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Value Chains in the Raw Materials Industry – the Example of the Cobalt Value Chain

Introduction

Critical raw materials (CRM) are an integral part of modern life, based on technology, electromobility and autonomy. At the same time, they are the foundations of development for innovative industries in every country. Due to their strategic importance, their use is growing dramatically, and with it the need to ensure their reliable and unlimited access through intensive exploration and mining. An important risk in these processes is that critical raw material deposits are located in politically unstable countries, where CRMs are a tool of governance and the revenue generated from their exploitation is an important source of export.

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Based on analyses, the global use of critical raw materials has been growing exponentially for a long time, especially in the context of lithium, cobalt or nickel. For over a century, statistics have shown that the average annual increase in global demand for raw materials is approximately 3% (Henckens et al. 2018). In the face of economic changes related to, for example, innovative technologies ensuring climate neutrality, it is estimated that the demand for raw materials will continue to grow.

Considering cobalt, which is one of the key materials for the production of batteries for mobile phones, laptops and electric vehicles (EV), it is estimated that the demand for that element may increase up to three times in the period from 2010 to 2040 (Howard and Gifford 2023). The indicated trends are particularly important in the case of Europe, due to its high dependence on the import of critical raw materials from non-European countries. Europe's dependence makes raw material supply chains vulnerable to numerous risks and threats of disruption. To reduce the risks and ensure stable functioning, it seems reasonable to promote safe, resilient, affordable and sufficiently diversified value chains to guarantee sustainable and secure supplies for the EU. The solution to that issue may be not only strengthening domestic supply chains but also reinforcing relations with third countries to develop international partnerships for mutual benefit. As a result, Europe as a continent has adopted a strategy of rebuilding exploration and mining capacity in order to become independent in terms of raw material extraction and develop recovery and processing processes. Educational programs in the form of studies and training are also serving this strategy at European universities by preparing professionals for the chosen strategic path. An example of such studies is the Raw Materials Value Chain (RaVeN) master's program implemented at AGH University of Krakow (Kustra et al. 2023).

The search for new sources of those raw materials, not only from natural deposits but also from waste, may also be the answer. However, some analyses indicate that due to low recycling rates, the mining industry will remain an important supplier of critical raw materials in the foreseeable future. Therefore, recycling would not eliminate the need for continued investment in new sources of raw material supply. However, based on a report (IEA 2022), it is estimated that by 2040, recycled volumes of copper, lithium, nickel and cobalt from used batteries could reduce the total demand for those raw materials by approximately 10%. Moreover, as indicated by Habib et al. (2014) in the long term, i.e. by 2100, the supply of recycled secondary raw materials can meet almost 50% of the demand while reducing the geopolitical aspects of supply risk due to geographical diversification by 2100.

As cobalt is one of the three most desirable critical raw materials, apart from lithium and nickel, the global value chains of that raw material are presented in this study. The focus is on an overview of the global sources of its exploration, extraction, processing and use in final products.

The research method used in this paper focuses on the review and analysis of global value chains for cobalt based on mapping the global sources of its extraction, processing and production within the value-added framework of each stage of the life cycle.

Based on the literature review, which initially contained a collection of 941 papers and was eventually reduced to 44, and on the existing acts, the current state of knowledge and the literature that relates to the subject of this study, the value chain for cobalt was identified. Additionally, the use of this raw material and the existing demand were examined. In this way, the possibilities for the operation of this chain in the future were indicated.

1. Raw material value chains

Critical raw materials are of key importance for economic development; they are widely used in the production chains of many goods for everyday life, high-tech industry and infrastructure components enabling the energy transition. On 16 March 2023, the European Commission published an updated list of critical raw materials. These are raw materials of which the availability is critical to the economy and, at the same time, the threat to their occurrence, or more precisely, the possibility of their shortage, is high. The regulation also includes defined value chain levels taking into account the production, processing and recycling for internal markets and implies the diversification of the supply of critical raw materials. The official list of raw materials critical to the European Union economy consists of thirty raw materials (Table 1).

Table 1. 2023 Critical Raw Materials (EC 2024)

Tabela 1. 2023 Surowce krytyczne

List of critical raw materials for the EU (2023)			
Bauxite	Coking Cobalt	Lithium	Phosphorus
Antimony	Feldspar	Light rare earth elements	Scandium
Arsenic	Fluorspar	Magnesium	Silicon metal
Baryte	Gallium	Manganese	Strontium
Beryllium	Germanium	Natural Graohite	Tantalum
Bismuth	Hafnium	Niobium	Titanium metal
Born/Borate	Helium	Platinum group metals	Tungsten
Cobalt	Heavy rare earth elements	Phosphate Rock	Vanadium
		Copper	Nickel

In the context of the critical raw materials identified by the European Commission, it seems important to analyze the correlation between the extraction of raw materials, their processing, industrial use and also their recycling. While analyzing these issues, the avail-

able literature was examined based on the Scopus database. In the first stage, the papers with the phrases “raw materials” and “value chain” in the article title, abstract or keywords were analyzed. A total of 941 such papers were found (as of 7 November 2023). The highest number of papers dealing with that topic was from 2023 (Figure 1).

What is interesting and also suggestive in the context of the European Union is that the analysis of the criterion of funding sponsors indicated that it was European institutions that commissioned or were the source of financing of the published works on raw material value chains (Figure 2). This confirms the significant role of critical raw materials for the conti-

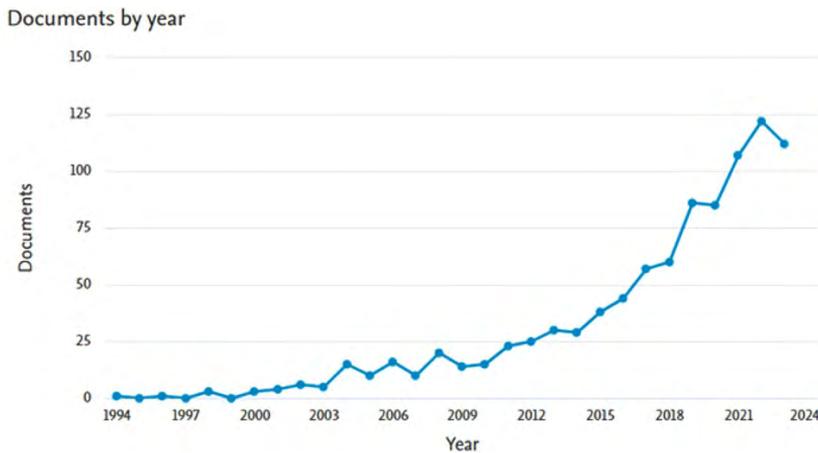


Fig. 1. Number of papers with the phrases “raw materials” and “value chain” in the article title, abstract or keywords (own elaboration)

Rys. 1. Liczba prac, które w tytule lub w słowach kluczowych miały słowa *raw materials* i *value chain*

Documents by funding sponsor

Compare the document counts for up to 15 funding sponsors.

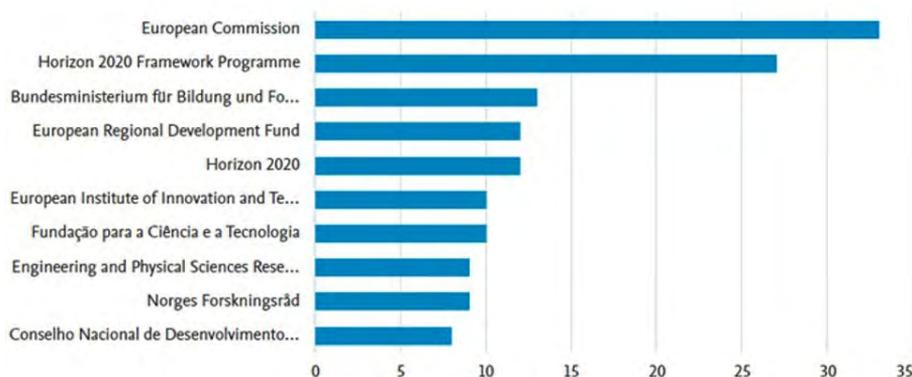


Fig. 2. Documents by funding sponsor (own elaboration)

Rys. 2. Publikacje z obszaru *raw materials value chain* według źródła finansowania

ment and demonstrates the awareness of scientists and the willingness to promote knowledge about the value chains they create. The recipients of that content should be stakeholders of the mining and processing industries as well as the modern technology industry, including electromobility and autonomy.

In the 941 identified works, the most popular subject areas were: Engineering (292 articles), Environmental Science (262) Business, Management and Accounting (196), Energy (178), Social Sciences (155), Agricultural and Biological Sciences (154) Economics, Econometrics and Finance (133), Materials Science (107) (Figure 3).

In the next stage of the literature review, attention was paid to cobalt, the raw material which is the subject of this article. While searching the Scopus database, papers with either “cobalt” or “value chain” in the title, abstract or keywords were analyzed. As a result, forty-four papers were found (as of 7 November 2023).

In that stage, the literature review made it possible to identify studies relating to the extraction of cobalt in the context of its use for industrial and social needs. Additionally, the works address the issue of environmental protection when cobalt is used and recycled.

The analysis of the available literature showed that a frequently addressed issue was the need to sustainably source the critical raw materials necessary to produce innovative materials. Additionally, it is emphasized that it is important to increase their industrial potential in terms of a circular economy or the sustainable development of production processes.

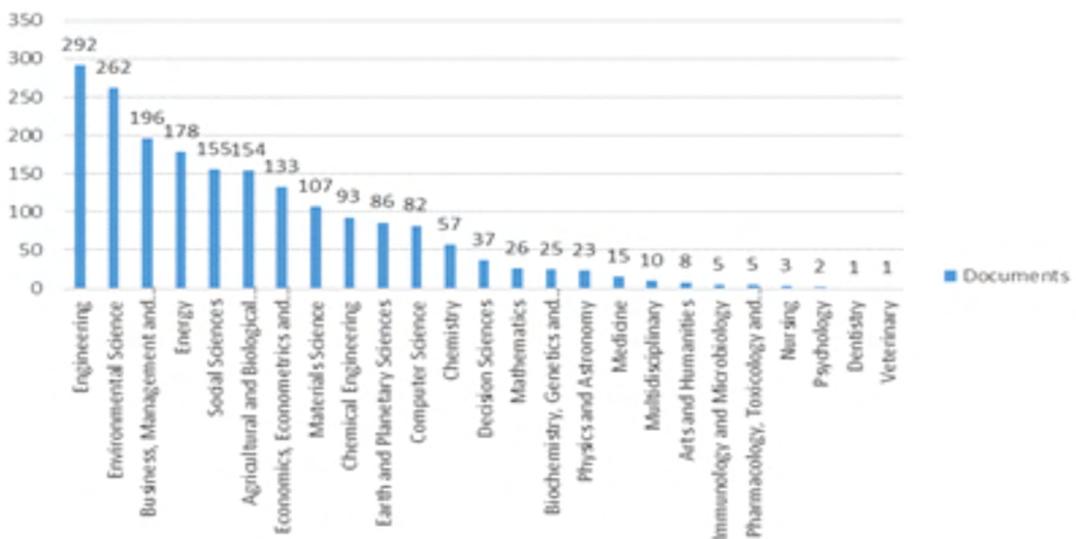


Fig. 3. Subject areas in papers with the phrases “raw materials” and “value chain” in the article title, abstract or keywords (own elaboration)

Rys. 3. Obszary tematyczne prac, które w tytule lub w słowach kluczowych miały słowa *raw materials* i *value chain*

In this context, the authors of studies point to the need for a global transformation towards innovation, which is possible if the demand for various resources, especially minerals such as copper, lithium and cobalt, is met (Gauß et al. 2023; Müller et al. 2023).

In parallel with the topic of sustainable development, the issue of electromobility, including battery production and the reduction of greenhouse gas emissions, is often discussed. With the progress of the transformation related to the change in car drives and the development of electric motors, the value chain of raw materials for the development of lithium-ion batteries (LIB) becomes crucial. The analyzed collection of works includes many studies presenting a pro-environmental approach in terms of the use of batteries also containing possible scenarios for modernizing their production in the context of sustainable development (Bobba et al. 2019; Mayyas et al. 2019; Berretta and Harvey 2022; Brilloni et al. 2022; Castro et al. 2022; Kallitsis et al. 2022; Manjong et al. 2023; Vicceli et al. 2023).

Issues of a low-emission economy associated with the production of copper, cobalt and gold in terms of increased demand for the elements can also be found in the literature (Laing and Pinto 2023; Lebrouhi et al. 2022). Ensuring the supply of raw materials for the needs of innovative industries was also treated holistically through the creation of interconnections as part of value building. The issue of building appropriate value chains in the area of raw materials such as lithium, cobalt, nickel, manganese and natural graphite was raised in the works (Schuster et al. 2023; Kondratiev 2020). The analysis of the indicated chains was also linked to their safety and risks in terms of chain breakage and resilience in the face of uncertain market expansion and evolving technologies (Kondrat'ev et al. 2020; Danino-Perraud et al. 2021; Lal and You 2023).

For the purpose of this study, the current development of the value chain topic can also be mentioned using the example of cobalt as a raw material required for the manufacture of energy batteries in the context of the present armed conflict and the sanctions imposed on Russia and China, which can be read about in one of the papers (Kirkham and Toplišek 2023). The risk assessment of cobalt supplies for the needs of electromobility and the technological support of the goals of sustainable development in the European Union is explored in other publications (da Silva Lima et al. 2023).

2. Cobalt and the directions of its use

Today, cobalt is considered one of the most important elements in the world. In the Cobalt Market Report 2022, it was recognized as a fundamental component of the solution enabling the achievement of a green, sustainable and fair energy transition (Cobalt Institute 2023). Its key economic importance was already evident in 2011 when cobalt was included by the European Commission in its first list of critical raw materials in a communication in which the list of fourteen CRMs was published. In recent years, the European Commission has extended the list of critical raw materials and cobalt remains there, which confirms that it is a strategic element for modern technology (Mathieux et al. 2017; Grohol et al. 2023).

In nature, cobalt is widely distributed, although it does not occur in the Earth's crust in large concentrations (it is a dispersed element, with an average content of 25–30 ppm) (Pourret et al. 2017). Most often, cobalt accompanies copper ores (approximately 60%) and nickel (38%), being a valuable “by-product” and a sort of precious additive. Only a small portion of cobalt deposits occur alone (2%) (Figure 4).

As a result of its thermal resistance, strength and magnetic properties, this metal finds a wide variety of applications. It is used primarily as a basic component of lithium-ion batteries for electric cars, laptops and mobile phones. It is very popular in industrial chemistry and used to produce the so-called superalloys, i.e. materials that can withstand very high temperatures (for the manufacture of, e.g. aircraft turbine engines), its implementation in the graphics industry and medical devices is also growing (Figure 5). Due to the fact that

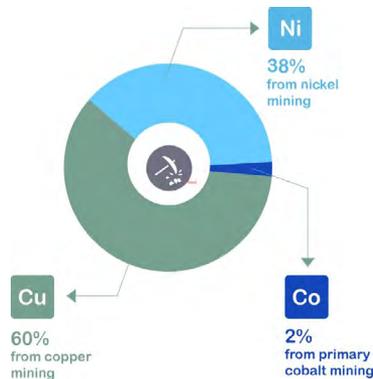


Fig. 4. Characteristics of cobalt deposits (Cruz 2023)

Rys. 4. Charakterystyka złóż kobaltu

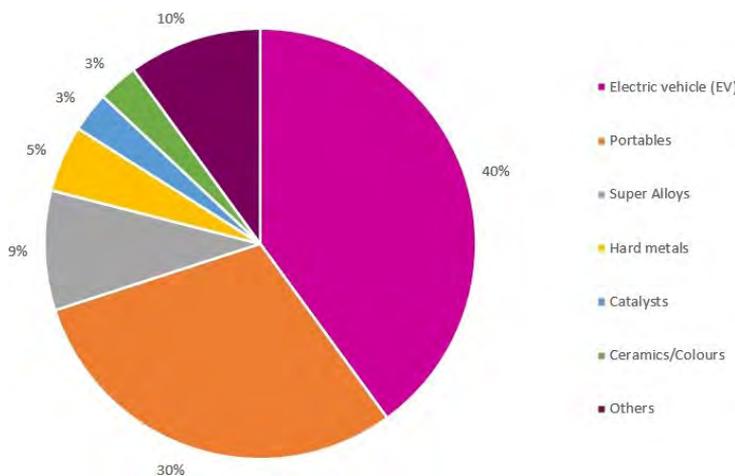


Fig. 5. Use of cobalt in specific sectors (%) (Cobalt Institute 2023)

Rys. 5. Zastosowanie kobaltu w poszczególnych sektorach (%)

cobalt is mainly used to produce batteries for electric cars and portables (a total of 70%), the issues discussed in the subsequent parts of the article will concern these industry sectors.

In recent years, due to the growing demand for cobalt, a rise in investment outlays for the exploration of cobalt deposits can be observed as well as growth in the number of exploration projects and, as a result, an increase in the number of entities engaged in the exploration and extraction of this element (Figure 6 and 7).

New mining and processing projects are necessary to meet both the growing market demands and the goals adopted in the Critical Raw Materials Act (CRMA). They assume, *inter alia*, that the following will be met by 2030:

- ◆ at least 10% share in the annual consumption of strategic raw materials in the EU by European mining;
- ◆ at least 40% of annual consumption in the EU by processing in the EU;
- ◆ at least 15% of raw material consumption by European recycling;
- ◆ no more than 65% of Europe's demand from a single non-EU country (EC 2023).

The demand for cobalt continues to grow, especially due to the increasing production of lithium-ion batteries (Van den Brink et al. 2020; Grohol 2023), which are crucial for the development of electric mobility and digitalization. According to some studies, cobalt demand may increase by up to twenty times by 2050 (Deetman et al. 2018). Other authors are a bit more conservative; Tisserant and Pauliuk expect a lower increase in cobalt demand but still predict a fourfold increase in the demand over the next four decades (Tisserant et al. 2016).

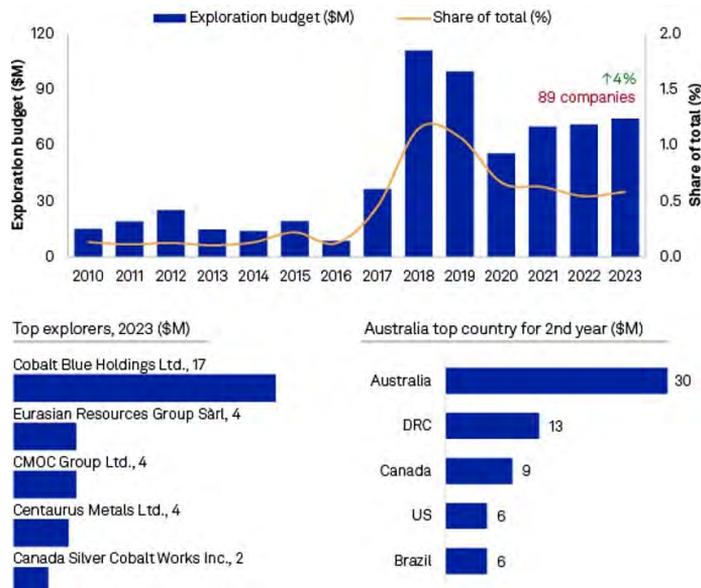


Fig. 6. Cobalt exploration budget (Cruz 2023)

Rys. 6. Budżet przeznaczony na wydobycie kobaltu

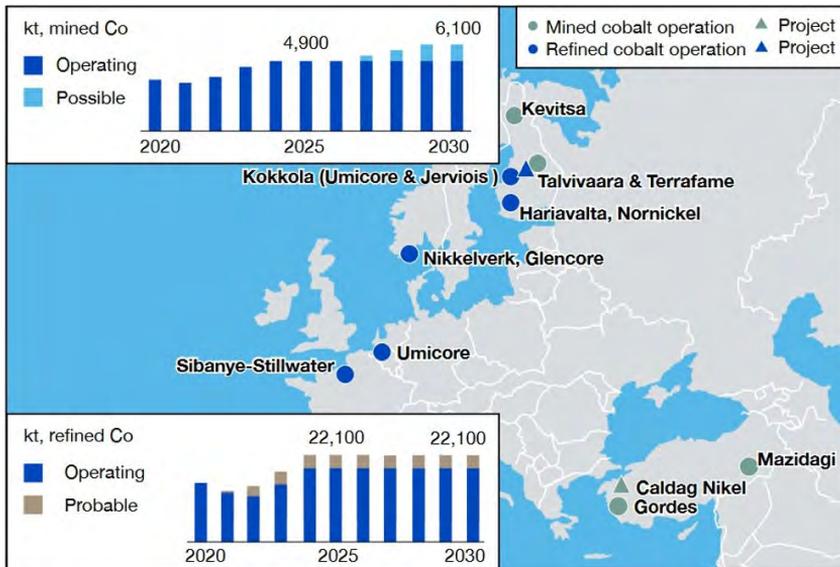


Fig. 7. European mined and refined cobalt operations and projects expected to be in operation by 2030 (Cobalt Institute 2023)

Rys. 7. Obecne przedsięwzięcia oraz projekty związane z wydobywaniem i rafinacją kobaltu, które rozpoczną się do 2030 r.

Helbig, in turn, mentions the need for a 3% annual increase in cobalt supply (Helbig et al. 2018) to meet electric car demand alone. The most recent analyses by the Cobalt Institute confirm the trend and indicate that cobalt demand maintained an annual growth rate of +13% in 2022 (Cobalt Institute 2023) (Figure 8).

With regard to the supply structure of cobalt, which is critical for the EU, some risks related to the uncertainty of the increase in the global supply of that element are pointed out, which will be discussed in the following sections of the paper.

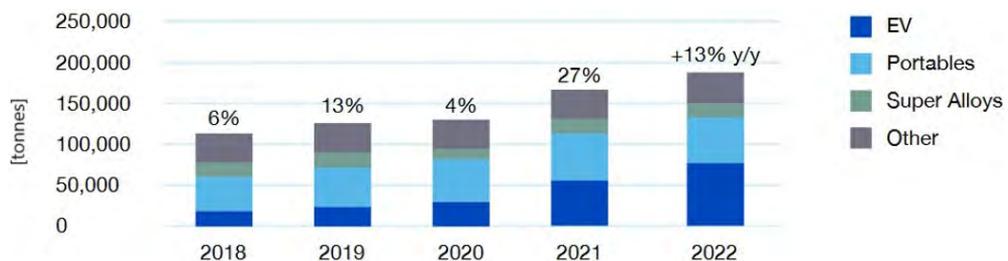


Fig. 8. Cobalt demand growth by sector (tonnes) (Cobalt Institute 2023)

Rys. 8. Wzrost popytu na kobalt według sektorów (tony)

3. Cobalt value chain

The following stages can be distinguished in the cobalt value chain: extraction and processing, refining and chemical manufacture, component manufacture, end producers and recycling and disposal (Figure 9).

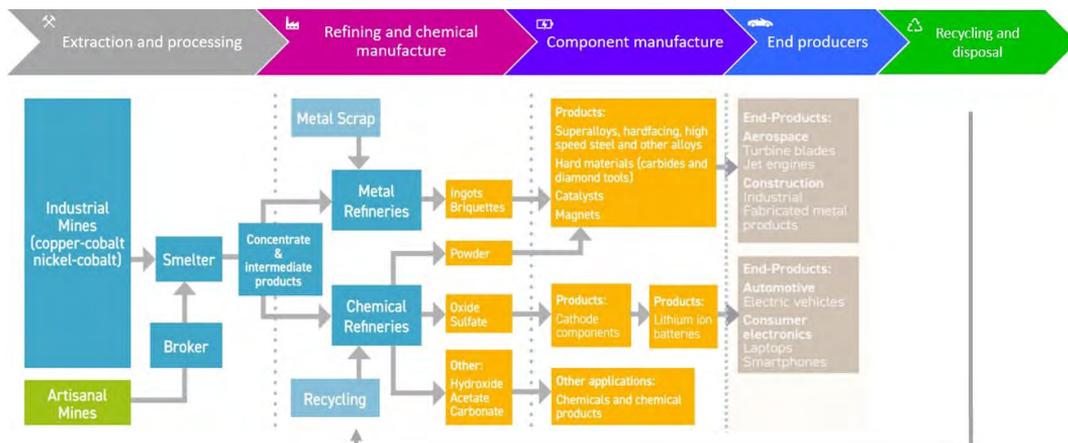


Fig. 9. Cobalt value chain (own elaboration based on: Howard and Gifford 2023; Cobalt Institute 2023)

Rys. 9. Łańcuch wartości kobaltu

Figure 10 indicates the most important locations concerning the individual stages of the cobalt value chain and the most important cobalt pathways connecting the different stages. Based on this figure, most cobalt value chains originate in the Democratic Republic of the Congo (DRC), where 70% of the cobalt is extracted. Then, cobalt is exported to China or Finland, where 86% of the refining and chemical processing takes place, resulting, inter alia, in products such as ingots, briquettes, powder and oxide sulfate. Cobalt refining products are delivered to factories where batteries are manufactured for EVs and portables (70% of cobalt demand – Figure 5 Use of cobalt in specific sectors (%)).

At total of 86% of lithium-ion batteries are manufactured in Asia (especially China, Japan, South Korea). Then, the batteries are delivered to end producers, i.e. where the largest car or electronics producers are located (China, USA, South Korea, Germany, Japan – Figure 10).

3.1. Extraction and processing

Cobalt is a mineral mainly associated with the extraction of copper (55%) and nickel (29%) ores. Cobalt mining is concentrated in Africa, in the Democratic Republic of the Congo (DRC). Around 130,000 MT of cobalt is extracted there, which is over 70% of the total global extraction (Figure 11).

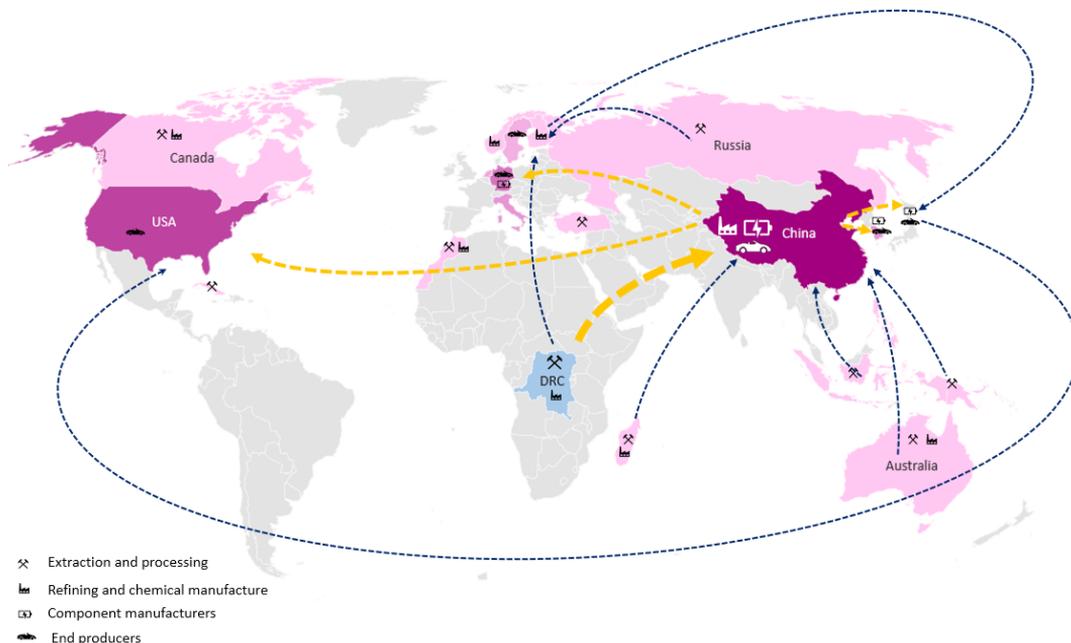


Fig. 10. The most popular cobalt value chains (own elaboration)

Rys. 10. Najpopularniejsze łańcuchy wartości kobaltu

The DRC resources are estimated at 4 million MT. Cobalt is extracted in both underground and open-pit mines. The DRC additionally distinguishes between large-scale mines (LSM), where 87% of the mineral is extracted, as well as artisanal and small-scale mining (ASM), where 13% of the extraction takes place. In the cobalt value chain, ASMs are a major challenge. Artisanal and small-scale mining are places where human rights are abused – children work in these mines, health and safety rules are not followed, mining is performed without proper techniques and to the detriment of the environment. This is a huge problem considering that more than 9% of global cobalt is extracted in ASMs. It is estimated that 200,000 people work in such mines.

High concentration in one region of the world means a great threat to ensuring the continuity of the raw material supply. Geopolitical issues and the unsettled internal situation in the DRC, as well as the controversy associated with the semi-slavery and non-industrialized cobalt mining system in the region (BGR 2017) determine a very high risk of disruption of the supply chains, which is why the world should strive to diversify supplies. Indonesia is moving in the right direction with cobalt production of only 2,700 MT in 2021 and as much as 10,000 MT in 2022, representing approximately 5% of the total global production (Figure 11). This rapid change was the result of increased investment in Indonesia's battery metal supply chain, mainly from Chinese companies. Indonesia is targeting a tenfold increase in cobalt production by 2030. This is estimated to account for 20% of the global production

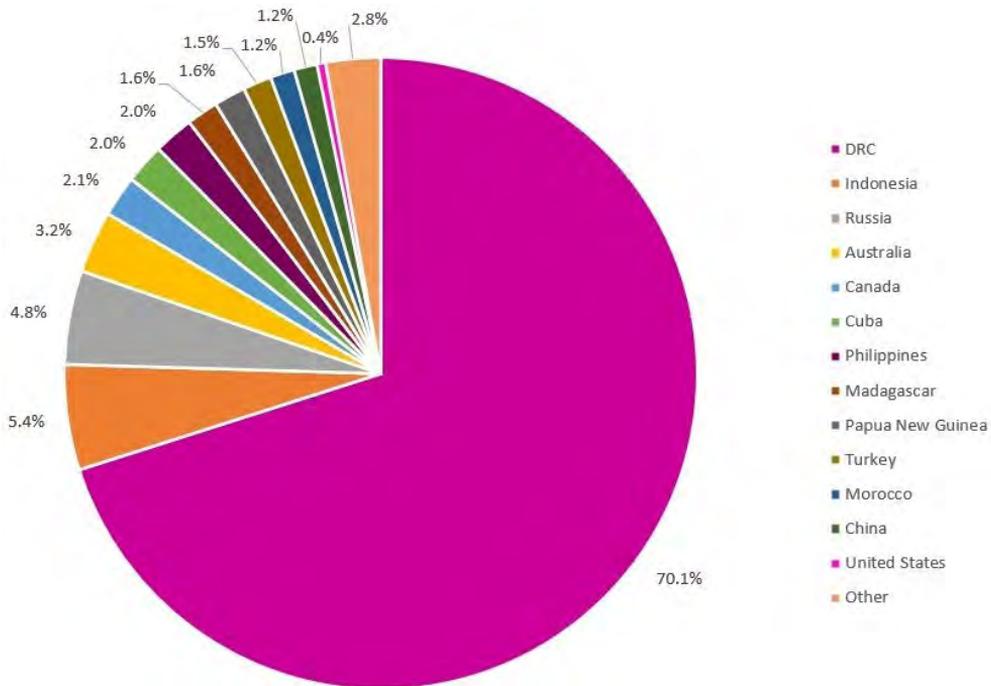


Fig. 11. Cobalt extraction and processing (own elaboration based on: Shedd 2023)

Rys. 11. Wydobywanie i przeróbka kobaltu

(Cobalt Institute 2023). Australia is another country to which investors are paying increasing attention. Currently, it extracts approximately 3% of the world's cobalt. The country has a lot of potential to increase production as it ranks second (after the DRC) in terms of the size of the resources (1.5 million MT). Moreover, Australia is estimated to have approximately 300,000 MT of cobalt in post-mining waste. Russia would also have the potential to increase mining. Currently, 8,900 MT (approximately 5%) is extracted there, and the country reserves amount to 250,000 MT. However, such an increase in mining in Russia would not be economically profitable at the moment, due to the fact that the country is at war with Ukraine. As a result of the ongoing war, various economic sanctions are being imposed on Russia. In April 2022, the USA imposed a 45% tariff on Russian cobalt, which will expire on 1 January 2024.

3.2. Refining and chemical manufacture

The second stage in the raw material value chain is refining and chemical manufacture. In the case of cobalt, at this stage cobalt hydroxide is refined with the use of hydrometallur-

gical and electrometallurgical methods. The end products in the refining process are pure cobalt chemicals (such as cobalt nitrate, cobalt sulfate and cobalt hydroxide) and metallurgical cobalt. The Democratic Republic of the Congo is seen as a supplier of 90% of the feedstock for Chinese refined cobalt production, as most of the mining facilities in the DRC have been wholly or partly owned by China since the signing of the Sino-Congolaise des Mines (Sicomines) agreement in 2007 (Nazar 2021). In China, 91% of cobalt compounds and approximately 30% of cobalt in metallic form is obtained during the processing stage. A total of 64% of cobalt in metallic form is produced in Canada, Norway and Australia. China accounted for 76% of global cobalt refining in 2022. Finland (10%) and Canada (4%) also had a significant share (Figure 12) (Cobalt Institute 2023).

At the refining and chemical manufacture stage, cobalt is also obtained from scrap (metallurgical waste, used industrial catalysts). However, at present, cobalt obtained through recycling constitutes only 5% of the global cobalt supply. In 2022, the secondary production of cobalt amounted to 9,300 tons, of which technological scrap accounted for 74% of the total scrap and 26% came from end-of-life equipment (EOL). The EU is currently able to slightly reduce its reliance on virgin materials by using secondary materials recycled domestically. However, in the future, total scrap is expected to increase by sixty times by 2040, and the share of secondary production may potentially increase to 41% of the total cobalt supply (Cobalt Institute 2023).

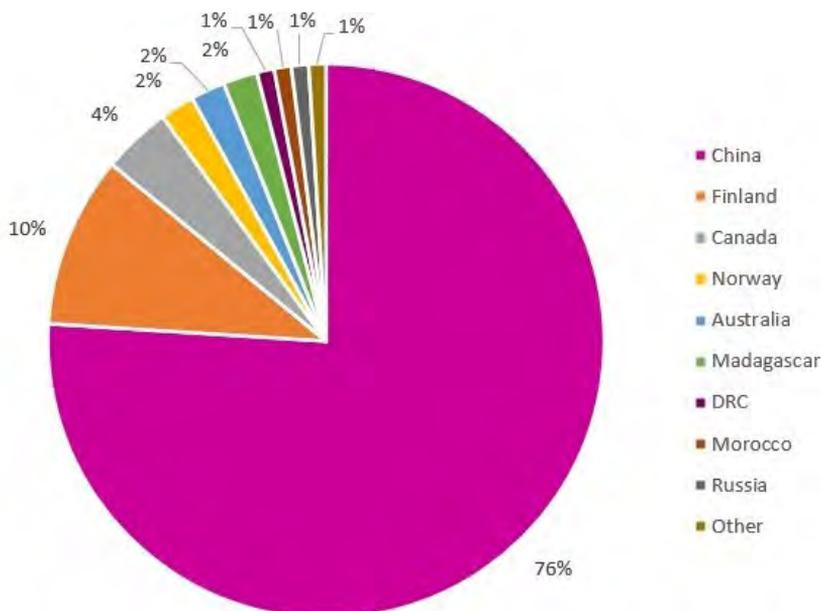


Fig. 12. Share of individual countries in global refined production (own elaboration based on: Cobalt Institute 2023)

Rys. 12. Udział poszczególnych krajów w światowej produkcji rafinowanej

3.3. Component manufacture

Component manufacturers produce cobalt cathodes from raw material obtained at an earlier stage during chemical refining. They also produce anodes and electrolytes, which when properly assembled, constitute battery cells, i.e. LCO, NCA, NMC. The cells are further integrated into battery packs consisting of modules and protective systems forming the final battery.

Figure 13 presents the main manufacturers of components and finished lithium-ion batteries, i.e. China (36%), Japan (33%) and the Republic of Korea (17%) (Kustra et al 2023).

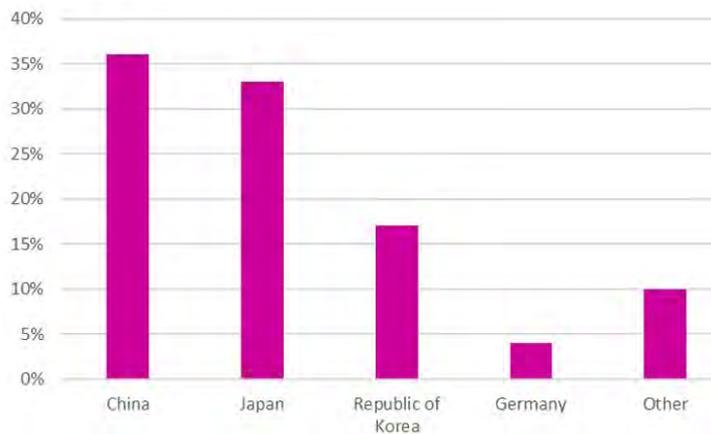


Fig. 13. Manufacturers of components and finished lithium-ion batteries (own elaboration)

Rys. 13. Producenci komponentów i gotowych baterii litowo-jonowych

3.4. End producers

A total of 40% of cobalt is used as a component of batteries for the production of electric cars, and 30% is used for the manufacture of batteries for portable devices, such as phones, tablets and laptops.

Figure 14, to the right, shows the countries that are leaders in the production of the fifteen most popular electric car brands (listed on the left of the figure), accounting for 80% of the global EV supply. China is first (32%), with the following brands: BYD, Geely Auto Group, GAC Group, SAIC Motor Corp., Chery Auto Co., Changan Auto Co. The second position is occupied by the USA (18%), and two brands should be mentioned here (Tesla and GM). Germany is third (16%), with the following brands: VW Group, BMW Group and Mercedes-Benz (Figure 14). The users for lithium-ion batteries are well-known brands, i.e. Stellantis

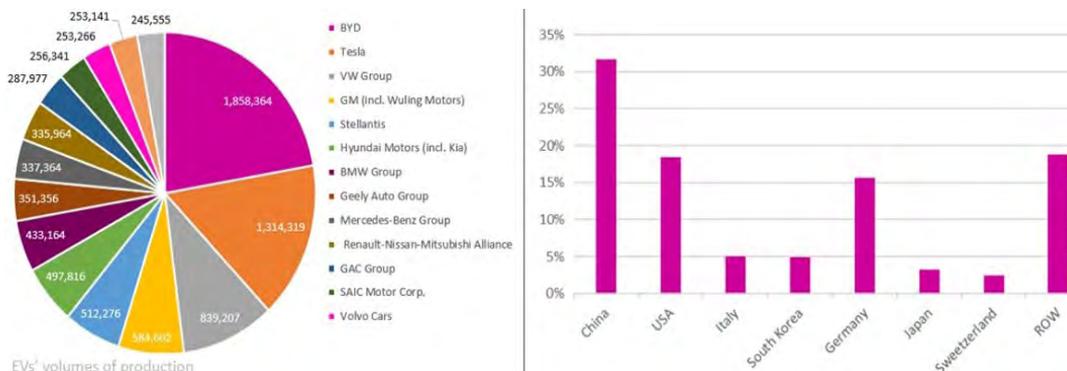


Fig. 14. Main manufacturers of electric cars in 2022 (Top 15) (own elaboration based on: EVvolumes.com 2023)

Rys. 14. Główni producenci samochodów elektrycznych w 2022 r. (Top 15)

(Italy), Hyundai Motors (incl. Kia) (South Korea), Renault-Nissan-Mitsubishi Alliance (Japan, Italy), Volvo Cars (Sweden).

Figure 15 presents the situation on the portables market. The figure on the left presents a list of the largest manufacturers of electronics (Top 10). The comparable value is sales revenue. The figure on the right (Figure 15) presents the countries where the headquarters of the manufacturers of portables are located. The USA ranks first (37%), with brands such as Apple and NVIDIA. South Korea comes second (29%), with Samsung and LG. The third position is occupied by China (18%) and the following brands: Lenovo, Xiaomi, Gree Electric, TCL Technology. Japan is in the last position (16%) with the Sony and Panasonic brands.

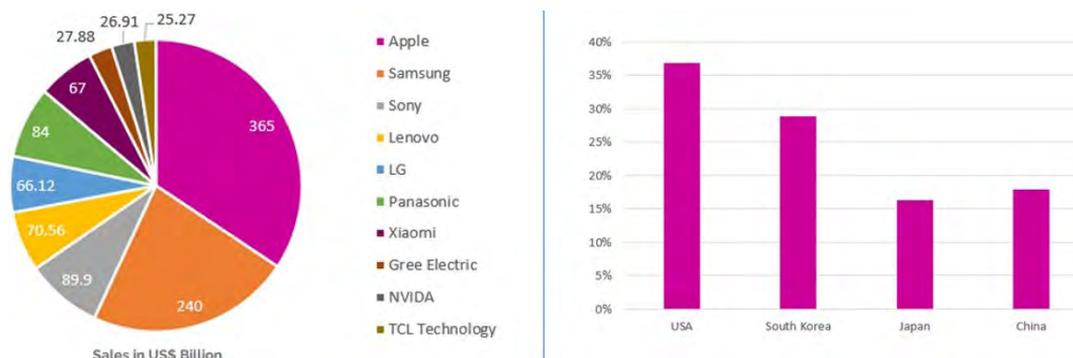


Fig. 15. Main manufacturers of portables in 2022 (Top 10) (own elaboration based on: Titoma 2023)

Rys. 15. Główni producenci urządzeń przenośnych w 2022 r. (Top 10)

Conclusions

Cobalt is one of the critical raw materials identified by the European Union for the development of advanced technologies, mainly related to sectors such as renewable energy, electric mobility, defense and aerospace as well as digital technologies.

Based on the analyses presented above, approximately 70% of cobalt consumption is dedicated to the production of lithium-ion batteries used in electric cars, laptops and mobile phones.

Cobalt and its production for the end user are subject to mechanisms specific to current value chains. Their analysis makes it possible to indicate who dominates in the area of mining (the Democratic Republic of the Congo) and who is the leader in processing and final production (China).

The trends in the cobalt market show that China's role will significantly grow in the future, especially in processing and production. It is believed that today more than thirty out of fifty key raw materials are already controlled by China, which is a significant threat to the world, as it can control the supply of these raw materials influencing their price and at the same time control the course of strategic processes for the world, such as energy transition. This means that the cobalt will become a subject not only of business, but also of broader geopolitics.

This must be taken into account by Europe, which in order to maintain innovation and the implementation of the transformation process should be independent in raw materials matters. For this, however, staff and educated employees are needed to ensure their proper implementation and results.

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VALUE CHAINS IN THE RAW MATERIALS INDUSTRY – THE EXAMPLE OF THE COBALT VALUE CHAIN**Key words**

metals criticality, raw materials industry, value chains, cobalt value chain, margins migrations

Abstract

The global development of electromobility and the innovation of life are becoming increasingly noticeable. A direct implication of this is the increase in demand for modern products and services, their components and thus the raw materials necessary to produce them (e.g. cobalt, lithium, rare earth metals). In the European Union (EU), raw materials related to strategic sectors – renewable energy, electric mobility, defense and aerospace and digital technologies – show a very strong dependence on import throughout the entire value chain. In the case of eleven out of thirty of the so-called critical raw materials (CRM), necessary for the energy transition, the EU's dependence on import exceeds 85%. Global supply chains, which had already been strained, were further affected by the COVID-19 pandemic and the exacerbated geopolitical situations leading to even greater shortages of critical raw materials in Europe and leaving the industry facing challenges in securing access to resources. An implication of this was the European Parliament's position on critical raw material legislation in September 2023, which called on the EU to increase its processing capacity across the value chain and enable the production of at least 40% of the annual consumption of strategic raw materials by 2030.

Growing importance in the transition to a low-emission economy is attributed to cobalt (Co), which is an essential component both in the production of electric vehicles (EV), stationary energy storage and in the developing sectors of wind energy, fuel cell systems and hydrogen storage technologies, robotics, unmanned vehicles (drones) and 3D printing as well as in digital technologies. Securing the supply of such raw material is crucial for the European Union's economic resilience, technological advantage and strategic autonomy.

The purpose of this article is to present and analyze the concept of value chains as strategic models of long-term development and ensuring efficiency from a sustainable perspective. According to the authors, a detailed analysis of value chains may enable defining strategic directions of action and identifying the risks of their disruption or interruption. To give a practical dimension to the presented analyses, the example of the cobalt value chain is provided and the determinants of its functioning on the current market along with development prospects are indicated.

ŁAŃCUCHY WARTOŚCI W PRZEMYSŁE SUROWCOWYM – PRZYKŁAD COBALT VALUE CHAIN

Słowa kluczowe

metale krytyczne, przemysł surowcowy, łańcuchy wartości,
łańcuch wartości kobaltu, migracje marż

Streszczenie

Globalny rozwój elektromobilności oraz innowacyjności życia stają się obecnie coraz bardziej widoczne. Bezpośrednią implikacją takiego stanu rzeczy jest wzrost popytu na nowoczesne produkty i usługi, ich komponenty i tym samym na surowce niezbędne do ich wytworzenia (np. kobalt, lit, metale ziem rzadkich). *Raw materials* w Unii Europejskiej (EU) związane z sektorami strategicznymi: energia odnawialna, mobilność elektryczna, przemysł obronny i lotniczy, czy też technologie cyfrowe, wykazują bardzo silne uzależnienie od importu w całym łańcuchu wartości. W przypadku 11 z 30 tzw. surowców krytycznych (CRM), niezbędnych do przeprowadzenia transformacji energetycznej, zależność UE od importu przekracza już teraz 85 procent. Globalne łańcuchy dostaw, które już wcześniej były napięte, ucierpiały jeszcze bardziej w wyniku pandemii COVID-19 oraz zaognionych sytuacji geopolitycznych, co doprowadziło do jeszcze większych niedoborów krytycznych surowców w Europie i sprawiło, że branża stoi przed wyzwaniami związanymi z zabezpieczeniem dostępu do zasobów. Implikacją tego faktu było przyjęcie we wrześniu 2023 r. przez Parlament Europejski stanowiska w sprawie prawodawstwa dotyczącego surowców krytycznych, w którym wezwał UE do zwiększenia swoich mocy przerobowych w całym łańcuchu wartości i umożliwienia wytworzenia co najmniej 40% rocznego zużycia surowców strategicznych do 2030 roku.

Rosnące znaczenie w procesie przechodzenia na gospodarkę niskoemisyjną przypisuje się kobaltowi (Co), który jest niezbędnym komponentem zarówno przy produkcji pojazdów elektrycznych (EV), stacjonarnych magazynów energii, czy też w rozwijających się sektorach: energii wiatrowej, systemach ogniw paliwowych i technologii magazynowania wodoru, robotyki, pojazdów bezzałogowych (dronów), druku 3D, jak również technologii cyfrowych. Zabezpieczenie dostaw tego surowca ma kluczowe znaczenie dla odporności gospodarczej Unii Europejskiej, jej przewagi technologicznej i strategicznej autonomii.

Celem artykułu jest przedstawienie i analiza koncepcji łańcuchów wartości jako strategicznych modeli rozwoju długoterminowego i zapewnienia efektywności w zrównoważonym ujęciu. Według autorów, szczegółowa analiza łańcuchów wartości może pozwolić na określenie strategicznych kierunków działania i zidentyfikowanie ryzyk ich zaburzenia czy przerwania. Dla praktycznego wymiaru zaprezentowanych analiz przytoczono łańcuch wartości na przykładzie kobaltu oraz wskazano determinanty jego funkcjonowania na obecnym rynku wraz z perspektywami rozwoju.