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**ECONOMIC AND MATHEMATICAL MODELING OF THE  
DEVELOPMENT PROCESSES OF TOURIST, MUSEUM, AND HOTEL-  
RESTAURANT ENTERPRISES**

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## **ЕКОНОМІКО-МАТЕМАТИЧНЕ МОДЕЛЮВАННЯ ПРОЦЕСІВ РОЗВИТКУ ТУРИСТИЧНИХ, МУЗЕЙНИХ ТА ГОТЕЛЬНО-РЕСТОРАННИХ ПІДПРИЄМСТВ**

*The current research is aimed at defining the specifics of economic and mathematical modeling of the development processes of tourist, museum, and hotel-restaurant enterprises and visualization of the outlined process on practical examples. The author realized the identification of the basic principles of development of such enterprises and the construction of models, which can be useful for the correction of new and received knowledge in this sphere. According to the study results, it is proved that the content of economic and mathematical models should be formed in such a way as to provide opportunities for research of peculiarities of development of tourism, museum, and hotel-restaurant enterprises in the stochastic environment. In particular, the models should take into account that development can be based not only on known factors but also consider the occasional behavior of quantitative features, inherent to independent organizational-separated business entities with the rights of a legal entity. We believe that the environment of development of tourist, museum, and hotel-restaurant enterprises is critical to stochasticity. Thus, we propose to abandon the application of the simple linear pair regression equations as the formation basis of economic-mathematical models in favor of regression equations with the number of factors. In this case, from a methodical point of view, the construction technique of the*

*equation is classic since it starts with the specification of the model of processes of development of tourist, museum, and hotel-restaurant enterprises, which includes: a selection of several factors of influence and the regression equation selection. Using multiple regression equations, one can construct a model transformed by several explanatory variables (multiple regression, able to take into account the influence of quite specific factors, including those whose influence is not currently unknown) under conditions that the factors described are not multicollinearity. The prospects of further developments in this direction lie in the use of the formed economic and mathematical models of development of tourism, museum, and hotel-restaurant enterprises for the development of the strategy of their post-war recovery.*

*Дослідження спрямоване на визначення специфіки економіко-математичного моделювання процесів розвитку туристичних, музейних та готельно-ресторанних підприємств та наочну візуалізацію окресленого процесу на конкретних практичних прикладах. Автором реалізована ідентифікація базових засад розвитку таких підприємств та побудови моделей, що можуть бути корисні для коригування нових і отриманих раніше знань у цій сфері. За результатами дослідження доведено, що зміст економіко-математичних моделей має формуватися таким чином, щоб забезпечувати можливість дослідження специфіки розвитку туристичних, музейних та готельно-ресторанних підприємств у стохастичному середовищі. Зокрема, моделі мають враховувати, що розвиток може скеровуватися не тільки відомими факторами, але і враховувати випадкову поведінку кількісних ознак, властивих самостійним організаційно-відокремленим суб'єктам господарювання з правами юридичної особи. Вважаємо, що наразі середовище розвитку туристичних, музейних та готельно-ресторанних підприємств відрізняється критичною стохастичністю. Відтак, пропонуємо відмовитися від застосування простіших рівнянь парної лінійної регресії як основи для формування економіко-математичних моделей, на користь регресійних рівнянь з великим числом факторів. За такого випадку із методичної точки зору техніка побудови рівняння є класичним, оскільки починається зі специфікації моделі процесів розвитку туристичних, музейних та готельно-ресторанних підприємств, яка включає: вибір кількох факторів впливу і вибір рівняння регресії. Використовуючи множинні рівняння регресії можна побудувати модель, що трансформується за кількома пояснювальними змінними (множинна регресія, здатна врахувати вплив доволі специфічних факторів у т.ч.*

тих, вплив яких наразі не невідомий), за умов, що окреслені фактори не мультиколінеарні. Перспективи подальших розвідок у даному напрямі полягають у використанні сформованих економіко-математичних моделей розвитку туристичних, музейних та готельно-ресторанних підприємств для розробки стратегії їх післявоєнного відновлення. При цьому ефективність таких заходів може визначатися шляхом застосування певних математичних перетворень до такої моделі.

**Key words:** *stochastic environment; result; sign factor; regression equation; basic indicator.*

**Ключові слова:** *стохастичне середовище; результат; ознака фактор; рівняння регресії; базовий показник.*

**Problem setting (description of the problem being analyzed in general and its connection with important academic or practical tasks).** Development of tourist, museum, and hotel-restaurant enterprises is considered a total, directed movement forward, which constantly causes the formation of new trends, new structural characteristics, and new milestones in the evolution (characterized by processes of improvement of the basic indicator, progress, or decline in it). It is not about the development of separate businesses. It is about the total development of enterprises operating in the tourist, museum, and hotel-restaurant sectors. Thus, the best tool for economic and mathematical modeling of the development processes of such enterprises is equal regression, oriented on a single basic indicator. We pay attention to the fact that any economic phenomenon can be quickly understood and late because of the substantiation of its connections with other phenomena. Therefore, it is the equalization of regression and their correlation and regression analysis that we consider to be effective enough for awareness and understanding of the economic phenomena and their directed changes in the new realities (formed by the open military attack of Russia on Ukraine).

**The analysis of the last research and publications in which the solution to this problem is begun.** Turning to the research by M. Rogozi, O. Kuzmenko, and Kramar

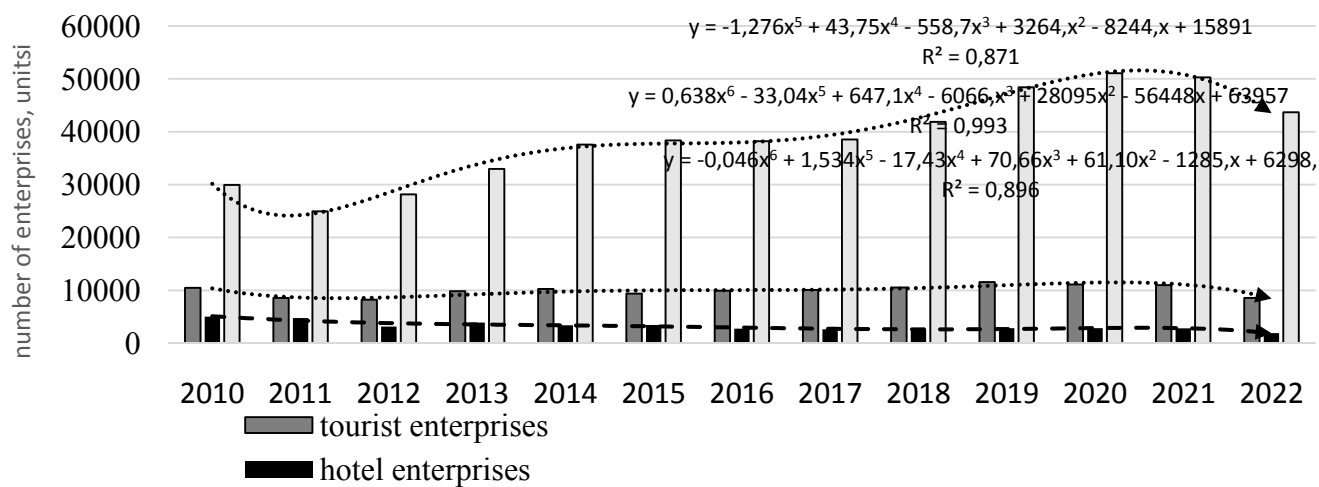
M. we will leave unchanged the choice as the basic indicator of the development of the number of existing enterprises of the described types. These scientists pay attention to the fact that this is a sign from the point of view of content, complex (multi-aspect) characterizes the development of all enterprises directed in one or several spheres of the economy (in this case, in tourist, museum, and hotel-restaurant spheres). However, Kramar M. stressed that if in the conditions of minimal stochasticity of the external environment, outlined by them the basic index could be based on only one sign (which is often accepted by the amount of income), then in the conditions of an open military attack on Ukraine by Russia outlined the fear becomes more and more critical. Therefore, this basic indicator is formed already under influence of not one, but several factors which are extremely specific for each sphere of the economy. Agree that in connection with the considerable stochasticity of the external environment, the modeling of development processes can no longer be oriented on the classical equalizations of the pair linear regression. These equations identify the logic of change of value X (income values as a sign of factor) and value Y (number of operating enterprises as a sign of result). Therefore, the technical analysis apparatus used to detect trends in such signs is also ineffective in such conditions. The outlined provisions also prove the relevance and timeliness of the research initiated by the authors.

**Formulating of article purposes (the purpose of the study).** According to the above, the article's purpose is to define the specificity of economic and mathematical modeling of development processes of tourist, museum, and hotel-restaurant enterprises and visualization of the outlined process on practical examples.

**The paper's main body with full reasoning of academic results.** We state that, in general, the mathematical model should provide the formation of such a description of possible development processes, which formalizes the rules of transition from one state to another in the best way taking into account the external environment realities. Therefore, within the framework of the research, we will focus on such transformations of the established approach to economic and mathematical modeling of the processes of enterprise development that will improve the quality of formalization of the mentioned rules. Formalization in mathematical logic is a process of presenting information about

changes that are taking place in the development of tourist, museum, and hotel-restaurant enterprises, which in a formalized form should ensure awareness of their nature.

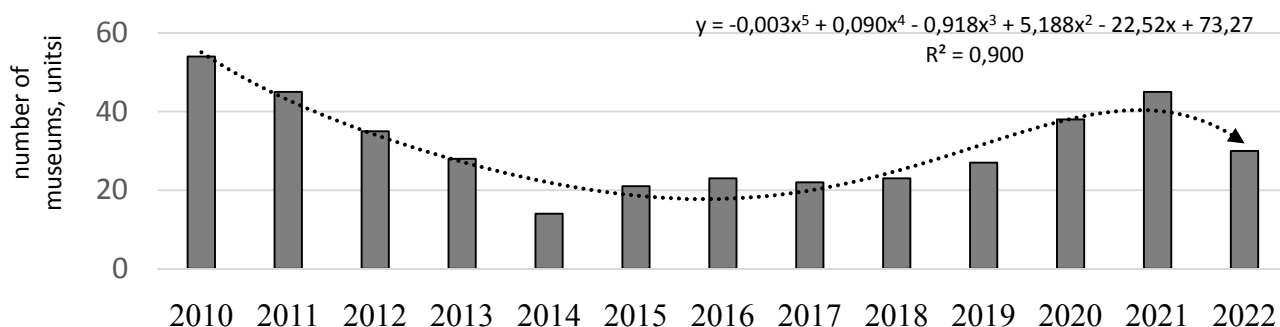
The specificity of changes in the number of tourists, hotel, and restaurant enterprises confirms their visual visualization in the polynomial interpolation (Fig. 1), which reveals their complex and difficult-to-predict nature. This nature in all groups is reflected in general trends (this is evidenced by the complex character of the trend lines constructed).



**Fig. 1. Visualization of changes in the number of tourist and hotel-restaurant enterprises, 2010-2022, Ukraine**

Source: formed according to the State Statistics Service and PricewaterhouseCoopers data [6]

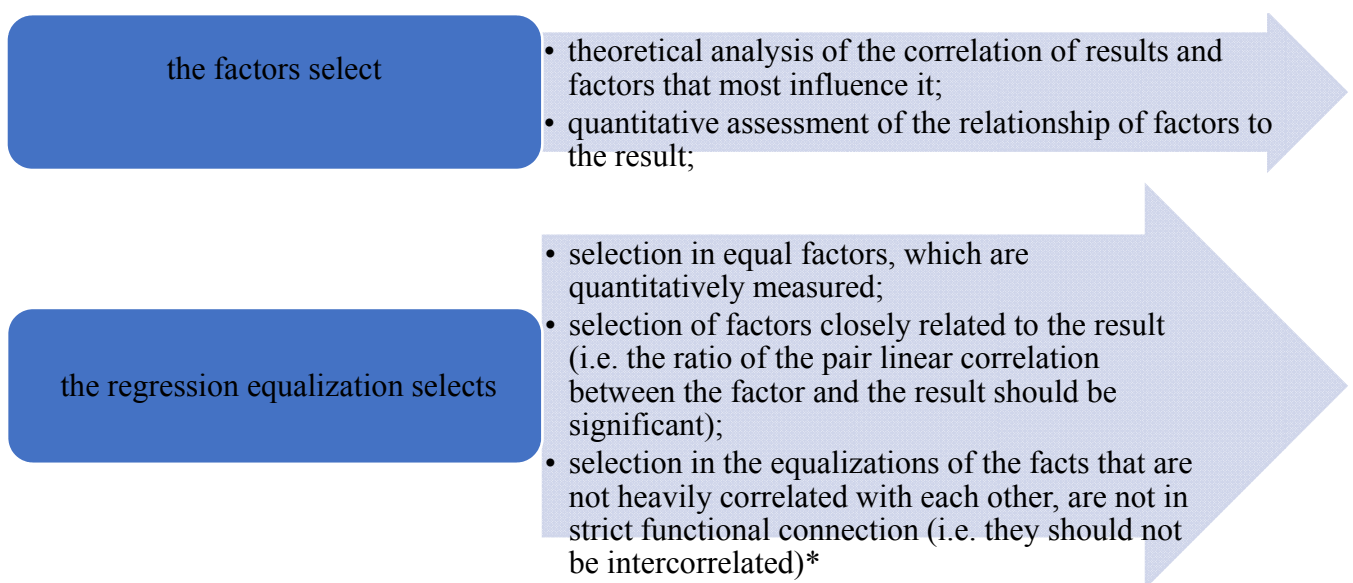
In addition, the changes in the functioning of museums are similar in their specificity (Fig. 2).



**Fig. 2. Visualization of changes in the number of museums, 2010-2022, Ukraine**

Source: formed according to the State Statistics Service and PricewaterhouseCoopers data [6]

Thus, it is necessary to refuse the application of the simpler equations of pair linear regression as the basis for the formation of economic-mathematical models in the non-stochastic environment (XY) in favor of regression equations with a large number of factors. In this case, from a methodical point of view, the technique of building the equation will be classic but starts with the specification of the model of development processes of tourist, museum, and hotel-restaurant enterprises, which includes: factors selection and choice of the regression equation. The components of the specification of model development processes of tourist, museum, and hotel-restaurant enterprises are shown in Fig. 3.



**Fig. 3. The components of the specification of model development processes of tourist, museum, and hotel-restaurant enterprises**

Note

\* It is imperative to choose factors taking into account intercorrelation. The important lack of multicollinearity between factors (which is determined by the F-criteria of Fischer)

Source: formed according to the [1; 5; 4]

The effective sign (Y) will be associated with the equation of multiple regression with the factor signs  $X_1, X_2, X_3, \dots, X_m$ . Using the proposed specificity, one can construct a regression model that is transformed by several explanatory variables (multiple regression, able to take into account the influence of quite specific factors, including those whose influence is not currently unknown) under conditions that are not multicollinearity factors. When calculating the parameters of such an equation will be oriented on the most popular matrix method. The modeling rules are as follows:

1. Formation of the qualitative equation of multiple regression. Conclusions on quality can be made through the free constant value.
2. Using the contents of the equation to define rules for economic and mathematical modeling can be described through the interpretation of regression coefficients.
3. Research of the object, where the description of the possible trajectory of development of the basic indicator of the development of the language of mathematics and research of this description is performed (within the framework of the economic-mathematical mode).

The result will allow expanding awareness and knowledge of development processes to the extent of influence of each of the symptoms separately, as well as their complex influence on the model indicated (which is the number of active enterprises of the mentioned types). At the same time, the general basis for the model specification (Table 1) is identified for studying the processes of development of tourist enterprises according to the basic sign of the result (which is the number of such enterprises) and the signs-factors. As the most significant sign factors selected were the number of profitable tourist enterprises and the number of final contracts for long-term service.

**Table 1. The general basis for the model specification of development processes of tourist enterprises is formed**

	Number of enterprises	Number of profitable tourist enterprises	Number of final contracts for long-term service	Vector of estimation of level regression coefficients *		
				Free constant	Constant for x1	Constant for x2
2016	9936	1821	3180	3103,0493	0.08175	2.0294
2017	10093	2616	4230			
2018	10520	3567	4545			
2019	11576	3185	4004			
2020	11116	2328	4823			
2021	11004	3027	4756			
2022	8554	2080	3437			

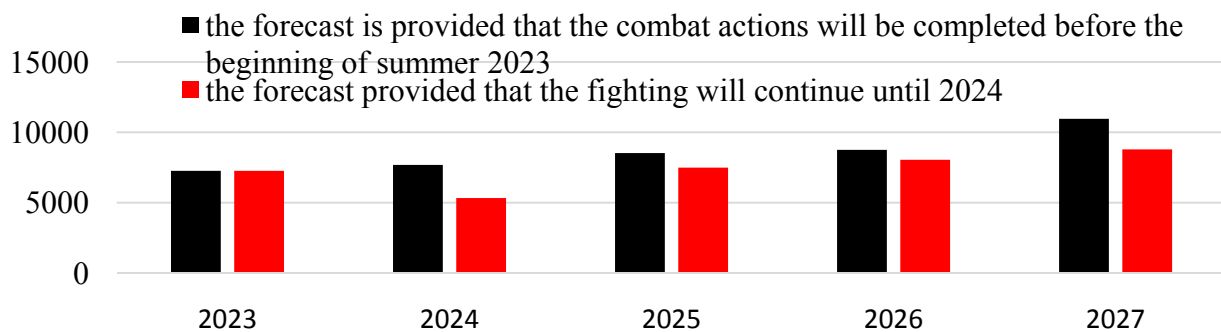
Note

\* The multicollinearity between factors according to the F-criteria Fischer is absent

*Source: formed according to the State Statistics Service and PricewaterhouseCoopers data [6]*



Based on the results of the specification, it is obvious that the formation of a high-quality regression equation can be used for awareness and understanding of the foundational development processes of tourist enterprises. The contents of the outlined level can be expressed as  $Y = 3103.0493 + 0.08175X_1 + 2.0294X_2$ . It has been found that in the investigated situation, 50% of the total variation  $Y$  is due to the change in the  $X_j$  factors. The rules for economic and mathematical modeling of processes of development of tourist enterprises are as follows: the regression coefficient  $b_1$  indicates that when the number of profitable enterprises ( $x_1$ ) increases by 1 unit,  $Y$  increases by 0,08175 units; the regression coefficient  $b_2$  indicates that with the increase in the number of final enterprises contracts for long-term service ( $x_2$ ) by 1 unit,  $Y$  increases by 2,0294 units. The free constant value should be taken into account along with the outlined rules. This specificity allows for taking into account the stochasticity formed by the open military attack of Russia on Ukraine. Free constant assesses the aggregated influence of other factors (except those taken into account in the model of the  $x_i$ ) on the result of  $Y$  and means that  $Y$  in the absence of  $x_1$  and  $x_1$  number of tourism enterprises would amount to  $\approx 3103$  units. Based on the outlined rules it is possible to form a variant forecast of the number of tourist enterprises in Ukraine for 2023-2027 (Fig. 4).



Forecast period	Calculation data for the forecast, units					
	the forecast is provided that the military action will be completed before the beginning of summer 2023			the forecast provided that the military action will continue until 2024		
	Y	X <sub>1</sub>	X <sub>2</sub>	Y	X <sub>1</sub>	X <sub>2</sub>
2023	7262	1850	1975	7262	1850	1975
2024	7685	1942	2180	5325	1620	1030
2025	8522	2009	2589	7487	1750	2090
2026	8754	2990	2664	8043	2350	2340
2027	10965	3339	3739	8783	2705	2690

**Fig. 4. The variant forecast of the number of tourist enterprises in Ukraine for 2023-2027**

Source: formed according to the State Statistics Service and PricewaterhouseCoopers data [6]

Since the beginning of a full-scale invasion, domestic tourism has reduced its activity (at the same time, the situation complicates those enterprises that have not fully recovered from the coronavirus pandemic). The majority of enterprises returned to losses again. This situation is reflected in the forecast, which is interesting because using the formed above rules of economic and modeling processes of development of tourist enterprises can visually visualize: 1) the option of the forecast change in the number of tourist enterprises in Ukraine provided that the military action is completed at the beginning of the summer of 2023. Under this option it is possible to restore Y to the level of 2021 in 2027; 2) the option of the forecast change in the number of tourist enterprises in Ukraine on condition that the military action will continue by 2025. Under this option, the Y reduction will accelerate and will continue by 2025 at least. The study of developmental processes of restaurant enterprises, although oriented on the same basic sign of the result (which is the number of such enterprises), is identified qualitatively by other factors, and the general basis for the specification of the model is identified (Table 2).

**Table 2. The general basis for the model specification of development processes of restaurant enterprises is formed**

Forecast period	Number of enterprises	The number of enterprises offering food according to individual recipes	The number of enterprises, engaged in food delivery and takeout food.	Vector of estimation of level regression coefficients *		
				Free constant	Free constant	Free constant
2016	38199	9605	3021	28056,33	0,203	2,4521
2017	38545	5396	3854			
2018	41860	10046	5441			
2019	48398	9615	7775			
2020	51069	8745	8681			
2021	50271	10054.2	7540			
2022	43678	12666	5367			

*Source: formed according to the State Statistics Service and PricewaterhouseCoopers data [6]*

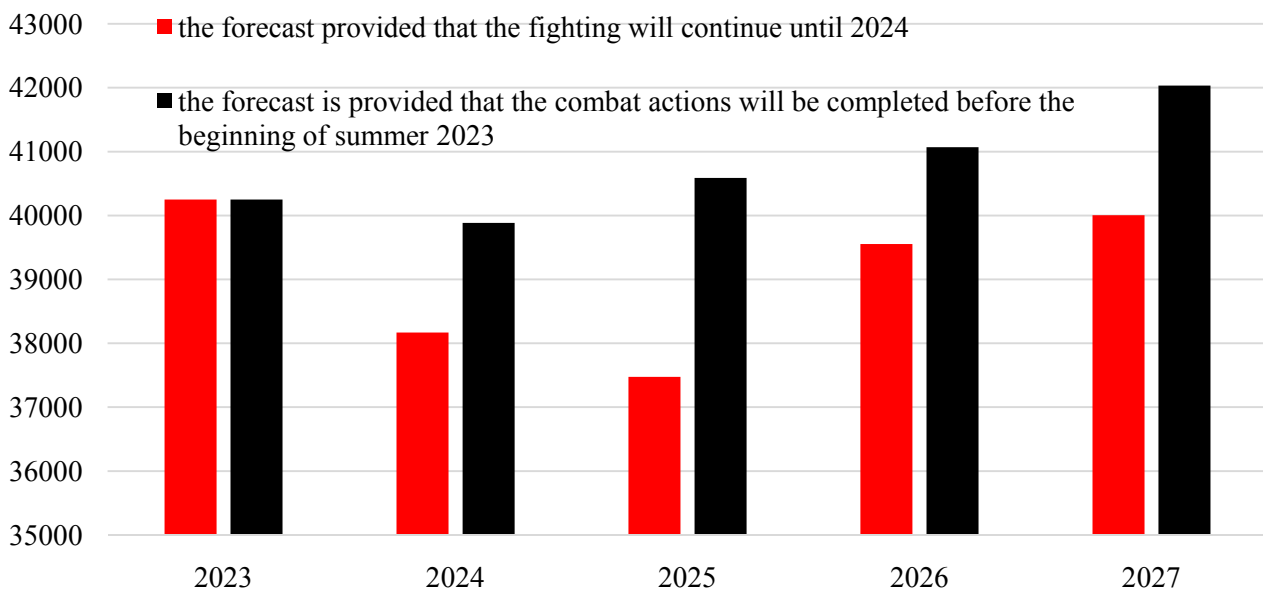
The most significant selected features - are the number of enterprises offering food on individual recipes and the number of enterprises engaged in food delivery and takeout food. Based on the results of the specification, it's obvious that the formation of a qualitative equalization of regression can be used to understand and understand the basic processes of development of restaurant enterprises. The contents of the outlined

level can be expressed as  $Y = 28056.33 + 0.203X_1 + 2.4521X_2$ . It has been found that in the investigated situation 96.32% of the total variation  $Y$  is due to the change in the factors of  $X_j$ . At that, the rules for economic and mathematical modeling of processes of development of restaurant enterprises are as follows: the coefficient of regression  $b_1$  indicates that with an increase in the number of enterprises offering food according to individual recipes ( $x_1$ ) by 1,  $Y$  increases by 0.203 units; the coefficient of regression  $b_2$  indicates that while increasing the enterprises engaged in the delivery of food, and food brought ( $x_2$ ) by 1 unit,  $Y$  increases by 2.4521 units.

The value of the free constant should be taken into account next to the specified rules. This indicates the stochastic functioning of such enterprises, formed by the open military attack of Russia on Ukraine [3]. Thus, the aggregated influence of unknown factors on the  $Y$  result without influence  $x_1$  and  $x_2$  can form the values as to the number of restaurant enterprises at the level of 28056 units. The described stochastic form is a situation of turning off the light several times per day and the associated shortcut menu of institutions. Since January 2022, the complete menu in institutions is not adhered to because it's inappropriate to keep in the kitchen a lot of products (which quickly deteriorate without the light). The second point forms stochastic relates to the fact that often do not follow the power cutoff schedules. This does not make it possible to predict whether the restaurant will be able to accept the reservation, for which time to call to work staff. But calling staff does not mean waiting for him. Often people cannot reach the workplace through air alerts.

Based on the outlined rules it's possible to form a variant forecast of the number of restaurant enterprises in Ukraine for 2023-2027 (fig.5). Use of the rules of economic modeling of processes of development of restaurant enterprises, as in the case of the previous example, allow visualizing: 1) the option of the forecast change in the number of such enterprises in Ukraine, provided that the military action is completed at the beginning of summer 2023; 2) the option of the forecast change in the number of restaurant enterprises in Ukraine, provided that the military action will continue by 2024.

In 2022, due to a significant decrease in attendance (up to 70%) daily receipts of the restaurant company may be lower than the cost of maintaining the facility [3]. That is why now there is a temporary business interruption if the funds allow keeping premises and part of the staff. Some facility announces work a few days a week or part-time, taking into account the disconnect schedules. Another scenario that most facilities are currently working on is to reduce costs to a minimum by keeping the team and the regular client. It's expected that the outlined trends will become more acute. Thus, although there are several scenarios in both cases Y decline will be significant. Even before 2027, the baseline will not be able to resume the pre-war level.



Forecast period	Calculation data for the forecast, units					
	the forecast is provided that the military action will be completed before the beginning of summer 2023			the forecast provided that the military action will continue until 2024		
	Y	X1	X2	Y	X <sub>1</sub>	X <sub>2</sub>
2023	40248	11890	3988	40248	11890	3988
2024	39884	10942	3918	38168	10942	3218
2025	40589	12339	4089,5	37474	10011	3012
2026	41069	12342	4285	39554	11034	3775
2027	42033	12443	4670	40004	11276	3939

**Fig. 5. The variant forecast of the number of restaurant enterprises in Ukraine for 2023-2027**

*Source: formed according to the State Statistics Service and PricewaterhouseCoopers data [6]*

The study of the development of hotel enterprises based on the results (which is the number of such enterprises) to date consumer expectations and the hotel economy are ideally similar in the segment of hotels of the average price level and suburban type. This is because according to factors they have the optimal balance of commercial use and management areas and effective management software. Thus, the following general basis for the model specification is identified (Table 3).

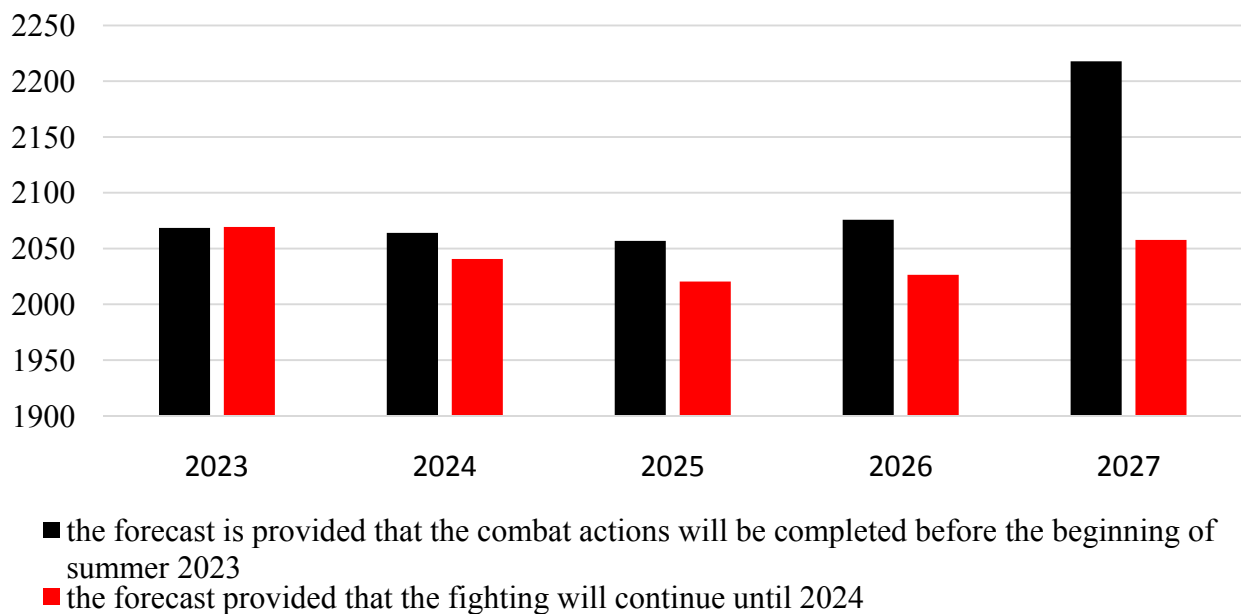
Based on the results of the specification, it is obvious that the formation of a qualitative equalization of regression, can be used to awareness and understand the foundational processes of the development of hotel enterprises. The contents of the outlined level can be expressed as  $Y = 1279.6169 + 0.9867X_1 + 3.4944X_2$ . It has been found that in the investigated situation, 67.81% of the total variation Y is due to the change in the Xj factors. At that, the rules for economic and mathematical modeling of processes of development of restaurant enterprises are as follows: the regression coefficient b1 indicates that with an increase in the number of enterprises in the average price level (x1) increases by 1 unit, Y increases by 0.9867 units; the regression coefficient b2 indicates that when the number of enterprises suburban type is increased by 1 unit, Y increases by 3.4944 units The values of the free constant should be taken into account, along with the rules outlined, which assesses the aggregated effect of other factors on the Y result. The value must be determined, that Y in the absence of xi would amount to 1280 units.

**Table 3. The general basis for the model specification of development processes of restaurant enterprises is formed**

Forecast period	Number of enterprises, units	Number of enterprises in average price level, units	Number of enterprises suburban type, units	Vector of estimation of level regression coefficients *		
				Free constant	Free constant	Free constant
2016	2762	359	248	1279.6169	0.9867	3.4944
2017	2636	527	184			
2018	2698	640	240			
2019	2858	657	250			
2020	2845	625	312			
2021	2805	580	282			
2022	1911	324	171			

*Source: formed according to the State Statistics Service and PricewaterhouseCoopers data [6]*

In the first months of the war, the hotel business started. The flow of guests stopped, and all scheduled arrivals and tourist/business trips had to be canceled. According to Fig. 1 from the beginning of the war until the end of 2022, the hotel business of Ukraine fell by 31,8%. Currently, the domestic hotel sector works by a maximum of 2–3% in monetary terms. In the south, this figure is 3–5% of the plan, in Kyiv and the region – 10–15%, in the east due to fighting and occupation of territories most hotels suspended activities [2]. Based on the above-mentioned rules, it is possible to create a variant forecast of the change in the number of hotel enterprises in Ukraine for 2023-2027 and to determine that it will be quite difficult to recover even to the 2021 level (Fig. 6). These conclusions do not change, regardless of whether the military action will end at the beginning of summer 2023 or continue until 2024.



Forecast period	Calculation data for the forecast, units					
	the forecast is provided that the combat actions will be completed before the beginning of summer 2023			the forecast provided that the fighting will continue until 2024		
	Y	X1	X2	Y	X <sub>1</sub>	X <sub>2</sub>
2023	2068	255	154	2069	255	154
2024	2064	254	153	2040	240	150
2025	2056	275	145	2020	255	140
2026	2075	312	140	2026	254	142
2027	2217	410	153	2057	275	145

**Fig. 6. The variant forecast of the number of hotel enterprises in Ukraine, 2023-2027**

*Source: formed according to the State Statistics Service and PricewaterhouseCoopers data [6]*

This specificity is because the development of the hotel sector requires several rooms, access to which will be limited for a long time, either through a bomb threat or being in rebuild and reconstruction.

As for studying the development of museums according to the basic characteristics of the result (what is their number) it is important to determine what will happen to them since with the beginning of the military activities there were the most significant changes in the signs identified as the most important (number of enterprises with the extended permanent exhibitions and collections). Thus, the following general basis for the model specification is identified (Table 4).

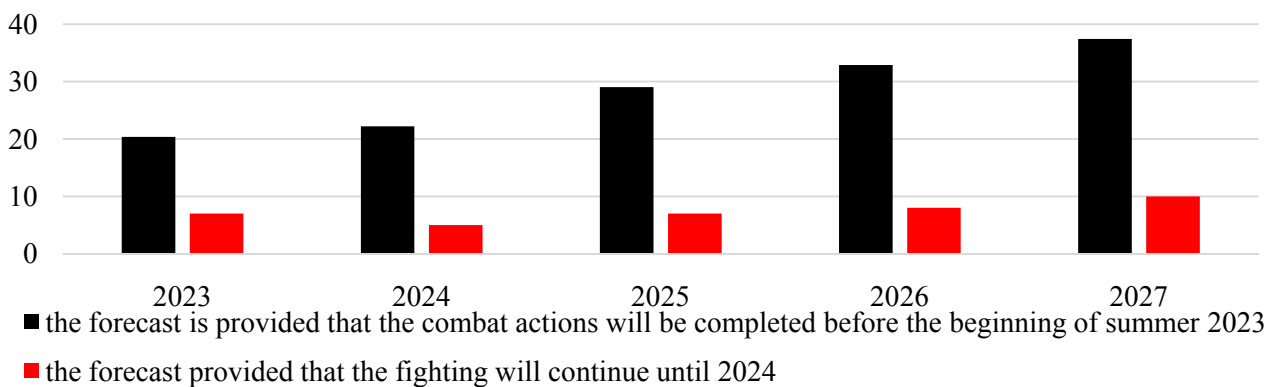
**Table 4. The general basis for the model specification of development processes of museums is formed**

Forecast period	Number of museums, units	Number of museums with the extended permanent exhibitions, units	Number of museums with the extended permanent collections, units	Vector of estimation of level regression coefficients *		
				Free constant	Free constant	Free constant
2016	23	10	8	14.5353	0.7562	0.02392
2017	22	20	9			
2018	23	21	9			
2019	27	23	10			
2020	38	35	11			
2021	45	23	11			
2022	30	7	3			

*Source: formed according to the State Statistics Service and PricewaterhouseCoopers data [6]*

Based on the results of the specification, it is obvious that the formation of a quality regression equation can be used for awareness and understanding of the basic processes of the development of museums. The contents of the outlined level can be expressed as  $Y = 14.5353 + 0.7562X_1 - 0.02392X_2$ . It has been found that in the investigated situation, 63.1% of the total variation Y is due to the change in the Xj factors. At that, the rules for economic and mathematical modeling of processes of development of museums are as follows: the regression coefficient b1 indicates that with the increase in quantity the number of museums with permanent expositions (x1) expanded by 1 unit, Y increases by 0.756 units, the regression coefficient b2 indicates that with the increase of museums with the expanded permanent collections (x2) by 1 unit, Y increases by

0.02392 units The values of the free constant should be taken into account, along with the rules outlined, which assesses the aggregated effect of other factors on the Y result. The value should be determined that Y in the absence of xi would amount to 14 units. Based on the above-mentioned rules, it is possible to form a variant forecast of changes in the number of museums in Ukraine for 2023-2027, taking into account unfavorable changes in the signs of factors (Fig. 7). Namely, given that the situation is not favorable at the moment to minimize permanent exposures and to the end of the military state to resume them will not be possible. In addition, museum collections were also evacuated to safe places and bomb shelters. Specialists remain in the field partly, partly moved together with collections. In general, the situation is very dynamic and depends on security factors. However, any option will make it difficult to recover at least to the level of 2021, regardless of whether the military action at the beginning of the summer of 2023 will continue until 2024.



Forecast period	Calculation data for the forecast, units					
	the forecast is provided that the combat actions will be completed before the beginning of summer 2023			the forecast provided that the fighting will continue until 2024		
	Y	X1	X2	Y	X <sub>1</sub>	X <sub>2</sub>
2023	20	7	3	20	7	3
2024	22	10	5	18	5	3
2025	29	19	6	20	7	5
2026	33	24	8	21	8	6
2027	37	30	9	22	10	8

**Fig. 7 The variant forecast of the number of museums in Ukraine, 2023-2027**

*Source: formed according to the State Statistics Service and PricewaterhouseCoopers data [6]*

The complexity is caused by the fact that the programs of restoration of the functioning of museums will contain a large restoration block (restoration of destroyed buildings and creation of expositions after the war). These processes are quite long and



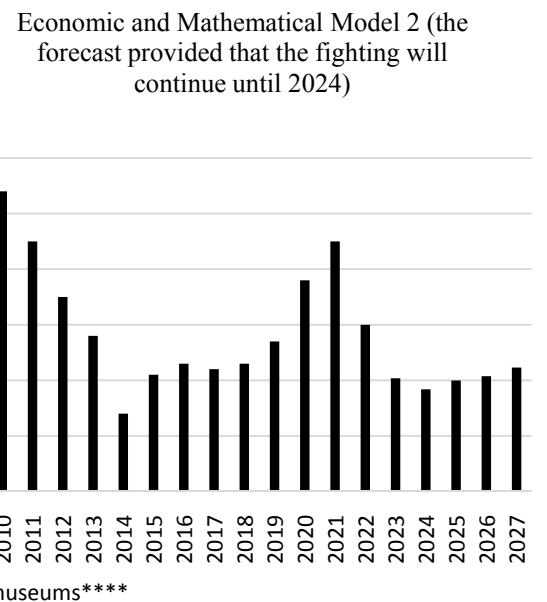
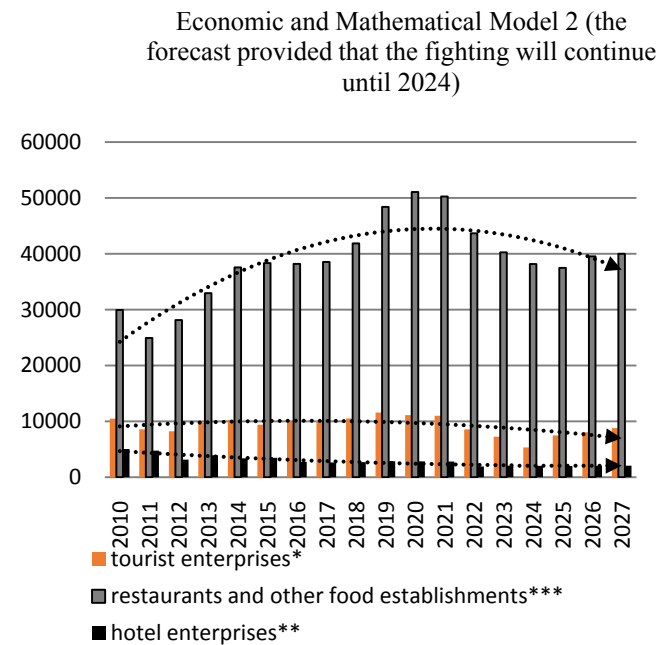
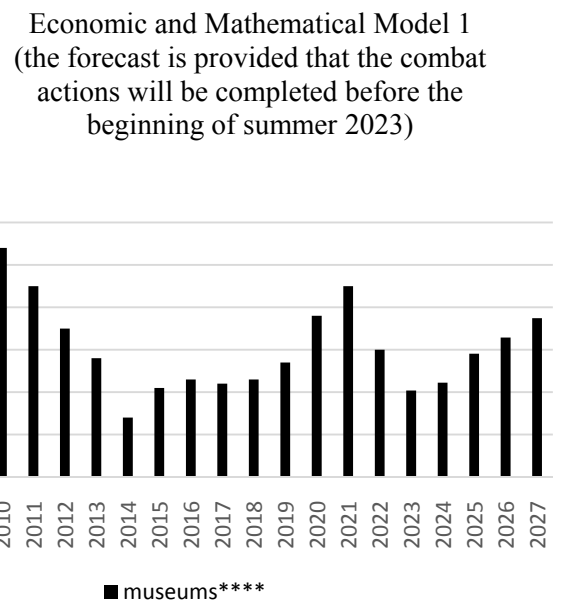
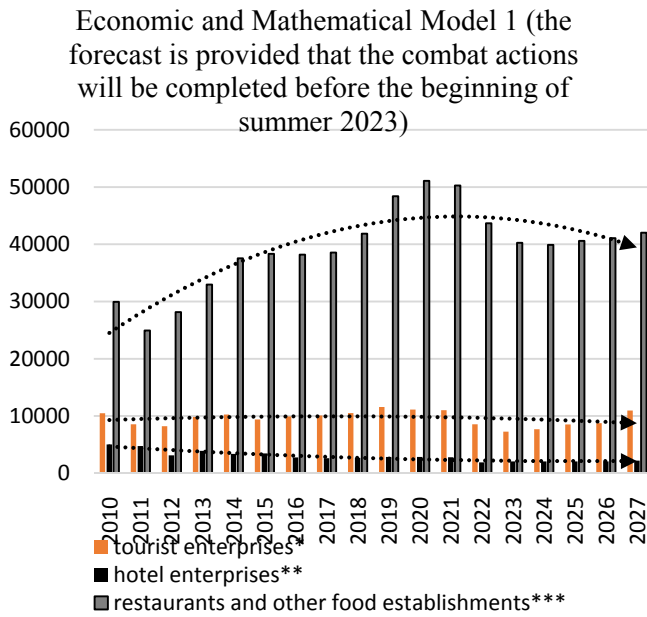
expensive, here Ukraine will be a very important assistance to foreign partners, and special intergovernmental programs. It is especially difficult to create that in Ukraine there are no museums that can earn money for the maintenance of collections, and the expenses for restoration are bigger and more serious than the profits from museum activity."

Using the results obtained by us it is possible to form the general economic and mathematical model of processes of development of tourist, museum, and hotel-restaurant enterprises according to their basic indicator (Fig. 8).

According to the results, it's obvious that the obtained based on the equations of multiple regression of the model is the most informative. Information is provided through research on the development processes of tourist, museum, and hotel-restaurant enterprises according to their basic indicators, which are values of several independent organizational-separated economic subjects with the rights of a legal entity.

**Conclusions from this study and prospects for further exploration in this area.** According to the research results following conclusions were made concerning peculiarities of economic and mathematical modeling of processes of development of tourist, museum, and hotel-restaurant enterprises:

1. Currently, the content of economic and mathematical models should be formulated in such a way as to provide opportunities for research on the specifics of the development of tourism, museum, and hotel-restaurant enterprises in the ancient environment. In particular, such models should take into account that development can be based not only on known factors but also to consider the occasional behavior of quantitative features, inherent to independent organizational-separated business entities with the rights of a legal entity.



**Fig. 8. The general economic and mathematical model of processes of development of tourist, museum, and hotel-restaurant enterprises according to their basic indicator, units**

Note

\* The specificity that determines the change in the number of tourist enterprises: by increasing the number of profitable enterprises (x1) by 1 unit, Y increases by 0,08175 unit; by increasing the number of final contracts for long-term service (x2) by 1 unit, Y increases by 2,0294 units. The aggregated effect of other factors on the result Y means that Y in the absence of x1 and x2 would be 3103 units.

\*\* The specificity that determines the change in the number of hotel enterprises: by increasing the number of the average price level enterprises (x1) by 1 unit, Y increases by 0.9867 units.; by increasing the number of the enterprise's suburban type (x2) by 1 unit, Y increases by 3.4944 9867 units. The aggregated effect of other factors on the result Y means that Y in the absence of x1 and x2 would be 1279.6169.

\*\*\* The specificity that determines the change in the number of restaurant enterprises: by increasing the number of the enterprises offering food according to individual recipes (x1) by 1 unit, Y increases by 0.203 units; by increasing the number of the enterprises engaged in food delivery and takeout food (x2) by 1 unit, Y increases by 2.4521 units.; The aggregated effect of other factors on the result Y means that Y in the absence of x1 and x2 can form values of restaurant enterprises at the level of 28056.33 units.

\*\*\*\* The specificity that determines the change in the number of museums: by increasing the number of museums with extended permanent exhibitions (x1) by 1 unit, Y increases by 0.756 units; by increasing the number of museums with extended permanent collections (x2) by 1 unit, Y increases by 0.02392 unit; The aggregated effect of other factors on the result Y means that Y in the absence of x1 and x2 can form values of museums at the level of 14 unit.

Source: formed according to the State Statistics Service and PricewaterhouseCoopers data [6]

2. We believe that the environment of development of tourist, museum, and hotel-restaurant enterprises is critical to their sustainability. Thus, we propose to abandon the application of the simpler linear regression equation equivalent to the basis for the formation of economic-mathematical models in favor of regression equations with a large number of factors. In this case, from a methodological point of view, the construction technique of equations is classic since it begins with the specification of the process model of the development of tourist, museum, and hotel-restaurant enterprises, which includes: several factors of influence selection and regression equation selection.

3. Using multiple regression equations, one can construct a model that is transformed by several explanatory variables (multiple regression capable of taking into account the influence of quite specific factors, including those which aren't currently unknown) under conditions that the factors described are not multicollinearity.

**The prospects of further developments in this direction** lie in the use of the formed economic and mathematical models of development of tourism, museum, and hotel-restaurant enterprises for the development of the strategy of their post-war recovery. At the same time, the effectiveness of such measures can be determined by applying certain mathematical transformations to such a model.

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