

ACTIVITIES FOR COUNTERACTING WASTING FOOD BY SUPERMARKET CHAINS IN THE CONTEXT OF SUSTAINABLE DEVELOPMENT

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ABSTRACT

The problem of food wastage, particularly in the recent period, has been broadly discussed worldwide with regard to various stages of the food supply chain. One of such stages is food distribution to consumers by supermarket chains. The study presents results of activities undertaken by supermarket chain administrators for the purpose of food wastage reduction. One of the basic measures is price reduction aimed at possibly fast sale of products. Such activities can cause an even 8-fold increase in sales in the case of price reduction by half. Other positive activities include donating food to charity organisations or food banks.

This study addresses the mutual correlation between the sales of various products, and the effect of the percent of discounts on the sale of products for different product groups in the offer of the supermarket chain, as well as the dependency of the trade volume and the amount of food donated to public purpose organisations. The research was conducted in the period of 4 years of operation (2020-2023) of a Polish chain of grocery supermarkets.

Introduction

According to statistics, in 2010, 925 million people around the globe struggled with malnutrition, although 1.3 billion tonnes of food (i.e. approximately one third of global food production) is wasted annually (Ishangulyyev et al., 2019). The highest number of starving people inhabits developing countries, although cases of malnutrition at a smaller scale are also encountered in developed countries. The problem of malnutrition particularly concerns those living in poverty, as well as those from extreme age groups, hospitalised chronically ill patients, or people struggling with serious immunological disorders (Mihalčová et al., 2021).

Malnutrition considerably affects not only the functioning, but also recovery of each human organ. Wasting food products occurs at every stage of the food supply process from farm to table (Głowacki et al., 2019). Already at the initial stages of food processing, their efficiency or potential wastage depends both on factors independent from human activity such as the place of cultivation (climatic factors) or animal breeding (habitat conditions), as well as those man-induced, from processing, to transport, warehousing, distribution or sale, to improper consumer habits (Bilska and Kołożyn-Krajewska, 2018; Iqbal et al., 2020). In response to the increasingly serious problem of food wastage and the growing issue of starvation and malnutrition, on 19 January 2012, the European Parliament issued a resolution aimed at adopting a strategy towards more efficient food management in the food supply chain in EU member states. According to the resolution, limiting food wastage is an important initial step in counteracting world hunger and improvement of the state of nutrition of humankind (Krishnan et al., 2020; Mellinas et al., 2020). Activities related to counteracting and reduction of the level of food wastage correspond with the concept of sustainable development (Jastrzębska, 2021; Rasoolimanesh et al., 2023). The global trend of activities in that area is outlined by objective 12.3 of the UN Sustainable Development Objectives, stipulating reduction by half by 2030 of the amount of wasted food per person in retail sale and consumption, in the production process, distribution, as well as losses occurring during harvest (Palmer and Flanagan, 2016; Iqbal et al., 2020). Because waste reduction should be the main priority of solutions in the scope of waste management, waste dumping should be permitted only when it is impossible to reuse the waste as resources (Starek-Wójcicka et al., 2023). This aims at reduction of waste production at the source through efficient use of materials, better design and planning, and reduced operational costs. The initial step towards undertaking effective remedial actions is appropriate estimation of the scale of losses and food wastage at the level of particular units and participants of the agricultural-food chain. Primary production, covering plant cultivation and animal breeding for food purposes, constitutes the first link of the agricultural-food supply chain. It already begins when food resources are ready to enter the economic and technological system of food production and consumption (Zapatrina, 2016; Dou et al., 2018; Herrera et al., 2020). Based on declarations of respondents, their knowledge regarding the issue of food wastage in Poland appears to be at the highest level. It is plausible, however, that they either overestimate their knowledge of the subject, or ignore the negative effects of wasting food (Slorach et al., 2019, 2020).

Some sectors of the food industry generate considerable amounts of waste, and although most of the used materials are not hazardous and are biodegradable, they are often poorly managed, and simply sent to waste dumps together with other types of waste (Bilska et al., 2018). Part of such waste, e.g. post-production flax mash, is suitable for direct use with no prior processing. It can also directly serve as a raw material for production of other goods (Pędzik et al., 2021). In many countries, discarding waste in waste dumps is the most common form of their processing, although it is considered the worst possible option of waste management (Watson et al., 2023). The standard practice of placing waste in dumps resulted in the contamination of soil, surface, and ground waters. Biodegradable waste constitutes approximately 55% of all waste from food processing (Sobczak et al., 2022). Another option is reuse of the products and their components with their minimum processing for the same purpose for which they were produced in the first place. In this context, in many cases it was

determined that overcapacity-driven waste accounts for as much as 20-40% of waste produced by producers of convenience meals (such as ready meals and sandwiches) (Zarzycki et al., 2020). The amount of waste is particularly evident in the food industry sector usually experiencing variable demand and offering products with a short expiry date. Many of such products are produced for specific retail brands against very short deadlines, therefore in the past, producers actively overestimated demand to ensure the required supply at the cost of generating vast amounts of overcapacity-driven waste. Such waste is inefficiently managed. The identification of particular classes of wastes contributes to minimising its excessive production owing to taking into consideration what a given material is and why it was generated (do Carmo Stangherlin et al., 2019; Bilska et al., 2020). Over the last decades, industrial and economic growth largely occurred at the expense of the natural environment. Food producers and sellers produce and process a broad variety of wastes some of which are common for all other industrial sectors, for example wastewater and packaging. Part of production waste is rich in potassium, phosphorus, and nitrogen that can be reused in the production process. In response to new trends in global activities aimed at minimising food wastage, industry is attempting to manage vegetable and fruit pulp that owing to its richness in antioxidants and polyphenols shows abundant healthy properties, and therefore constitutes valuable waste. Unused and easily rotting, however, it poses a serious problem for the enterprise due to the necessity of its fast neutralisation (Ray et al., 2019; Brizga et al., 2020; Domin et al., 2021).

The objective of this article is to present a coherent discussion on waste in food distribution based on the example of grocery supermarket chains, and to define a number of preventive methods for minimising the amount of waste (Bachanek, 2020).

Materials and Methods

The study material were data from one of Polish supermarket chains operating throughout the country. The subject of study were data from 50 commercial objects functioning in east Poland. The collected data were presented in the form of trade volume on a group of products such as fruit and vegetables, fresh meat, and refrigerated goods. Those products are the most sensitive to wasting, and simultaneously constitute a substantial share of the trade volume of supermarket chains. The article also presents the remaining groups of products particularly susceptible to wasting, but also taken into consideration as products subject to periodical promotional actions for the purpose of prevention of their wasting. They are groups of products such as: fruit and vegetables, bake off, flowers, fresh meat, fresh poultry, fresh fish, frozen goods, refrigerated goods, and dry assortment.

The data were subject to statistical processing in Statistica 13.3 programme. The effect of activities of the supermarket on the amount of wasted food was determined, and consumer behaviours in response to promotional actions were analysed. Promotional actions (discounts on products) and donating food to charity organisations were adopted as the assessment indices.

Results and Discussion

The study was implemented at the turn of 2020 and 2022. It should be emphasised that based on the regulation of the Minister of Health, the state of pandemic was binding in Poland from 20th March 2020 to 15th May 2022. On 16th May 2022, the state of pandemic was changed to the state of pandemic threat that was revoked on 1st July 2023. Supermarkets operated in the sanitary regime but with various restrictions in stationary form.

Activities limiting food wastage at the stage of sale and from the point of view of supermarket chains include the application of promotional actions for products with approaching expiry date.

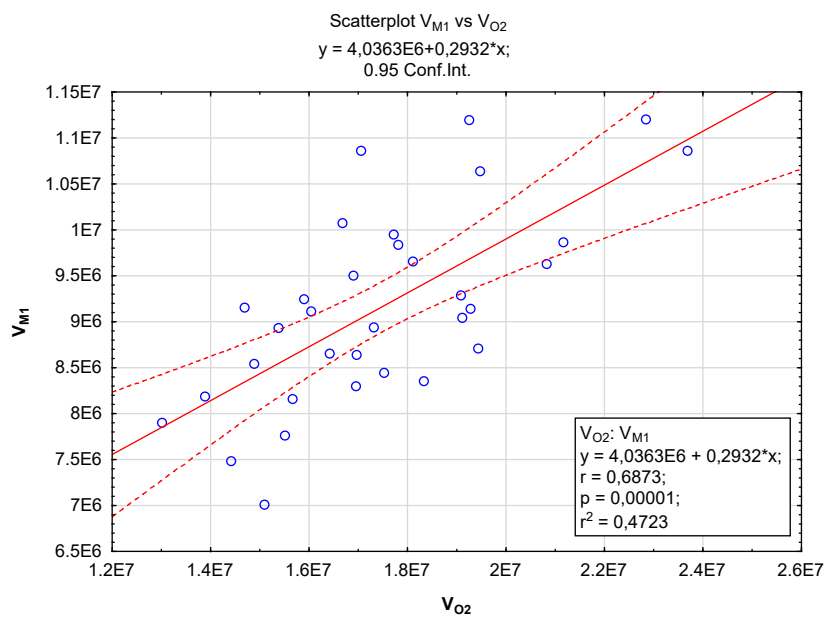


Figure 1. The relationship between the turnover of fresh meat and fresh poultry (V_{M1}) and fruit and vegetables (V_{O2}) over a 12-month period

Figure 1 presents the trade volume dependency based on the example of product group I (V_{O2} – fruit and vegetables), and trade volume for product group II (V_{M1} – fresh meat and fresh poultry). The statistical analysis confirms a high positive correlation between these two groups (correlation coefficient of $r = 0.6873$, $p = 0.00001$). This suggests that an increase in the trade volume of meat is accompanied by an increase in the sale of fruit and vegetables. It is certainly related to the culture of meal preparation in which both types of products are often combined in different kinds of dishes. Here, the “Category Management” is also of importance, i.e. the location of product groups in a commercial object. In most supermarkets, fresh products (fruit, vegetables, bake off, fresh meat, refrigerated goods) are located at the beginning of the standard route of the customer in the shop. This is also a resultant of the said culture of meal preparation.

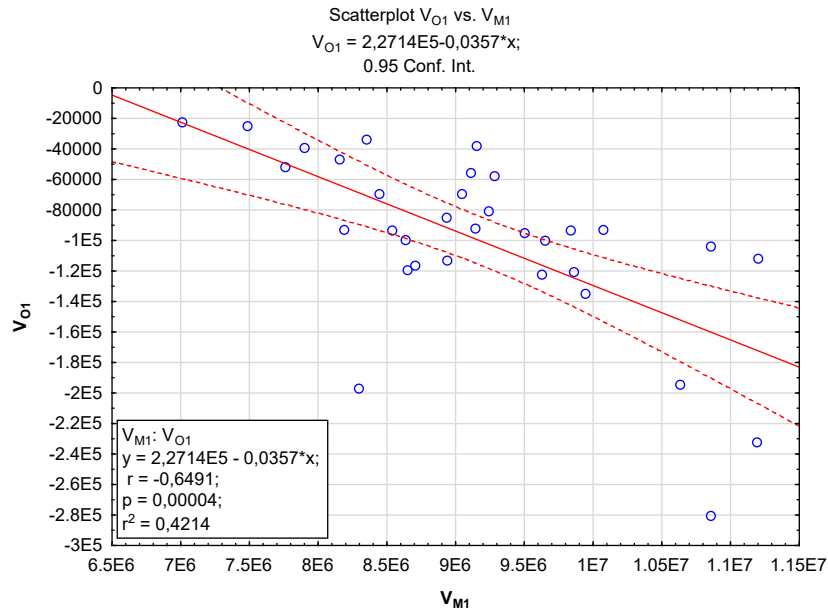


Figure 2. Dependence of promotional activities on the group of fruit and vegetables (V_{O1}) in relation to the sale of fresh meat and fresh poultry (V_{M1}) without promotional prices over a 12-month period.

Figure 2 presents the graph of the regression line for discounts on product group I comprising fruit and vegetables (V_{O1}), and trade volume for product group II comprising fresh meat and fresh poultry (V_{M1}). As seen in the figure, there is a highly significant negative correlation (correlation coefficient of $r = -0.6491$, $p = 0.00004$) between discount (V_{O1}) and trade volume for product group II (V_{M1}). Moreover, as suggested by the coefficient of determination r^2 , the variability of one feature (discount) is explained with the variability of the other (i.e. trade volume for product group II- V_{M1}) in 42%. The statistical analysis confirms that customers of supermarkets are highly susceptible to promotional actions. Having a specified budget for expenses to their disposal, they are more likely to choose discounted products from the group of fruit and vegetables than products from the group of fresh meat at the standard price.

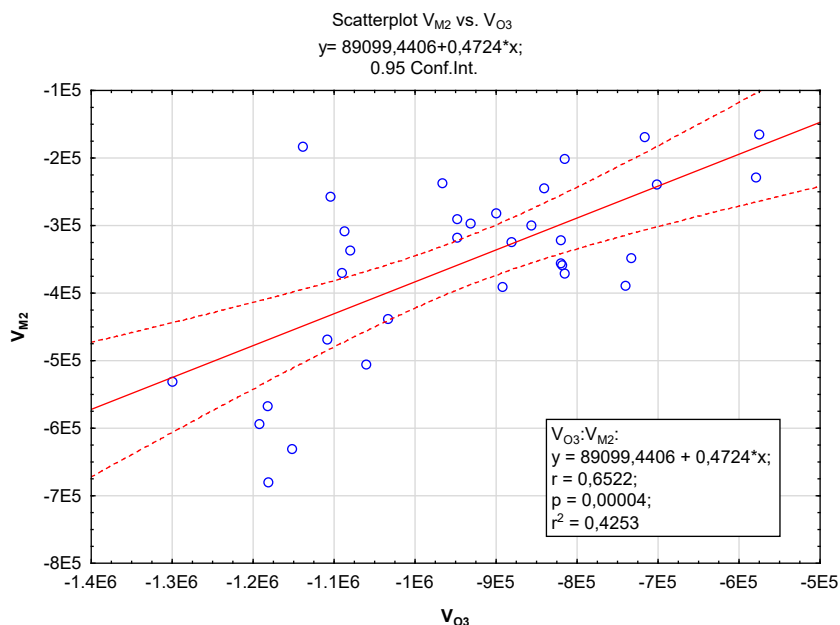


Figure 3. The relationship between promotional deductions for both product groups, fresh meat and fresh poultry (V_{M2}) and fruit and vegetables (V_{O3})

Figure 3 presents the effect of promotional discounts on the group of fruit and vegetables and on the group of fresh meat and fresh poultry. There is a highly significant correlation (correlation coefficient of 0.6522, $p = 0.00004$) between total discounts on product group I (V_{O3}) and discounts on product group II (V_{M2}). Moreover, based on the coefficient of determination r^2 , the variability of one feature (discounts on product group I – V_{O3}) is explained with the variability of the other (i.e. total discounts on product group II – V_{M2}) in 43%. This suggests that the policy of ordering products in the supermarket is not optimal, because in the case of promotional actions in both groups at the same time, a positive correlation is observed between the groups, resulting in wastage in the food supply chain. Pursuant to the act, the supermarket is then obliged to donate the food free of charge (within its expiry date) to charity organisations such as foundations or community fridges with which they previously concluded a relevant agreement. Based on the collected data, over a period of one year (March 2020-March 2021), the analysed part of supermarkets made free of charge food donations to foundations comprising less than 25 tonnes of food products.

The percent of the discount on products with a short expiry date varied from 20% to 70% of the standard price of the product. It depends on the type and characteristics of the product group as well as the pricing strategy of the trade enterprise. It should be emphasised that the sale processes of grocery supermarket chains force detailed and timely controls of products to avoid overlooking the expiry date of a product in the case of fresh goods, and the use-by date of the product in the case of frozen and dry assortment.

Table 1.
The impact of the size of the discount on the sale of goods for the commodity group of fresh meat and fresh poultry

Groups of products	Discount percentage	Resale growth factor
Fresh meat and poultry	20%	170%
	30%	320%
	40%	510%
	50%	780%

According to Table 1, the effect of sale of goods for the product group of fresh meat and fresh poultry increases with the proposed percent of discount. For 20% discount, 170% of goods are sold, and 50% discount causes a 780% increase in sales for the product group of fresh meat and fresh poultry.

Table 2.
The impact of the size of the discount on the sale of goods for the fruit and vegetables product group

Groups of products	Discount percentage	Resale growth factor
Fruits and vegetables	20%	120%
	30%	180%
	40%	330%
	50%	480%

According to Table 2 the effect of sale of goods for the product group of fruit and vegetables also increases with an increase in the proposed percent of discount, but it is smaller than for the previously mentioned group. In the case of 20% discount, 120% of goods are sold, and 50% discount causes a 480% increase in sales for the product group of fruit and vegetables.

Table 3.
The impact of the size of the discount on the sale of goods for the product group of refrigerated products

Groups of products	Discount percentage	Resale growth factor
Cold room	20%	150%
	30%	180%
	40%	220%
	50%	300%

According to Table 3, the effect of sale of goods for the product group of refrigerated goods increases with an increase in the proposed percent of discount. In the case of 20% discount, 150% of goods are sold, and 50% discount causes a 300% increase in sales for the product group of refrigerated goods.

Table 4.

The impact of the size of the discount on the sale of goods for the frozen food product group

Groups of products	Discount percentage	Resale growth factor
Frozen food	20%	200%
	30%	170%
	40%	380%
	50%	510%

According to Table 4, the effect of sale of goods for the product group of frozen goods also increases with an increase in the proposed percent of discount. In the case of 20% discount, 200% of goods are sold, and 50% discount causes a 510% increase in sales for the product group of frozen goods.

Table 5.

The impact of the discount size on the sale of goods for the bake off group

Groups of products	Discount percentage	Resale growth factor
Bake off	20%	55%
	30%	70%
	40%	60%
	50%	60%

According to Table 5, the effect of sale of goods for the product group of bake off is the least attractive for customers, although here the trend is maintained at the positive level – it increases with an increase in the proposed percent of discount. In the case of 20% discount, 55% of goods are sold, and 50% discount causes a 60% increase in sales for the product group of bake off.

Table 6.

The impact of the discount size on the sale of goods for the dry assortment group

Groups of products	Discount percentage	Resale growth factor
Dry assortment	20%	160%
	30%	180%
	40%	240%
	50%	200%

Table 6 presents the effect of the magnitude of discount on dry assortment. In the case of 20% discount, 160% of goods are sold, and 50% discount causes a 200% increase in sales for the product group of dry assortment.

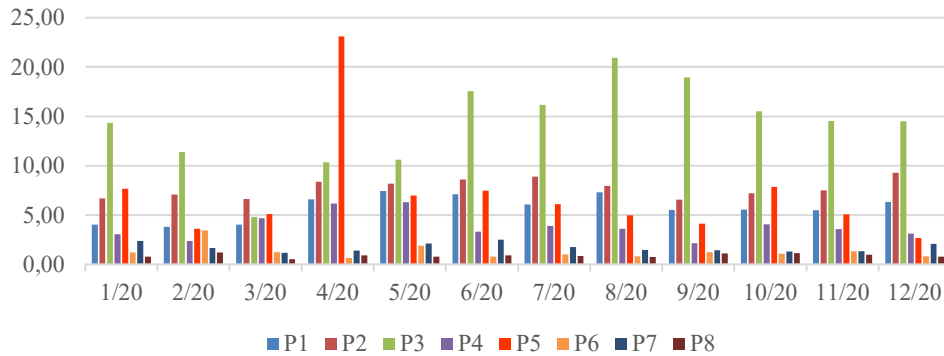


Figure 4. Share of write-off (quantity of unsold/unsellable goods) in relation to turnover in a given product group in the period of 12 months of 2020

Abbreviation: P1 - fruit and vegetables, P2 – bake off, P3 - flowers, P4 - fresh meat and fresh poultry, P5 - fresh fish, P6 - frozen food, P7 - chilled products, P8 - dry assortment.

According to data presented in Figure 4, the product groups particularly unattractive appear to include P3 – flowers – a group generating a high number of returns, P2 – bake off, and P1 – fruit and vegetables. All three groups are fast rotating products with relatively high sensitivity to the time of storage in the shop.

According to data presented in Figure 5, a particularly unattractive product group appears to remain group P3 – flowers and P2 – bake off, generating a high number of returns, and group P1 – fruit and vegetables. An interesting product group is also P5 – fresh fish – it also enjoyed low popularity, particularly in the middle part of the year. All these three groups comprise fast rotating products with relatively high sensitivity of the time of storage in a shop. Group P6 – frozen goods and P8 – dry assortment are products with relatively long shelf life. Therefore, a small share of discounts was observed in their trade volume.

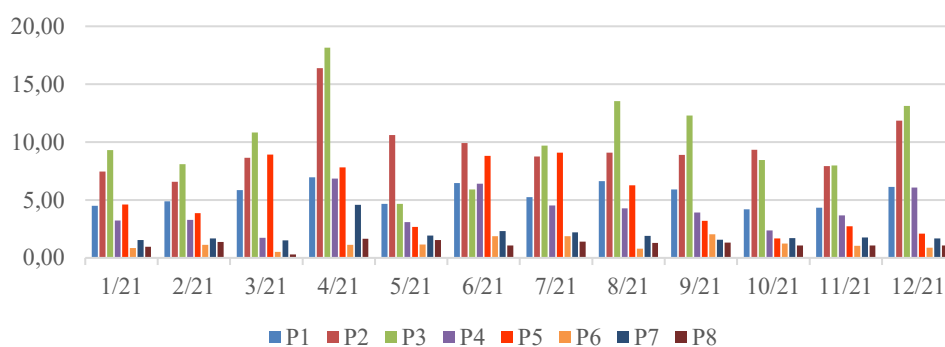


Figure 5. Share of write-off (quantity of unsold/unsellable goods) in relation to the turnover in a given product group in the period of 12 months of 2021

Abbreviation: P1 - fruit and vegetables, P2 – bake off, P3 - flowers, P4 - fresh meat and fresh poultry, P5 - fresh fish, P6 - frozen food, P7 - chilled products, P8 - dry assortment.

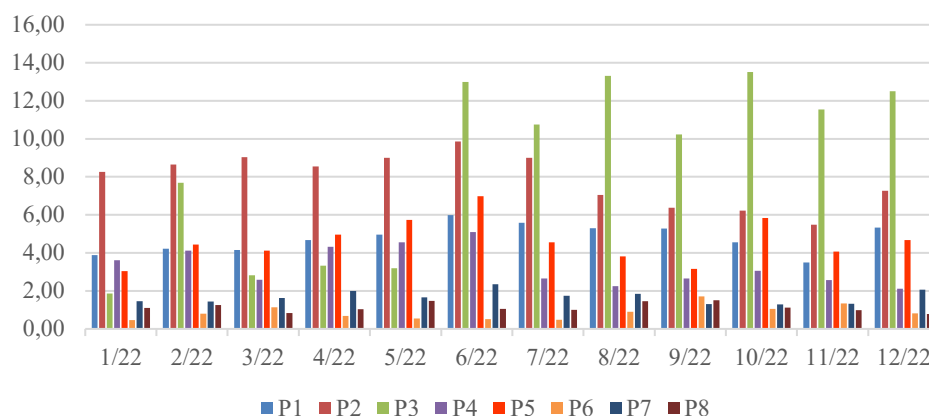


Figure 6. Share of write-off (quantity of unsold/unsellable goods) in relation to the turnover of a given group of goods in the period of 12 months of 2022

Abbreviation: P1 - fruit and vegetables, P2 – bake off, P3 - flowers, P4 - fresh meat and fresh poultry, P5 - fresh fish, P6 - frozen food, P7 - chilled products, P8 - dry assortment.

According to data presented in Figure 6, the product group particularly unattractive in 2022 was group P2 – bake off, generating a high number of returns, and from mid-year (from June), it also concerned group P3 – flowers and P1 – fruit and vegetables. An interesting product group is also P5 – fresh fish, showing numerous cyclical fluctuations in the graph.

All these three groups are fast rotating products with relatively high sensitivity to the time of storage in the shop.

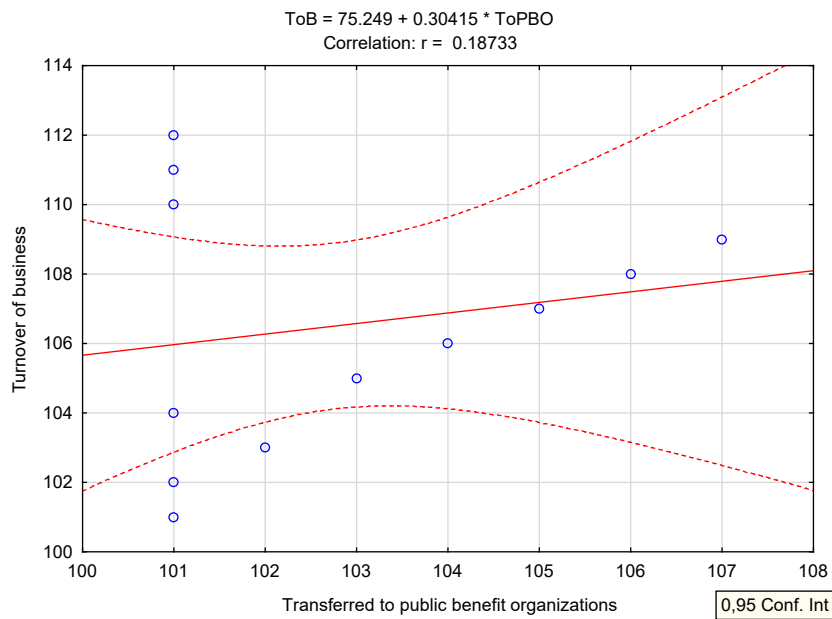


Figure 7. Relationship between trade turnover and the amount of food donated to public benefit organizations in 2020

Unfortunately, in the case of wasted food, not all of it is donated to charity organisations. As presented in the figure, the correlation is positive, but very weak ($r = 0.18733$), rendering the statistical analysis and therefore drawing conclusions impossible.

In the following year, the trend was more pronounced, with a strong correlation ($r = 0.75836$) and positive direction. Therefore, the dependency between the trade volume of the analysed object and donating unsold food to public purpose organisations is evident.

In 2022, in the case of wasted food, as shown in Figure 9 the correlation is positive, but very weak ($r = 0.23426$), rendering statistical analysis and therefore drawing conclusions impossible.

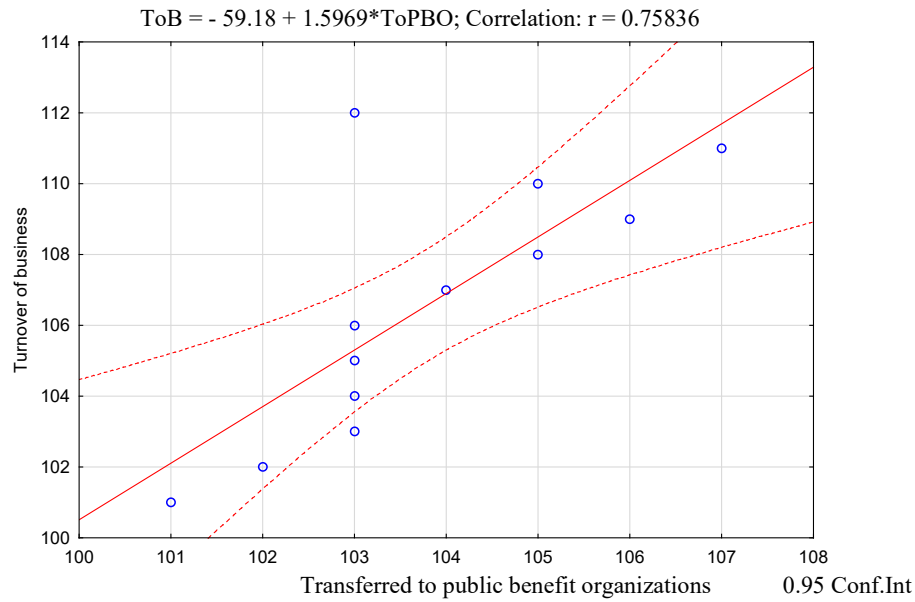


Figure 8. Relationship between trade turnover and the amount of food donated to public benefit organizations in 2021

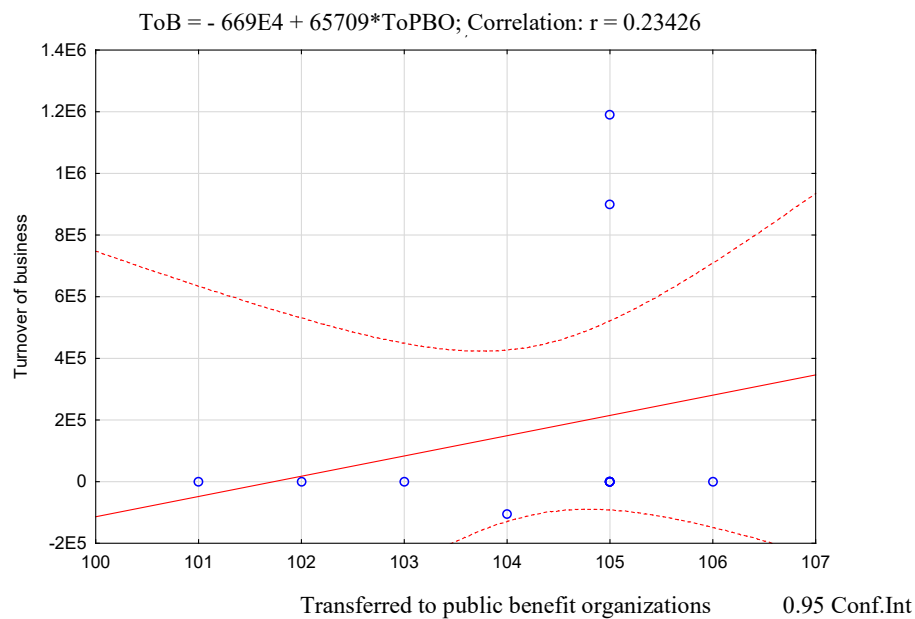


Figure 9. Relationship between trade turnover and the amount of food donated to public benefit organizations in 2022

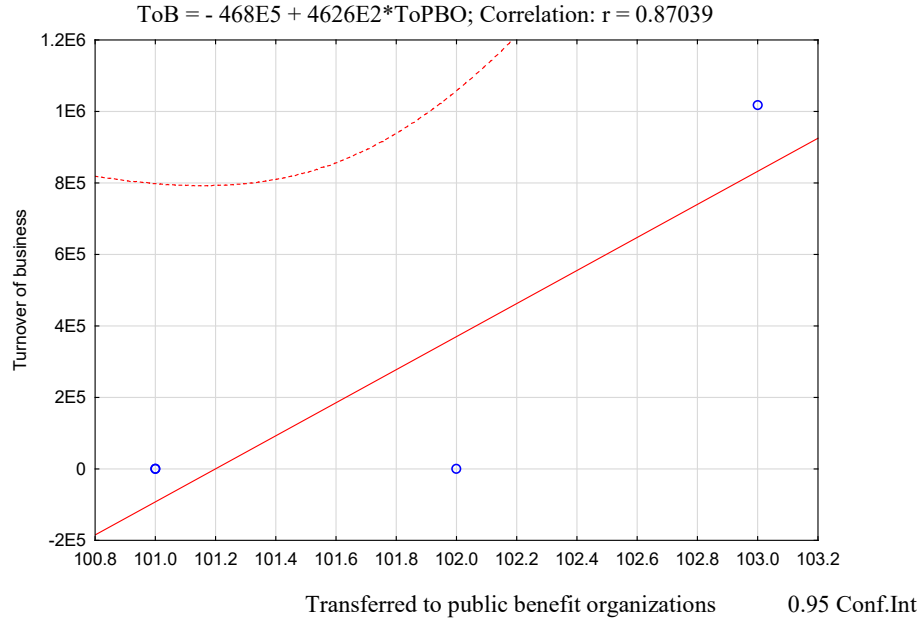


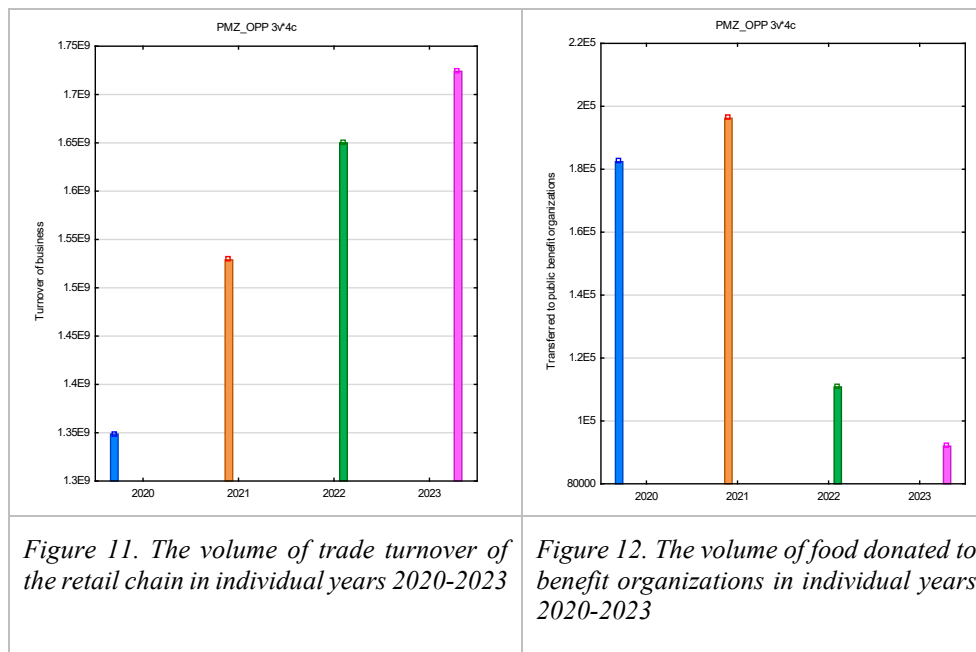
Figure 10. Relationship between trade turnover and the amount of food donated to public benefit organizations in 2023

In the following year, the trend was more pronounced, with a strong correlation ($r=0.87039$) and positive direction. The dependency between the trade volume of the analysed object and donating unsold food to public purpose organisations was evident. It should be emphasised that in the case of 2023, the amount of collected information is half smaller than in the remaining years (the data concern the first half of the year).

Table 7.

Descriptive statistics between retail chain turnover and food donated to charities

Variable	Descriptive statistics				
	N	Mean	Minimum	Maximum	Std.Dv
Turnover of business	4	1.562841E+09	1.348629E+09	1.724046E+09	163915207
Transferred to public benefit organizations	4	1.453500E+05	9.200000E+04	1.962000E+05	51634



An increase in trade volume in supermarket chains frequently generates a number of consequences related to creating excessive orders in the processing sector. The binding law does not necessarily favour donating food for charity purposes. According to the act of 19th July 2019 on counteracting food wastage, food products threatened with wastage can be only donated to public purpose organisations with which the commercial object previously concluded a relevant agreement. In practice, the market has been dominated by the largest institutions such as Caritas and the Federation of Food Banks that play the role of a distributor of free food. The act does not admit any other, smaller, local recipients, which is not helpful in reaching the goal of minimising the amount of wasted food. The trend is evident in Figures 11 (trade volume) and 12 (volume of food donated to public purpose organisations). It is worth asking the question why it happens and whether it is justified, as well as what are the possibilities to change this state of the matter. Supermarkets often burden the consumer with the “problem” of food wastage, particularly in the context of the fact that when buying an expiring product they dispose of it themselves. It should be emphasised, however, that next to donating food to charity organisations, it is the most effective way of counteracting wastage of food products.

Promotional actions are beneficial for both supermarket chains and less wealthy customers, but do they affect wastage throughout the food supply chain? The answer requires referring to the survey conducted directly in households. The data strongly suggest that a large share of food is wasted at the stage of consumption. This raises two questions: do consumer purchases exceed the needs of the household, and how much food is thrown away due to rotting (Amicarelli et al., 2021; Babbitt et al., 2021). Almost 1/5 of respondents declare that throwing away food is related to preparing excessive amounts of food or excessive shopping.

This was particularly evident in the period of the Covid-19 pandemic (Amicarelli et al., 2021).

Considering the current visual culture that focuses on strictly specified aesthetics of food products, it also contributes to an increase in the amount of wasted food, although wastage is lower at the trade stage (through promotional actions aimed at promoting less visually attractive food – it substantially contributed to an increase in sales) (Jagadiswaran et al., 2021; Mookerjee et al., 2021). Unfortunately, study results show that 90% of respondents admit throwing away food. The cited reason is usually exceedance of the expiry date. According to Bilska, products thrown away the most frequently include fresh meat and bake off, as confirmed by own research (Bilska et al., 2019). Interestingly, the respondents declare knowledge of campaigns and educational programmes aimed at prevention of food wastage, which suggests those campaigns do not sufficiently meet their function (Mattila et al., 2020).

The most effective form of managing excess food from supermarkets appears to be its donating for charity purposes. Initiatives aimed at increasing public awareness and limiting consumerism are also of high importance (Balan et al., 2022). Organisations with a mission to manage excess of produced food include Caritas or Food Banks. They have their own warehouses and cold stores. Next to recycling food, they also deal with education on avoiding food wastage and on rules of proper nutrition (Bilska et al., 2019).

The modern mass culture unfortunately favours food wastage. Supply considerably exceeds demand. Changes in lifestyle are observed towards consumerism and popularisation of nutritionally irrational behaviours. The desired specific aesthetic of food products is also one of the aspects of this complex problem (Conrad et al., 2018; Filimonau et al., 2020).

The sales policy of supermarket chains is one of important factors contributing to the issue of food wastage. Factors that contribute to the escalation of the problem include the following:

Aesthetic standards – supermarket chains frequently apply stringent aesthetic standards requiring food products to be visually perfect. Fruit and vegetables that fail to meet the standards due to their shape, size, or appearance are rejected by supermarket chains, even if they are fully edible and of good quality.

The strategy of full availability and reserve planning – supermarket chains often plan their food reserves based on estimated sales with consideration of variables that are difficult to predict such as consumer preferences and seasonal changes. As a result, if the demand for a given product is lower than expected, excess food products may exceed their expiry dates and be wasted.

Logistic problems – in some cases, supermarket chains can encounter logistic problems that lead to food wastage. They can be delays in deliveries, errors in orders, or issues with storage and transport of food products due to which food loses its value and is thrown away. –Pricing policy – some supermarket chains prefer discounting prices to attract customers and compete in the market. This strategy, however, can lead to excessive production and improper management of reserves, therefore increasing the risk of food wastage.

The distribution sector is directly responsible for 5% of wasted food according to FUSIONS (Project “Food Use for Social Innovation by Optimising Waste Prevention Strategies”) (Stenmarck et al., 2016; Galanakis et al., 2022). It also considerably, although indirectly, affects the remaining participants of the food supply chain.

It is important to emphasise that not all supermarket chains are responsible for wasting food. Many of them run initiatives aimed at limiting food wastage through a change in aesthetic standards, better reserve planning, cooperation with charity organisations, and use of unsold food for charity purposes. Effective limiting of food wastage by supermarket chains, however, requires further activities such as education of consumers, promotion of changes in aesthetic standards, improvement of logistic processes, and introduction of a suitable food management policy.

Conclusions

The following conclusions were drawn based on the presented results and discussion:

1. At the stage of food distribution in supermarket chains, food wastage particularly concerns the group of products comprising fruit and vegetables and fresh meat.
2. The simplest and most effective method of limiting food wastage at the stage of supermarket chains is its discounting, or even sale of products below the purchase price. Price reduction by 50% results in an even 8-fold increase in the trade volume of a given group. Unfortunately, such actions can also cause a considerable decrease in the trade volume of other analysed product groups, which may eventually lead to introducing promotional actions limiting food wastage in another group.
3. The most effective activity towards prevention of food wastage is its donation for charity purposes to public purpose organisations. Food donated to this group of recipients appears to be optimally managed, although it is also a channel of distribution of food products to consumers who can also waste, in this case, free food.
4. The greatest amount of food is wasted by the last link of the food supply chain, namely the consumer who purchases excessive amounts of food products. It largely results from the consumerism promoted in mass media, but also from the trade policy of the distribution sector that has a strong impact on the production sector, and pricing-marketing strategies that often manipulate consumer behaviour.

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DZIAŁANIA ZAPOBIEGAJĄCE MARNOWANIU ŻYWNOŚCI PRZEZ SIECI SUPERMARKETÓW W KONTEKŚCIE ZRÓWNOWAŻONEGO ROZWOJU

Streszczenie. Problem marnowania żywności, szczególnie w ostatnim okresie, jest szeroko dyskutowany na świecie w odniesieniu do różnych etapów łańcucha dostaw żywności. Jednym z takich etapów jest dystrybucja żywności do konsumentów przez sieci supermarketów. W opracowaniu przedstawiono wyniki działań podejmowanych przez administratorów sieci supermarketów na rzecz ograniczania marnotrawstwa żywności. Jednym z podstawowych działań jest obniżanie cen w celu możliwie szybkiej sprzedaży produktów. Takie działania mogą spowodować nawet 8-krotny wzrost sprzedaży w przypadku obniżenia ceny o połowę. Inne pozytywne działania obejmują przekazywanie żywności organizacjom charytatywnym lub bankom żywności. Niniejsze badanie dotyczy wzajemnej korelacji pomiędzy sprzedażą różnych produktów, a wpływem procentu rabatów na sprzedaż produktów dla różnych grup produktowych w ofercie sieci supermarketów, a także zależności wielkości handlu i ilości żywności przekazywanej na rzecz organizacji pożytku publicznego. Badania przeprowadzono w okresie 4 lat działalności (2020-2023) polskiej sieci supermarketów spożywczych.

Słowa kluczowe: marnotrawstwo żywności, mięso, owoce i warzywa, sieci supermarketów