Conversely, Iran, a net energy exporter, exhibits a notably low external degree centrality, potentially reflecting the impact of U.S. sanctions on its energy trade and highlighting the influence of political relations and power struggles in shaping the energy market.

On the other hand, examining the inner degree centrality values related to energy product imports, global energy actors such as the U.S., EU countries, and China rank high, while Russia and Canada do not due to their leading energy production status and substantial energy imports despite being net energy exporters. Other actors with low inner degree centrality are also net energy exporters. India's significant position with a 92% inner degree centrality is noteworthy, indicating its potential strength in energy commodities, essential inputs in nearly all sectors. India could make substantial strides if it effectively addresses its managerial challenges and leverages this advantage.

Analyzing both inner and outer degree centrality values reveals that countries identified as global energy actors in this study have high centrality values. Particularly in the outer degree centrality table, Russia, the U.S., and some EU countries have higher centrality values than Türkiye, providing crucial insights into the positions of these countries in Türkiye's trade network.

Degree centrality, criticized for considering only direct connections and ignoring indirect ones, is deemed applicable in this study as there are no isolated actors in Türkiye's energy trade network, and the network exhibits relatively high density. This mitigates the criticism regarding the degree centrality criterion for the network (Hanneman & Riddle, 2005: 155).

In addition to degree centrality, betweenness centrality is another fundamental metric in social network analysis, which measures the ability of an actor to mediate based on the geodesic distance between any two actors in the network. It signifies not only being an intermediary among multiple actors but also holding the unique position of the sole intermediary between two actors (Hanneman & Riddle, 2005, p.163).

When an actor is in an isolated state, or all other actors are interconnected, their betweenness value can be zero. Maximum betweenness is achieved when an actor occupies the position of the sole intermediary in all geodesic distances among other actors in the network. Betweenness is generally defined as the power to control flows in the network. An actor with high betweenness centrality, acting as a gatekeeper in the network, possesses the ability to disrupt activity flows in the network (Borgatti et al., 2013, p.176).

However, the strength or weakness of this position depends on the ease with which other actors, with their own betweenness centrality, can form new connections by bypassing the actor in question. An example illustrating this is a medieval Russian trade network where Moscow, initially indistinguishable from other Russian principalities in the 12th century, quickly rose to a superior position. This transformation was attributed to the trade routes between principalities running along rivers, with Moscow situated at a crucial center. Other principalities, unable to find alternative routes due to geographical constraints, were compelled to accept Moscow's high toll demands for many years (Borgatti et al., 2013, p.177). The betweenness centrality values of actors in the 2019 Türkiye energy trade network are presented in Table 4:

Table 4: Betweenness Centrality Results of Energy Trade Network of Türkiye

BETWEENNESS CENTRALITY RESULTS		
Country	**Betweenness**	**nBetweenness**
The Netherlands	19,403	3,234
Türkiye	17,763	2,960
Germany	14,598	2,433
India	13,876	2,313
USA	13,670	2,278
Italy	13,670	2,278
China	13,315	2,219
Belgium	12,441	2,074
Spain	11,965	1,994
UK	11,565	1,928
Russia	7,342	1,224
UAE	6,929	1,155
Greece	4,415	0,736
Canada	3,990	0,665
Romania	3,913	0,652
Egypt	3,556	0,593
Algeria	1,511	0,252

Colombia	0,889	0,148
S. Africa	0,825	0,138
Iraq	0,571	0,095
Bulgaria	0,514	0,086
Israel	0,495	0,082
Kazakhstan	0,354	0,059
Australia	0,206	0,034
Norway	0,134	0,022
Iran	0,091	0,015
Mean	6,846	1,141
Std. Dev.	6,300	1,050
Network Centralization Index: 2,18%		

The table reveals various values ranging from nearly zero to 19.4, indicating significant diversity with a mean betweenness of 6.846 and a standard deviation of 6.3. However, the total network centralization index is considerably low, suggesting that betweenness centrality is not overwhelmingly strong in the network. Despite the absence of dominant betweenness power, some actors in the network exhibit significant differences in betweenness centrality compared to others. For instance, the Netherlands, known as a major energy hub in Northern Europe due to its role in oil refining and storage, ranks highest with a betweenness centrality degree of 19.4. This is not surprising given the country's prominent position in energy trade. Although Türkiye does not exhibit dominance in the betweenness, ranking second with a degree of 17.7 suggests its ability to wield betweenness power within its trade network. Notably, dominant energy players like Russia and Canada rank lower in the betweenness activities, potentially due to their direct export-focused connections. For example, Russia exports natural gas to neighboring countries, but the transmission to Central and Western Europe involves intermediary countries like the Netherlands. Similarly, Canada's export focus primarily on the United States contributes to its lower ranking (3.99) in betweenness centrality.

Conclusion and Discussion

The study employs social network analysis to investigate Türkiye's energy trade network derived from the import/export of dominant energy resources, namely oil, natural gas, and coal, extensively utilized as fundamental inputs across various sectors. Focusing on relational dynamics among actors rather than demographic characteristics, the research underscores the critical role of these energy sources in micro (individuals), meso (organizations), and macro (international/global) contexts, aligning with countries' strategic development plans. Figure 8 summarizes the framework of the paper.

The study delves into the international dimension of energy trade, exploring the policies and maneuvers of global and regional actors to assert dominance in ensuring energy supply security. Utilizing social network analysis, it scrutinizes the commercial relationships formed based on these policies, examining strong ties, weak ties, and structural gaps within the network through the lenses of network theories. The research highlights the critical role of energy resources, particularly oil, natural gas, and coal, which serve as fundamental inputs across diverse sectors and play a pivotal role in micro (individuals), meso (organizations), and macro (international/global) contexts.

The findings reveal that Türkiye's energy trade volume constitutes approximately one-third of the global energy trade. Despite the absence of a dominant actor in the network, certain actors exhibit more substantial brokerage power. Notably, the analysis underscores the influence of global energy players such as Russia, the United States, and some European countries like Germany, the Netherlands, and the UK, indicating their centrality in Türkiye's energy trade network.

The study emphasizes the importance of energy in economic and sociological aspects, particularly during energy shortages. Countries, aware of the significance of energy resources, shape their energy trade to fulfill their needs and, in some cases, utilize it as a tool beyond profit motives. The calculated total network centralization index suggests that Türkiye lacks strong brokerage activities, and actors with such power are relatively weak.

Furthermore, the examination of both external and internal centrality values reveals the dominance of the United States, EU countries, and China in global energy trade. The study notes Germany's unique position in the network despite being less dependent on fossil energy sources. Additionally, the low internal centrality of Russia and Canada suggests their vulnerability compared to the United States in the global energy trade network.

Subsequently, the social network analysis of Türkiye's energy trade network highlights its substantial role globally, emphasizing the need for Türkiye to leverage its position and address challenges and opportunities in energy supply and demand balance. Structural gaps, especially in trade relations with the U.S. and Russia, present opportunities for Türkiye to strengthen its position in the global energy landscape. Implementing policies focused on alternative energy sources, energy efficiency, and conservation, akin to Germany's approach, could further enhance Türkiye's energy trade.

Limitations

The unit prices at which energy resources are procured by states can be kept confidential for various reasons, raising concerns about the reliability of the obtained data. In addition to this issue, the inconsistency in export-import data provided by different national sources further complicates matters, making it challenging to determine which set of data is more realistic.

Another challenge, closely related with the same issue is countries do not provide their data regularly. On the other hand, the implementation of social network analysis requires as much data as possible. In this parallel, the more countries have missing data within the network in the selected year, the more ambiguous results will be obtained.

To address these problems, all data has been obtained by applying "fuels" and "imports" filters from the dataset provided by the World Bank. The data, considered reliable on an international scale, is acquired by various methods employed by this institution. Also, 2019 was selected as the most suitable year in terms of data availability. Yet, there was still a challenge in the form of missing 2019 trade data for three countries, namely Iraq, Iran, and Algeria, included in the network. To resolve this particular issue, the "export" filter was applied to the World Bank dataset, allowing for a separate examination of the exports to these three countries by the other nations in the network. This adjustment significantly mitigated the consequences of the mentioned problem.

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