



## GREEN LOGISTICS IN E-COMMERCE

Arkadiusz Kawa, Bartłomiej Pierański

Poznań University of Economics and Business, Poznań, Poland

**ABSTRACT. Background:** Along with the very dynamic development of e-commerce, the number of logistics operations involved in order fulfilment is increasing at a similar rate in B2C relationships. Each product must be completed, packed and shipped or handed over for collection by the customer. Although online shopping is very convenient for customers, it has a negative impact on the environment. The problem lays with the transportation of individual shipments, additional packaging and materials used for this purpose, and returns.

The aim of this paper is to present the main logistics challenges related to ecofriendly e-commerce and examine the influence of the green logistics approach in e-commerce on customer satisfaction and loyalty.

**Methods:** Both computer-assisted telephone interviews (CATI) and computer-assisted web interviews (CAWI) were applied to gather data. In total, 592 correctly completed questionnaires were received – 200 records from CATI and 392 interviews using CAWI. The Pearson correlation coefficient was used to determine the relationship between the variables.

**Results:** The empirical study confirmed the relationship between green logistics, satisfaction, and loyalty. This means that the more attention online retailers pay to green delivery (parcel lockers, pick up drop off points, click & collect), packaging (environmentally friendly materials and sizing of the packaging) and returns (returnable packaging, return of used products), the more satisfied and willing to buy from the same retailers again the customers are.

**Conclusions:** For online shoppers, not only price, and wide products selection as well as fast delivery are important, but also environmental aspects matter more and more often. Logistics is of particular importance. If it is not well planned and organised, it can have a negative impact on the environment. The winners are those who invest in ecological solutions. The presented research results encourage further scientific exploration, which would be devoted only to this issue, taking into account other e-commerce stakeholders, i.e. sellers, suppliers and complementors.

**Key words:** e-commerce, green logistics, logistics value.

## INTRODUCTION

Undoubtedly, online shopping is now one of the most important trends in economy. According to Statista, global e-commerce sales in 2020 grew by approx. 18.9% compared with 2019 and amounted to approx. \$ 4.2 trillion [Statista, 2021b]. It is growing much faster than the GDP. By 2023, the global sales via the Internet is even expected to reach \$ 4.9 trillion [Lipsman, 2019].

Most orders placed online involve products that need to be physically delivered. E-

commerce generated around 125 billion CEP (courier, express, parcel) shipments in 2020 [Solomon, 2020]. Only during Singles Day (online shopping festival in China) Alibaba's Tmall and Taobao received 2.3 billion orders [Statista, 2021b], which translated into a similar number of shipments. At peak times, there were even more than half a million orders per second [Chargedretail, 2020]. This is a huge challenge for logistics - both for retailers, logistics and fulfilment companies and CEP operators. This means hundreds of billions of shipment operations, billions of kilometers driven and millions of tons of packaging material.

E-commerce has shifted the center point of the logistics system from retailer to consumer, a new set of expectations emerges. The consumers are seeking ways to maximize convenience, choice, and price – establishing a completely different shopping experience [Righby, 2011]. As more shoppers buy online, the demand for a seamless shopping experience lands on retailers. They have to look for new possibilities to meet the customer expectations. Recently, more and more attention has been paid to navigating e-commerce sustainably. The biggest challenges in this area are delivery, returns and packaging. Therefore, the question arises how to deal with the logistics challenges of e-commerce, maintaining ecological issues at the same time.

In addition to eliminating the last-mile problem (by introducing different ways to receive shipments), online retailers are increasingly adopting the paperless concept and abandoning printed leaflets and invoices in favour of electronic versions, trying to reduce returns or neutralise their negative impact on the environment, or using eco-friendly packaging and fillers or even reusable packaging [Abukhader, Jönson, 2003].

The Green Generation report shows that some e-customers are willing to wait longer for the delivery, if it is due to the e-store's care for greener delivery, and to pay extra for foil-free packaging. Some customers go further with their expectations and always demand green or sustainable e-commerce shopping [Oláh et al., 2019]. Retailers are trying to respond to these needs. For example, Zalando, one of the biggest fashion e-tailers, reduced its CO<sub>2</sub> per package from their "direct and indirect greenhouse gas emissions in the value chain" [Hischier, 2018; Zalando, 2021], from 2.8 kg to 1.8 kg between 2016 and 2019. For the presented reasons the very dynamic e-commerce growth cannot be considered without its sustainability [Fedorko et al., 2017; Dabija, 2016].

Third-party logistics serving retailers also care about environmental protection. Transport companies are investing in modern means of transport and the development of a fleet of electric cars and charging stations. In addition, they are building or using warehouses that rely

on renewable energy sources, energy-efficient lighting, rainwater utilisation systems, etc. This also applies to the way they work. Companies are training employees to keep the environment in mind when performing their daily routine duties, e.g. by reducing the consumption of office materials, etc. [DHL, 2021].

Numerous authors [Liu et al., 2012; Heiskanen, 2005; Zhang, 2015] prove that the consumers' environmental awareness is increasing and their expectations in this respect will grow. Therefore, research is needed to show what is important for customers and what the directions of development of green logistics in e-commerce are.

In recent years, sustainability implications of e-commerce have been attracting more attention from researchers and practitioners [Mangiaracina et al., 2015; Abukhader, Jönson, 2003]. However, research into the environmental effects of e-commerce is still in its infancy and requires a deeper insight. This follows from a systematic literature review conducted by Mangiaracina et al. [2015], who indicated that the publications they reviewed focused mainly on some drawbacks but did not present a structured discussion; no key topics, such as the measurement of the ecological impact of e-commerce or green solutions, were analysed in detail or addressed at all.

Therefore, the aim of this paper is to present the logistics challenges in navigating e-commerce sustainably and examine the influence of the green logistics approach in e-commerce on customer satisfaction and loyalty.

## LAST MILE

Many people associate e-commerce with convenience - placing an order at any time, anywhere with access to the Internet is possible. After some time the customer can enjoy the ordered product. This is often done without leaving one's home at all. By not moving, the customer does not release any pollutants and does not consume much energy or natural resources. However, someone else has to deliver the product, and as we know,

transport (especially road transport) increases pollution, emissions and congestion, which negatively affects the environment [Oláh et al., 2019; Mangiaracina et al., 2015]. That is why picturing the negative impact of e-commerce on the environment is very tricky [Tiwari, Singh, 2011].

According to the United Nations Environment Programme, which has published extensive research on both European and global impacts on the environment, the transport sector is responsible for 23-24 % of global CO<sub>2</sub> emissions from fossil fuel combustion and is expected to grow to one-third by 2050. That is why consumer-friendly services are needed which allow customers to modify their delivery times and locations, as well as provide access to an extensive network that supplies customers with new ways of receiving deliveries at an alternative location.

The most popular forms of delivery are courier services. The biggest advantages of courier services are the door-to-door option and short delivery time. Neither the sender nor the recipient has to leave their office or home to use this service. Delivery within a given country usually takes one working day. The disadvantage of this solution for the customer is the price of the service, which is the most expensive one among all forms of delivery. Besides, couriers usually deliver shipments when e-customers are at work and some employers prohibit collection of private parcels in the workplace.

Instant or same-day deliveries are also a major challenge. If the process of such deliveries is not well optimised, couriers have empty runs or only partially filled transport vehicles. This significantly increases fuel consumption [Sui, Rejeski, 2002; Tiwari, Singh 2011]. According to the research from MIT's Center for Logistics and Transportation, fast deliveries generate more than double carbon dioxide emissions per shopper, increasing by nearly 0.75kg [Jiang, 2016].

A solution to the last mile problem is to allow customers to pick up and drop off shipments at specially designated points (PUDO). These are places to which access is relatively easy, such as newsagents, shopping

malls, petrol stations, grocery shops. An advantage of parcel delivery or collection points is a lower price than in the case of door-to-door courier services. However, their disadvantage is that the availability of the service is limited by the opening hours of the points. A solution to this problem are parcel lockers, where customers can collect and send a parcel at any time of day or night. Deliveries in the PUDO model and parcel lockers are characterised by greater flexibility of the place and time of delivery. This is an advantage for customers who are more mobile and want to have the freedom to choose where and when to send or collect their parcel, and a cost for those who live a long way from such a point, e.g. in rural or less populated areas. Parcel lockers largely eliminate the last mile problem [Mangiaracina et al., 2015]. Both reliability and efficiency are increased. Almost 100% of deliveries are made the first time. With home deliveries, there are more undelivered parcels. Besides, a courier is able to deliver approx. 100 parcels to customers daily, whereas in the case of parcel lockers, there may be over 1000 of such deliveries per day. InPost, which delivers parcels to lockers, reduces harmful emissions in cities by 60%, and in villages by 90% [InPost, 2021].

## RETURNS

Another problematic issue related to greenhouse gas emissions is the return of products. E-commerce return rates are between 20% and 30%, which is more than double the 9% traditional retail return rate [Pierce, 2017]. Returns may concern damaged products and those to be repaired. Most frequently, goods purchased via the Internet are returned because they do not meet the buyer's expectations, have technical faults, are delayed or ordered by mistake. These are called consumer returns [XiaoYan et al., 2012]. In the case of online shopping, the customer has the right to withdraw from the contract without giving any reason and return the ordered product [Kawa, 2019].

Returns require additional processes. The goods must first be picked up by a courier or delivered by the customer to a PUDO, parcel locker or click & collect point, then transported

to the seller or a company that handles returns. The products are then prepared for resale, which sometimes requires repairs or refreshment. Then there is the packaging, which is used for transport and often not reused. Each of these processes involves additional costs and has an impact on the environment. Nevertheless, there are researchers who argue that despite the high rate of return, e-commerce logistics operations seemed to have a lower environmental impact, especially if private cars were used for offline shopping [Mangiaracina et al., 2015]. In addition, with the return service, waste can be reduced because one can return products unwanted for some reason. In traditional trade, returning products without giving a reason is not widely available. As can be seen, the environmental impact of returns can be both positive and negative. Additionally, returns are a challenge for logisticians because it is difficult to plan and forecast them in the supply chain [Mollenkopf, et al., 2007; Srivastava, Srivastava, 2006]. Since returns are an inherent part of e-commerce, they need to be properly addressed.

The number of returns can be limited. In the case of clothing and shoes, returns are due to the product being a different size or appearance than the customer expected. That is why it is important to have an accurate description of the sizes, including the length, width and height of individual items, or the exact parameters of equipment such as electronics. It is also advisable to present accurate photographs without unnecessary retouching, as well as three-dimensional visualisations. This gives the customer more information and allows him/her to check whether the product fits or not, and the seller can thus reduce the number of returns [Powers, Jack, 2015].

In addition, the return procedure should be simple. Ideally, it should not require generation of additional paper documents. Also, the packaging is very important and it should be designed in such a way that the return of the products is possible in the same box or bag (see next section).

## PACKAGING

The next challenge is packaging. As mentioned earlier, e-commerce deals with individual orders which are packed in separate boxes. Due to the transport, the product is often additionally protected, thus generating additional packaging material which is often not recycled [Mangiaracina et al., 2015].

The design and functionality of the packaging are very important, as the consignment of goods is subject to a large number of operations. The logistics system of e-commerce engages more service providers and processes, resulting in significantly more touchpoints than the traditional retail environment. Products are handled four times more in the e-commerce network than in a traditional retail supply chain [Pierce, 2017].

Properly packaged goods have a better chance of arriving intact, reducing the number of returns and the overall environmental footprint [Oláh et al., 2019]. Moreover, packaging made from sustainable materials also helps to further reduce the environmental impact and reduce waste, while demonstrating to customers that the company uses ethical and thoughtful practices.

Packaging is the element that customers see and have physical contact with it. This is important because other processes in the entire e-commerce supply chain are either not seen by the customer at all or only to a limited extent (e.g. delivery). Research shows that customers pay attention to packaging, particularly to the unecological practices of online retailers. In particular, consumers pay attention to non-optimal packaging of shipments, i.e. packaging that is too large in relation to the product. This affects not only the protection of the parcels but also the transport. Moreover, the packaging is also wrapped in plastic or stretch film and there is a lot of filler inside. This is the waste that ends up at consumers' homes. It is often not segregated and, on the other hand, it is not biodegradable [Oláh et al., 2019].

As e-commerce generates a very large amount of packaging waste in the form of additional packaging, fillers, foils, tapes, etc.,

there is a need to introduce reusable packaging that will be utilised by all stakeholders in the ecosystem. Consumers will receive products in specially designed, durable packaging that will be collected, cleaned and reused for loading and shipping after the delivery. Packaging should provide the best protection, but also fulfil a marketing and informational function. In the future, packaging should be 'intelligent', i.e. it should collect information from the environment and pass it on, but also react to various incidents. An example of such packaging is ePack, which is being developed at Łukasiewicz Research Network - Institute of Logistics and Warehousing and two other Łukasiewicz institutes. It is based on the concept of the physical Internet, allowing all players in the e-commerce ecosystem that handle or transport goods to share resources.

However, before we can see a large-scale use of such packaging, final packaging, which is suitable for transport without additional packaging and protection, should already be used by producers in the first instance. If necessary, the fillings and packaging tape should be made of environmentally friendly materials. In addition, as previously noted, the packaging should be designed in such a way that the product can be returned in it. Besides, sales documents (e.g. invoice) should be sent electronically or be available in the order panel of the online shop.

## GREEN LOGISTICS, SATISFACTION, AND LOYALTY

Previous research shows that greening is an investment that pays off. The effect is not always visible immediately and everywhere. Undoubtedly, green logistics can increase customer satisfaction, but also loyalty to the retailer [Kawa, 2019; Rashid, Rahman, Khalid, 2014] (Figure 1).

Satisfaction is treated as “a pleasant feeling that you get when you receive something you wanted, or when you have done something you wanted to do” or “the act of achieving a need or wish” [Cambridge University Press, 2021]. In the case of management studies, satisfaction is understood as the customer's needs fulfillment [Olivier, 1999]. In turn, loyalty is

related to as a feeling of support or duty towards someone or something and faithfulness to commitments or obligations [Cambridge University Pres, 2021]. In With respect to management studies, loyalty is understood as the customer's willingness to buy the product of a given brand or to use a service again [Oliver, 1999].

On the basis of the above considerations, we formulated the following hypotheses:

*H1: Green logistics positively influences customer satisfaction.*

*H2: Green logistics positively influences customer loyalty.*

*H3: Satisfaction positively influence loyalty.*

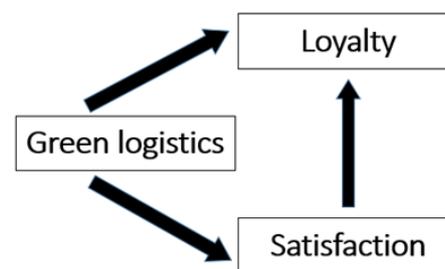


Fig. 1. Model for testing relationship between green logistics, satisfaction, and loyalty

## RESEARCH METHODOLOGY AND RESULTS

### Research stages and data gathering

The study was conducted in several stages. Based on the literature review, a scenario was prepared for 3 FGIs (focus group interviews). The results of this research enabled the design of a measuring instrument for a quantitative study.

We used a structured questionnaire for the study. In addition to questions about the availability of products, returns, cross border buying, status order, questions were asked about green issues of logistics. In particular, they covered the following aspects possibly offered by the online retailers: deliveries parcel lockers and PUDO (pick up drop off) points, returnable packaging, return of used products, using environmentally friendly materials for packing their parcels. Apart from

the issues related to green logistics, the respondents were asked about customer satisfaction with the purchases made and their loyalty to the online sellers.

We used the database of e-tailers as the sample. It included data from the Regon database kept by the Central Statistical Office in Poland and commercial databases, such as DBMS, Bisnode.

Approximately 13.7 thousand respondents took part (44% of the total population of e-tailers in Poland). Non-random purposeful sampling was applied. The sample was selected from those entities that had relevant experience in selling products via the Internet for at least one year. Both computer-assisted telephone interviews (CATI) and computer-assisted web interviews (CAWI) were applied

to data gathering between November 2017 and May 2018. In total, 592 correctly (N=592) completed questionnaires was received – 200 records from CATI and 392 interviews using CAWI.

## Measures

Green logistics, satisfaction, and loyalty are multi-faceted constructs. There are variables that are not directly observed, but affect the observed variables. Because it is a deficit of empirical research on green logistics in e-commerce, it was necessary to prepare indicators of this latent variable. Based on an in-depth literature review and the results of the FGI, observable indicator was developed and included in the questionnaire in the form of statements (Table 1).

Table 1. Constructs, items and scales of green logistics, satisfaction, and loyalty

<p><i>Green logistics. Cronbach's alpha = 0.719</i></p> <p>Customers buy from online sellers who offer deliveries to self-service terminals (e.g. parcel locker)</p> <p>Customers buy from online sellers who offer deliveries to PUDO (pick up drop off) points (eg. a traffic kiosk, gas station)</p> <p>Customers buy from online sellers who offer pickup at their branches</p> <p>Customers buy from online sellers who use environmentally friendly materials for packing their parcels</p> <p>Customers buy from online sellers who match the size of the packaging to the size of the product</p> <p>Customers buy from online sellers who offer returnable packaging</p> <p>Customers buy from online sellers who offer return of used products</p> <p><i>Satisfaction. Cronbach's alpha = 0.720</i></p> <p>My customers feel that we understand their needs.</p> <p>My customers will recommend their nearest and dearest or friend to buy from these us</p> <p>My customers are satisfied with their purchases.</p> <p><i>Loyalty. Cronbach's alpha = 0.724</i></p> <p>My customers will continue to buy from us, even if their payment for products offered by other sellers is more competitive.</p> <p>My customers will continue to buy from us, even if the shipments offered by other sellers are more competitive.</p> <p>My customers will continue to buy from us, even if the products offered by other sellers are more competitive.</p>
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We studied our model from the seller perspective. The respondent was to look at the green logistics value, satisfaction, loyalty and evaluated them through the final customer's "eyes". This approach is in line with what is presented in the literature [Kawa and Światowiec-Szczeńska, 2020].

We adopted a five-point Likert-type scale to assess the statements in the questionnaire where 1 meant "strongly disagree" and 5 – "strongly agree".

We used the Cronbach's  $\alpha$  as a method of the reliability analysis. All Cronbach's  $\alpha$  were above 0.7 indicating satisfactory internal consistency of variables.

## Results and discussion

The Pearson correlation coefficient was used to study the relationship between the variables. In addition to the strength of the relationship, it was very important to determine whether the correlation was statistically significant. Our study showed that the correlations between all variables were

positive and statistically significant. The strongest relationship was found between satisfaction and loyalty, which is very well supported in the literature. The relationships between green logistics and satisfaction, and green logistics and loyalty were a little weaker. The results of the research indicate that green logistics influences satisfaction and loyalty. Therefore, online retailers who pay more attention to the ecological aspects have satisfied and more loyal customers. The green approach is primarily about developing delivery methods alternative to courier deliveries, i.e. deliveries to parcel lockers, PUDO points or pickup at branches. It also means taking greater care of the packaging, in particular using environmentally friendly materials for packing parcels and matching the size of the packaging to the size of the product. Returns are also a very important aspect, which should reduce additional packaging by selling products in returnable packaging and enabling the return of used products. It is important that these green logistics elements are included in the offer of online retailers. Some of them result from other needs, e.g. OOH, and we wrote about this in another article. The same is true for returns. They can all be treated as separate issues or, more broadly, as logistics value. It should also be noted that it is not always possible to implement all components of green logistics. Not all companies have their own branches. Not every shipment is suitable for PUDO and parcel lockers - for example large goods (bulk) or fresh or temperature-controlled products. The same applies to the return of used products - some items cannot be returned after being used, such as underwear, cosmetics, etc. Some products do not need to or cannot be packed in ordinary packaging, let alone packaging made of environmentally friendly materials - e.g. tyres, which are transported without any packaging or additional protection.

Table 2. Correlations between green logistics, satisfaction, and loyalty

	Green logistics	Satisfaction	Loyalty
Green logistics		.396**	.363**
Satisfaction			.630**
Loyalty			

\*\* indicates  $p < 0.01$

## CONCLUSIONS

E-commerce has been growing rapidly for several years. The pandemic period has further accelerated this growth. During the lockdown, the necessary products are picked, packed, shipped and delivered to the customer's chosen location. This reduces unnecessary car traffic, which decreases the carbon footprint. E-commerce also generates inconvenience not found in traditional retail. The problems include the last mile, excess packaging and packaging materials and product returns. There is also a view that e-commerce has caused a very large increase in mass production, because anyone can buy almost anything. This stimulates customers to buy more and more, which in turn often leads to generating waste [Tiwari, Singh 2011]. The final effect is not yet known, as research to date has not clearly answered the question of whether Internet shopping increases or decreases environmental impacts [Matthews et al. 2001; Abukhader, Jönson, 2003; Sui, Rejeski, 2002; Tiwari, Singh, 2011].

However, it is inevitable that the Internet will gain importance in trade, and therefore it must be organised immediately in such a way that it has as little impact as possible on the environment. This approach also has direct positive effects for sellers. Our research has shown that customers pay attention to the ecological aspects of logistics. The more they appreciate green logistics, the more satisfied they are with their purchases and the more likely they are to repeat purchases from the same retailer.

The slogan of one of the e-commerce leaders that "the efficiencies of online shopping result in a greener shopping experience than traditional retailing" [Amazon, 2021] needs to be backed up by many additional measures. Customers expect real change, so companies must choose initiatives that have a positive environmental impact.

The research results presented here have limitations that can be addressed in further studies. Firstly, attention was focused only on selected aspects of green logistics as perceived by online retailers. A more thorough and deeper study on a larger sample involving

different stakeholders (sellers, customers, suppliers) would be needed. Establishing sustainability for e-commerce requires a holistic approach that examines the entire logistics system. Secondly, it was limited to the simplest statistical analyses. A multifaceted and more detailed study would require the use of more advanced analytical methods, such as structural modelling equations. Thirdly, the customers' environmental awareness has recently been growing more and more rapidly, and our study was conducted some time ago. It is worth repeating this research soon.

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## ZIELONA LOGISTYKA W E-HANDLU

**STRESZCZENIE. Wstęp:** Wraz z bardzo dynamicznym rozwojem e-commerce w relacjach B2C, w podobnym tempie rośnie liczba operacji logistycznych związanych z realizacją zamówień. Każdy produkt musi zostać skompletowany, zapakowany i wysłany lub przekazany do odbioru przez klienta. Choć zakupy online są bardzo wygodne dla klientów, mają negatywny wpływ na środowisko. Problemem jest transport poszczególnych przesyłek, dodatkowe opakowania i materiały użyte do tego celu oraz zwroty.

Celem niniejszego artykułu jest przedstawienie głównych wyzwań logistycznych związanych z ekologicznym e-handlem oraz zbadanie wpływu podejścia zielonej logistyki w e-handlu na satysfakcję i lojalność klientów.

**Metody:** Do zebrania danych zastosowano zarówno wywiady telefoniczne wspomagane komputerowo (CATI), jak i wywiady internetowe wspomagane komputerowo (CAWI). W sumie otrzymano 592 poprawnie wypełnionych kwestionariuszów - 200 wywiady z CATI i 392 z wykorzystaniem CAWI. Do określenia zależności między zmiennymi wykorzystano współczynnik korelacji Pearsona.

**Wyniki:** Przeprowadzone badanie empiryczne potwierdziło istnienie zależności pomiędzy zieloną logistyką, satysfakcją i lojalnością. Oznacza to, że im więcej uwagi dentyści internetowi poświęcają ekologicznej dostawie (skrytki na paczki, punkty odbioru i odbioru, click & collect), pakowaniu (materiały przyjazne środowisku i wielkość opakowania) oraz zwrotom (opakowania zwrotne, zwrot zużytych produktów), tym bardziej klienci są zadowoleni i skłonni do ponownych zakupów.

**Wnioski:** Dla kupujących w Internecie ważna jest nie tylko cena i szeroki wybór produktów oraz szybka dostawa, ale coraz częściej liczą się także aspekty środowiskowe. Szczególne znaczenie ma logistyka. Jeśli nie jest ona dobrze zaplanowana i zorganizowana, może mieć negatywny wpływ na środowisko. Wygrywają ci, którzy inwestują w ekologiczne rozwiązania. Przedstawione wyniki badań zachęcają do dalszych eksploracji naukowych, które byłyby poświęcone tylko temu zagadnieniu, z uwzględnieniem innych interesariuszy e-commerce, tj. sprzedawców, dostawców i komplementatorów.

**Słowa kluczowe:** e-commerce, zielona logistyka, wartość logistyczna.

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Arkadiusz Kawa, ORCID ID: <https://orcid.org/0000-0003-0697-8838>  
Poznań University of Economics and Business  
al. Niepodległości 10, 61-875 Poznań, **Poland**  
e-mail: [arkadiusza.kawa@gmail.com](mailto:arkadiusza.kawa@gmail.com)

Bartłomiej Pierański ORCID ID: <https://orcid.org/0000-0001-5327-8725>  
Poznań University of Economics and Business  
al. Niepodległości 10, 61-875 Poznań, **Poland**  
e-mail: [bartlomiej.pieranski@ue.poznan.pl](mailto:bartlomiej.pieranski@ue.poznan.pl)