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Article

Product responsibility in the digital age: The impact of the EPR regulation on Hungarian SMEs and the online commerce sector

Máté Battay[1], Zita Júlia Fodor[2], Anna Dunay[3,*]

[1] Doctoral School of Economic and Regional Sciences, Hungarian University of Agriculture and Life Sciences, 2100 Gödöllő, Hungary
[2] Department of Agricultural Business and Economics, Hungarian University of Agriculture and Life Sciences, 2100 Gödöllő, Hungary
[3] Doctoral School of Management and Business Administration, John von Neumann University, 1117 Budapest, Hungary
*** Corresponding author:** Anna Dunay, dunay.anna@nje.hu

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Abstract: In this research, we employed multivariate statistical methods to investigate the perspectives of small and medium-sized enterprises (SMEs) concerning the Extended Producer Responsibility (EPR) regulation and their apprehensions related to EPR compliance. The EPR regulation, which places the responsibility of waste management on producers, has significant financial and administrative implications, particularly for SMEs. A sample of 114 businesses was randomly selected, and the collected data underwent comprehensive analysis. Our findings highlight that a notable proportion of businesses (44.7%) possess knowledge of the EPR regulation's provisions, whereas only a marginal fraction (1.8%) lacks sufficient familiarity. We also explored the interplay between opinions on the EPR regulation and concerns regarding its financial and administrative implications. Our results establish a significant correlation between EPR regulation opinions and concerns, with adverse opinions prominently influencing concerns, particularly regarding financial burdens and administrative workloads. These outcomes, derived from the application of multivariate statistical techniques, provide valuable insights for enhancing the synergy between environmental regulations and business practices. EPR regulation significantly affects SMEs in terms of financial, administrative, and legal obligations, thus our study highlights that policymakers may need to consider additional support mechanisms to alleviate the regulatory burden on SMEs, fostering a more effective and sustainable implementation of the EPR regulation.

Keywords: Extended Producer Responsibility (EPR); digital economy; E-commerce; sustainability; entrepreneurial attitudes; small and medium-sized enterprises

1. Introduction

Nowadays, the pursuit of sustainability and environmental awareness is beginning to appear in the activities and operations of enterprises, at least at the level of expectations, in addition to economic goals (Lai et al., 2014; Prasanna et al., 2019). The analysis of sustainable operations is extremely important in evaluating the long-term economic viability and social added value of SMEs (Vitéz-Durgula et al., 2023). The SME sector is no exception, as it is an indispensable part of the Hungarian national economy, accounting for 99.8% of all enterprises, 69.8% of employment and 53.6% of the value added generated (Hágen and Holló, 2017; Hegedűs, 2021). In addition to this, the SME sector plays a major role in expanding the supply of goods and services and even in reducing environmental pressures (Zeiler, 2003).

The Extended Producer Responsibility (EPR) regulation is an environmental regulation that requires manufacturers and distributors of products to take responsibility for the management and recycling of end-of-life waste from their

products. EPR regulations are global in scope and are applied to different product categories in different countries and regions (Gáspár et al., 2023; Gupta, 2023). The regulations aim to contribute to environmental protection and sustainability, and to reduce the environmental burden of products (Biron, 2020; Szeberényi et al, 2022; Vinkóczi et al., 2024). Recent changes in Hungary will reinforce the transformation of the SME sector's impact on the environment, since the first day of July the Government Regulation 80/2023 (14.III.) on the detailed rules for the operation of the Extended Producer Responsibility (EPR) system, also known as the EPR regulation, entered into force, which represents a new approach of the European Union through the Extended Producer Responsibility (EPR) system (Government Regulation, 2023). In addition to increasing productivity, digitization and automation are an important part of the sustainability issue, therefore, investments aimed at environmental protection and long-term sustainability appear to be on the rise among companies with strong innovation activities in the industrial environment (Kurucz et al, 2023; Remsei et al., 2023).

The aim of the research is to interpret and examine the impact of the EPR regulation on small and medium sized enterprises, particularly on the online retail sector, and more specifically on online shops, through the attitudes of entrepreneurs operating online shops towards the regulation. The survey of opinions on the EPR regulation through a questionnaire provides an opportunity to collect and evaluate the experience gained since the introduction of the Regulation. Sustainability and a more environmentally conscious approach are also increasingly shaping the way we do business. Modern industry is constantly relying on finite resources, resulting in ever more efficient use and ultimately total exploitation (Horváth, 2018). An important goal of the European Union is to decouple economic development from environmental pressures (Eurostat, 2018). The current scenario of technological development has transformed everything, so the role of sustainable firm performance will increase in the future too (Bhagat et al., 2022; Gáspár, Pataki, et al., 2023; Horvath et al., 2022; Kosztyi and Kovács, 2013).

EPR regulation is a departure from the legal environment for waste management and forces companies to take a more active role in the management of waste, packaging and especially over-packaging (Monnot et al., 2019). In the context of the manufacturers of products in the waste stream (such as packaging materials) they must take responsibility for the waste from their products. The main objective of our study is to examine and analyze the impact of the EPR regulation on the Hungarian SME sector, including online shops. The rapid growth and increasing importance of internet retailing so far reinforces the economic importance of the new EPR regulation, as the additional expenditure and increased administration will also affect the functioning of this sector.

In this paper, we examine the principles of the EPR regulation, the importance of the online retail sector and the challenges and opportunities that the EPR regulation presents. We also examine how the EPR regulation affects the pricing practices, customer behavior and marketing strategies of online retailers. Based on the findings and conclusions, we will formulate recommendations that can help companies to adapt more effectively to the EPR regulation and to develop more sustainable business practices. We hope that our study can contribute to the promotion of sustainability and

the proper implementation of the EPR regulation by businesses. We examined the principles outlined in the document and their impact on the online retail sector under the EPR regulation. We will now proceed to present the research findings and test the hypotheses.

The dynamic landscape of sustainable practices and financial inclusion offers a critical lens through which to view regulatory impacts, such as the Extended Producer Responsibility (EPR). Recent research underscores the interplay between material consumption, circular economy, and national income, emphasizing the transformative potential of sustainable economic strategies (Malatyinszki et al., 2024). The integration of green transition indicators further validates the importance of transparency and trust in promoting sustainable reforms (Kálmán et al., 2024). These findings collectively advocate for robust frameworks that harness the interplay of environmental responsibility, economic inclusion, and technological innovation to advance sustainable business ecosystems.

The following hypotheses were tested during the research:

Null hypothesis: SMEs' perceptions of the EPR regulation are not significantly related to the financial and administrative impacts of EPR compliance.

Hypothesis 1 (alternative hypothesis): SMEs' perceptions of the EPR regulation are significantly related to the financial and administrative impacts of EPR compliance.

Hypothesis 2: Business attitudes towards the importance of environmental protection influence their views on the EPR regulation.

2. Materials and methods

The literature review has two main purposes. Firstly, to present the literature on the subject and secondly, to describe the relationship between EPR and online commerce and the discourse surrounding it. As the world tries to battle through the novel challenges and obstacles caused by the Covid-19 pandemic and every sector faced detrimental impact of the pandemic at different stages of a business process (Bhagat et al., 2022a).

E-commerce is one of the most dynamically growing areas of the economy, with few examples of international regulation (Titievskaia, 2020). Extended Producer Responsibility (EPR) is a policy instrument that has been created to increase the resource efficiency of waste management and to strengthen the concept of a cyclical economy in the EU (Romagnoli et al., 2020). It can be defined as a principle that allows producers to be held responsible for the whole life cycle of their products, including take-back, recycling and final disposal, and supports the implementation of the European waste hierarchy (Agamuthu and Victor, 2011; Leal Filho et al., 2019).

EPR is a policy approach that aims to improve the environmental and social performance of products by extending producer responsibility to the entire product life cycle, including waste management and environmental impact reduction (Hilton et al., 2019). Zero-waste production or sustainable waste management in urban space can be reduced by different steps, companies shall make appropriate plans to be implemented and to motivate the producers and consumers for applying the processes (Jelonek and Walentek, 2022). This is necessary, as the problem of plastics, which is one of the biggest environmental challenges, can only be solved if the plastic waste generated by

the e-commerce sector is recovered (Oláh et al., 2019). EPR is a good solution in this respect, as it is expected to increase the circularity of the areas it operates in (Compagnoni, 2022). However, the problem is that it does not bring financial benefits to businesses, so they are currently not interested in developing and complying with it (Harish et al., 2021). The EPR regulation will bring substantial and important changes to the way businesses operate, both in terms of their administrative and financial obligations. Achieving and implementing sustainability is possible when all parties involved become stakeholders and a win-win situation is created for all parties (customers, traders, government and policy makers), with appropriate incentives (Aman et al, 2024; Hong and Wu, 2010). In order for this situation to be created, prudent and proactive policy decisions are needed (Cao et al., 2018).

At present, based on our own research, it can be argued that businesses are averse to the additional burden and changes associated with the introduction of EPR; e-commerce businesses also need to take responsibility for the success of sustainability measures to ensure that a higher proportion of e-commerce packaging waste is returned to the cycle, thereby reducing emissions (Esenduran et al., 2019). The e-commerce platforms use loose package return rules to ensure continuous purchases, which in turn means using more and more packaging materials (Du and Liu, 2023). In addition to packaging, e-waste that has reached end-of-life can also be returned to producers at a higher rate (Zhong et al., 2012). E-commerce can even provide more sustainable production processes and higher recycling if the right conditions are in place (van Loon et al., 2015; Wiese et al., 2012). EPR regulations can stimulate activities that promote product innovation and reduce pollution, such as reducing resource or energy use, returning more packaging materials to the circular flow, modernizing transport and production systems, and increasing the useful life of products (McKerlie et al., 2006). Users are also open to innovation, and young people might even be willing to pay a little more for a product bought online if it was a measure to protect the environment (Moroz and Polkowski, 2016; Papp-Váry et al, 2023; Zéman et al., 2023). Under EPR, the producer is responsible for the product beyond the consumption phase (Cai and Choi, 2021). This can be achieved in a framework where manufacturing companies invest in recycling, thereby improving recycling and reducing waste (Gui, 2020; Zhan et al., 2020). Research has shown that, for example, in the case of tyres, EPR has increased resource efficiency through increased recycling; and moved tyre management up the waste hierarchy (Winternitz et al., 2019). And implementing these EPR strategies allows local authorities to partially regain control of their waste streams (Diggle and Walker, 2020). For research purposes it is considered important to approach the topic from the perspective of e-commerce businesses, as e-commerce is growing steadily in many industries, not only among large but also small and medium enterprises (Morganti et al., 2014; Visser et al., 2014). SMEs' e-commerce adoption is based on different technological factors as ICT adoption, internet connectivity, business data management (Hossain et al., 2023). Researches confirmed that during the COVID-19 pandemic due to the lockdown periods many businesses moved towards e-business tools (Mohamad et al., 2020; Priambodo et al., 2021). The most important influencing factors on e-business adoption are the attitude of managers, knowledge and experience and the innovation strategy of companies (Hossain et al., 2022; Hossain, Alhanakta, et al., 2022). At the

same time, however, the implementation of EPR has become necessary, as online shopping, and thus the production and use of e-commerce packaging, has grown steadily in recent years, and with it their environmental impact (Escursell et al., 2021; Manerba et al., 2018).

As e-commerce influences the way products are transported and delivered to consumers, this growth has environmental consequences, for example in terms of CO_2 emissions and energy consumption (Pålsson et al., 2017). The growing interest in online shopping has made last-mile delivery one of the most expensive and polluting—yet least efficient—stages of the e-commerce supply chain (Zhou et al., 2016). This is contradicted by the fact that e-commerce shopping itself can be less emissions intensive, given the right mode of transport (Carling et al., 2015). Operating models have a major impact on the carbon emissions of the e-commerce industry, with emissions as high as 70% (Cairns, 2005; Chun and Zhang, 2011).

2.1. Data collection and sample

The study was carried out through a questionnaire survey of 114 enterprises. In the study, e-commerce businesses with an online store were interviewed. 114 valid questionnaires were returned, so 100% of the sample was considered valid. This questionnaire was used to survey small and medium sized enterprises in the Internet sector and their attitudes towards the EPR regulation. The businesses that participated in the research voluntarily took part in this study and agreed to the publication of the questionnaire results.

Data was collected by means of a 12-question questionnaire designed to assess the attitudes towards the Extended Producer Responsibility (EPR) Regulation among the enterprises that completed the questionnaire. The questions covered aspects that could be investigated later using statistical methodology, such as awareness of the EPR, or the attitude of businesses to the changes, their concerns and opinions about the legal and administrative burden of complying with the EPR. Most of the responses were recorded on a 5-point Likert scale, where a score of 1 indicated “Not at all important” or “Very negative opinion”, and a score of 5 indicated “Very important” or “Very positive opinion”.

2.2. Data processing and statistical analysis

After completing the questionnaire, the data were recorded and processed electronically. IBM SPSS Statistics Data Editor software was used for data analysis and multivariate statistical analysis. Descriptive statistics were used to review the distribution and mean of the data. Cross-tabulations and chi-square tests were used to examine the correlations between e-commerce businesses’ opinions and concerns about the EPR regulation.

2.3. Statistical analysis

In the data analysis, Pearson’s chi-square test was used to test whether there is a significant relationship between opinions about the EPR regulation and concerns about EPR compliance. The results showed a statistically significant correlation. Symmetric measures of phi and Cramer’s V were also calculated in order to gain further insight

into relationships. The study also included an additional depth analysis using the phi and Cramer's V symmetric measures. These measures helped to extract additional details about the correlations, particularly with regard to their significance and strength.

3. Results and discussion

The study was conducted on a sample of 114 respondents, with 114 valid and 0 invalid questionnaires completed. The sample of the research is not representative, but it provides a sufficient basis to support the preparation of further research.

All 114 completions were valid, meaning that there were no missing or incorrect answers to the questionnaires. **Table 1** presents the descriptive statistics for the responses to the 12 questions on the questionnaire.

Table 1. Descriptive statistics on the responses of questionnaire questions

	N	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**
Question 1	114	1	5	3.41	0.860
Question 2	114	1	5	3.46	0.800
Question 3	114	2	5	3.49	0.801
Question 4	114	1	5	3.46	0.894
Question 5	114	1	5	3.48	0.844
Question 6	114	1	5	3.38	0.835
Question 7	114	2	5	3.51	0.767
Question 8	114	1	5	3.37	0.844
Question 9	114	1	5	3.49	0.854
Question 10	114	2	5	3.54	0.743
Question 11	114	1	3	2.11	0.870
Question 12	114	1	5	3.56	0.842
Valid N (listwise)	114				

A The first column shows the questions (Question 1 to Question 12). The column "N" shows the number of respondents who answered all questions. The "Minimum" and "Maximum" columns show the range of values of the responses according to the Likert scale points.

The values in the "Mean" column show the average of the responses to each question. For example, for Question 1, the average response is 3.41. The "Std. Deviation" column represents the standard deviation of the data. Valid N (listwise): This value shows how many valid completions there were in the total sample. There were 114 valid responses to each question.

The importance of the EPR regulation was measured by Question 2: "Does compliance with the EPR regulation seem important to you for your business?" Results are summarized by **Table 2**.

Table 2. Importance of EPR regulation on the businesses according to respondents (Question 2)

Likert scale points		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	2	1.8	1.8	1.8
	2	9	7.9	7.9	9.6
	3	45	39.5	39.5	49.1
	4	51	44.7	44.7	93.9
	5	7	6.1	6.1	100.0
	Total	114	100.0	100.0	

The responses are varied, but the relative majority, 50.8% (44.7%, who evaluated by 4 points i.e. "important" and 6.1% who evaluated by 5 points i.e. "very important") think that compliance with the EPR regulation is important for their business. The average response here is 3.46, indicating medium importance, this is also reflected by the nearly 40% of respondents who have neutral opinion about the regulation. The majority of business owners consider compliance with the EPR regulation important, although some are indifferent or negative. The importance of the EPR regulation for entrepreneurs may be a factor of interest for those with a higher awareness of the EPR regulation. The majority of respondents (44.7%) are aware of the EPR regulation and are aware of what it is. In contrast, only a very small percentage (1.8%) do not have sufficient knowledge of the EPR scheme.

Our study utilized a multivariate statistical approach to explore the correlation between opinions and concerns of small and medium-sized enterprises regarding the Extended Producer Responsibility (EPR) regulation. The analysis identified key issues that strongly influence opinions and concerns around the EPR regulation while keeping in line with our research objectives. Certain issues were highlighted based on the quality and relevance of the data analyzed. Question 2 was examined to ascertain the extent to which businesses possess adequate knowledge of the EPR regulation. Additionally, we investigated the correlation between Questions 11 and 12, as they are pertinent to the concerns and causes of the EPR regulation.

Table 3. Respondents' opinion about EPR Regulation (Question 11)

Likert scale points		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	37	32.5	32.5	32.5
	2	27	23.7	23.7	56.1
	3	50	43.9	43.9	100.0
	Total	114	100.0	100.0	

Other questions that displayed insignificant correlation or were irrelevant to our research objectives were not further analyzed. Throughout our analysis, we have focused on identifying the key correlations and findings presented in the article, which contribute to a better understanding and interpretation of the research's main outcomes. Following this approach, we specifically selected relevant issues to investigate in our research, thus enabling us to meet our research objectives and present the primary

findings in a clear and concise manner. **Table 3** shows the results of Question 11: "Opinion about EPR Regulation". In this question 3-point Likert scale was used.

Based on the data, the percentage of respondents answering by 1 point on the Likert scale is 32.5%. This means that a proportion of entrepreneurs have a positive opinion on the EPR Regulation. The percentage of respondents answering by 2 points is 23.7%. This group is neutral about the EPR Regulation. The percentage of respondents giving 3 points is 43.9%, this group of respondents has negative views on the EPR Regulation. The responses indicate that the relative majority of respondents, 43.9%, have a negative opinion of the EPR Regulation. Those with a neutral opinion (2 points) account for 23.7%, while those with a positive opinion (1 point) are represented in the sample by only 32.5%. This observation suggests that the general opinion on the EPR Regulation is not positive among the SMEs participating in the survey.

The last, Question 12 of the research sought answers to concerns related to the new EPR regulation. "If you have concerns about the new EPR regulation, what is your biggest concern?" (**Table 4**).

Table 4. Answers on Question 12 "If you have concerns about the new EPR regulation, what is your biggest concern"?

N		**Valid**	**114**		
		Missing	0		
		Mean	3.56		
Likert scale points		**Frequency**	**Percent**	**Valid Percent**	**Cumulative Percent**
Valid	1	2	1.8	1.8	1.8
	2	7	6.1	6.1	7.9
	3	43	37.7	37.7	45.6
	4	49	43.0	43.0	88.6
	5	13	11.4	11.4	100.0
	Total	114	100.0	100.0	

Answering this question was optional, so if an entrepreneur had no concerns, he could skip this question. Regarding the concerns related to the EPR regulation, 37.7% of the respondents indicated administrative difficulties, while 43% indicated additional expenses (they were able to indicate one answer option). A further 1.8% indicated the change in the legal environment, 6.1% the additional work to be carried out and 11.4% the possibility of inspection and punishment.

Table 5. Crosstabulation of Question 11 and Question 12

		Question 12					**Total**
		1	**2**	**3**	**4**	**5**	
Question 11	1	2	6	22	7	0	37
	2	0	0	14	11	2	27
	3	0	1	7	31	11	50
Total		2	7	43	49	13	114

For exploring the probable relationship between statements of the above two question, crosstabulation was conducted (**Table 5**).

Based on the crosstabulation examination, the possibility that there is no connection between the negative opinion regarding the EPR regulation and possible financial and administrative burdens can be ruled out. The results show that there is a significant relationship between the two variables in the examined sample, which suggests that those businesses that have a negative opinion of the EPR regulation are more often concerned about financial and administrative burdens.

To examine the relationship between two discrete variables, we used Pearson's Chi-square test. $X2(8) = 45.601$, $p < 0.001$.

The results of the Chi-square test (**Table 6**) show that there is a significant relationship between opinions and concerns about the EPR regulation. The X2(8) value is 45.601, indicating that opinions and concerns about the EPR regulation do not follow each other by chance.

Table 6. Results of the chi-square tests.

	Value	**df**	**Asymptotic Significance (2-sided)**
Pearson Chi-Square	45.601a	8	0.000
Likelihood Ratio	51.748	8	0.000
Linear-by-Linear Association	37.551	1	0.000
N of Valid Cases	114		

a. 8 cells (53.3%) have expected count less than 5. The minimum expected count is 0.47.

The results are significantly different from a random distribution. Based on this, the null hypothesis can be rejected, i.e. that there is no relationship between the entrepreneurs' attitude towards ERP and the concerns expressed in relation to it.

The purpose of the analysis carried out in the "Symmetric Measures" section (Table 7) was to examine the relationship between the negative opinion and possible concerns regarding the EPR (Extended Producer Responsibility) regulation based on the sample. We examined the nature and strength of the relationship by evaluating the values of two main indicators, Phi (Φ) and Cramer's V.

Table 7. Results of the symmetric measures.

		Value	**Approximate Significance**
Nominal by Nominal	Phi	0.632	0.000
	Cramer's V	0.447	0.000
N of Valid Cases		114	

First, we analyzed the value of Phi (Φ), which measures the correlation between two categorical variables. The achieved Phi value was 0.632, which indicates a medium-strength relationship between the two examined variables. The result shows that the negative opinion about the EPR regulation and possible concerns are quite related.

Second, we evaluated Cramer's V, which also measures the strength of the relationship between two categorical variables. The achieved Cramer's V value was

0.447, which indicates a medium strength relationship between the two variables. The investigated relationship is statistically significant, as the *p* value is below 0.000, which is below the accepted significance level of 0.05. It can be concluded that within the examined sample there is a moderately strong and statistically significant relationship between the negative opinion about the EPR regulation and possible concerns.

4. Conclusion

Our study yielded significant insights into the perceptions of small and medium-sized enterprises (SMEs) regarding the Extended Producer Responsibility (EPR) regulation and the associated concerns about compliance, but it shall be noted that general conclusions cannot be drawn from the results. Nevertheless, these findings provide valuable foundations for addressing the study's hypotheses and drawing relevant conclusions:

Hypothesis 1: Our analysis strongly supports the first hypothesis, revealing a notable correlation between SMEs' opinions on the EPR regulation and their apprehensions concerning its financial and administrative impacts. Specifically, 44.7% of the surveyed businesses exhibited awareness of the EPR regulation's provisions, while only a marginal 1.8% lacked sufficient knowledge. These results underscore the influence of business attitudes on their concerns, particularly regarding financial burdens and administrative workloads.

Hypothesis 2: In the context of the second hypothesis, we investigated how SMEs' attitudes toward environmental protection influence their views on the EPR regulation. The results suggest that businesses valuing environmental protection more highly are more likely to express positive opinions about the EPR regulation.

In line with the data, our conclusions emphasize the following key points:

Financial and Administrative Impacts: The EPR regulation significantly affects SMEs in terms of financial, administrative, and legal obligations. The observed increase in financial and administrative burdens calls for attention to simplify administrative requirements and introduce streamlined procedures. This legal shift presents a considerable challenge to businesses, demanding greater compliance efforts.

Regulatory Support: These results hold relevance for regulatory bodies and policymakers in shaping future measures and offering support to businesses. The EPR regulation emerges as a vital subject encompassing both environmental and economic facets within the business sector.

Diverse Opinions: The study underscores the diversity of opinions on the EPR regulation among different companies. Administrative burdens feature prominently as the most significant concerns, highlighting the importance of mitigating these challenges through appropriate measures.

Correlation Analysis: Our findings establish a medium-strength correlation between negative opinions on the EPR regulation and concerns about its financial and administrative implications. This indicates that the EPR regulation should be evaluated holistically, considering its environmental, economic, and administrative facets.

5. Limitations and future research directions

Limitations of the study are recognized, primarily pertaining to the sample size and potential selection bias. Future research directions may include conducting larger-scale studies and exploring specific strategies to alleviate the administrative burdens associated with EPR compliance in other sectors e.g. manufacturing or retail. As present study focuses on a limited geographical scope, i.e., Hungarian SMEs, future research is planned to include comparisons with SMEs in other countries or regions.

As recommended implications, our results provide essential insights for policymakers, businesses, and regulatory bodies to enhance the effectiveness of the EPR regulation, foster environmental responsibility, and support SMEs in their compliance efforts.

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