Parameterization of the Company's Business Model for Machine Learning-Based Marketing Stress Testing

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Summary

Marketing stress testing is a new method of identifying the company's strengths and weaknesses in a turbulent environment. Technically, this is a complex procedure, so it involves artificial intelligence and machine learning. The main problem is currently the development of methodological approaches to the development of the company's digital model, which will provide a framework for machine learning. The aim of the study was to identify and develop an author's approach to the parameterization of the company's business processes for machine learning-based marketing stress testing. This aim provided the company's activities to be considered as a set of elements (business processes, products) and factors that affect them (marketing environment). The article proposes an author's approach to the parameterization of the company's business processes for machine learning-based marketing stress testing. The proposed approach includes four main elements that are subject to parameterization: elements of the company's internal environment, factors of the marketing environment, the company' core competency and factors impacting the company. Matrices for evaluating the results of the work of expert groups to determine the degree of influence of the marketing environment factors were developed. It is proposed to distinguish between mega-level, macro-level, meso-level and micro-level factors depending on the degree of impact on the company. The methodological limitation of the study is that it involves the modelling method as the only one possible at this stage of the study. The implementation limitation is that the proposed approach can only be used if the company plans to use machine learning for marketing stress testing.

Key words:
marketing stress testing, machine learning, artificial intelligence, business models, digitalization.

1. Introduction

Stress testing is an important functional method of assessing the company's standing as a whole or the operation of its individual units or business lines. Zozulov and Menkova worked on the detailed development of a separate area —marketing stress testing of the company's business model [1]. The volatile environment produces a high level of uncertainty for each company. On the other hand, the internal environment also has a significant impact on the company's activities. Taken together, these effects can overlap and can have unexpected implications. No company can afford to operate under the conditions of complete uncertainty in today's business environment, therefore everyone is trying to minimize this uncertainty. Marketing stress testing is such a tool to minimize market uncertainty.

Each company is unique and has a unique sequence or combination of business processes. The parameterization of the company's business processes is a necessary element for creating the company's digital portrait and implementing machine learning for marketing stress testing.

1.2. Literature review

The issue of stress testing comes to one of the most important places in the companies' business process management. Experts from Ernst & Young [2] emphasize the importance of stress testing, especially in the banking sector, which is key to the stability of the economic system. The authors propose a four-step approach to machine learning-based stress testing. The use of machine learning allows ensuring continuous improvement of the stress testing system and its adaptation to new conditions of the company's operation environment.

Jacobs [3] also considers stress testing in the banking sector and emphasizes that statistical regression and vector autoregression are the most common approaches to testing. However, the flexibility of such approaches depends on researchers introducing new parameters at their own discretion. Note that machine learning in this process is more promising in terms of prospects for use. This is especially true for marketing stress testing, where the internal and external environment is highly volatile.

An interesting study of the validation of deep learning models conducted by a group of authors [4]. Researchers compare the reliability of the deep learning model with the approaches of constant and dynamic balance. The results of the study show that the deep learning model is better suited for modelling profits and financial performance. We can assume that machine learning-based approaches will also prove to be better for marketing stress testing.

Machine learning is also used for risk management. According to the results of the study of Aziz and Dowling [5], the use of artificial intelligence allows identifying new risk factors and develop methods of managing them. Note that the use of artificial intelligence is also appropriate in marketing stress testing, where there are also a large number of uncertainties about the company's future standing.

PWC experts emphasize the importance of using machine learning and artificial intelligence in risk assessment and management models [6]. The authors of the study considered the possibilities of transforming existing methods of risk assessment and management for the use of artificial intelligence and machine learning, and identified opportunities for such use. In our opinion, marketing stress testing can also be implemented through artificial intelligence and machine learning. The use of information technology will provide a qualitative leap in improving the effectiveness of such testing. The architecture of marketing stress testing using machine learning has not yet, however, been developed.

Haaker, Bouwman, Janssen, de Reuver have studied the reliability of business models [7]. The authors note that the advantage of this method is the possibility of its widespread use. Besides, machine learning-based stress testing methods can expand the list of variable models and provide their interpretation. We believe that the use of artificial intelligence and machine learning also has prospects for marketing stress testing. But the main problem is that there are currently no formalized models of marketing stress testing that could be used for machine learning.

Licari [8] studied market risk testing models, which are one of the elements of marketing stress testing in terms of external factors. The main testing methods are regression and estimating Impulse Response Functions (IRFs). We believe that for qualitative analysis in the dynamics it is necessary to conduct machine learning to adapt the model to the conditions of a particular company. This will take into account not only the current state of the factors, but also a model of their change in the past to predict their future state.

Aragonés, Blanco, Dowd studied the introduction of stress testing in the market risk model [9]. The authors investigated the use of a vector autoregressive model to assess market risks, but its use may currently have some limitations. In particular, this applies not so much to the model itself as to the dynamic environment in which the company operates. Elimination of this shortcoming requires the use machine learning, which will ensure the adaptation of the model to the new company's operating conditions. Besides, it will increase the reliability of the predicted simulation values.

Alexander and Sheedy [10] come to similar conclusions in a study to develop a stress testing model of market risks. The results show that stress testing reveals weaknesses in the operation of the bank. This makes it possible to model different scenarios of changes in the input parameters of the model and build different scenarios of the dynamics of indicators.

Engle studied stress testing based on market data [11]. Research has shown that the use of market data significantly increases the reliability of modelling results. These results support the idea that the use of machine learning for marketing stress testing will also improve modelling results. Given the fact that marketing stress testing is carried out on the basis of data from the company's external environment on the market situation, the appropriateness and prospects of using machine learning is beyond doubt.

1.3. Research objectives

The aim of the study is to identify and develop an author's approach to the parameterization of the company's business processes for machine learning-based marketing stress testing. This aim provided the company's activities to be considered as a set of elements (business processes, products) and factors that affect them (marketing environment).

2. Research methodology

- Modelling was the main method used in the study. Its application is justified, because the aim of the study involves the parameterization of business processes for marketing stress testing. So, the simplification of reality and its reproduction in the digital environment involves modelling. The following symbols were used for parameterization:

- W — the parameter weight ratio;

- HR — Hard Requirements;

- SR — Soft Requirements.

- n — the ordinal number of the parameter.

- The method of analysis — the decomposition of complex objects into simpler ones — was also used. The analysis involved identifying key components of the company as an integrated structure. As a result, four elements were identified that make up the company's overall structure:

- 1. Elements of the internal environment, which are represented by the company's business processes and products;

- 2. Marketing environment factors, which are represented by the risks and opportunities of the external environment, as well as the risks and opportunities of the internal environment;

- 3. The company's core competency, which is represented by a unique combination of Hard Requirements and Soft Requirements;

- 4. Factors impacting the company.

- The sample for the study was based not on the choice of a particular company, but on the company's decomposition into the components described above. Therefore, the key is certain elements that can be parameterized. The method used can be applied to any company, regardless of ownership and type of activity based on the fact that any company can be represented as part of the elements that we selected.

The expert group to determine the factors impacting the company should consist of representatives of the company's top management in various areas of work:

internal environment and external environment. Besides, to assess the factors of macro and mega-environment, it is advisable to include external experts from analytical centres, who can provide an assessment of the parameters of the global environment and their possible degree of impact on the company.

3. Results

Parameterization of the company's business processes involves their formalized description in a digital environment. The key attention in this study will be paid not to the technical aspect of parameterization of business processes, but to the structural and logical one. The whole company's structure can be presented as a combination of elements of internal and external business environment, with the company's core competency being at their intersection. Based on the concept of the company's integrated business model [12], the company's core competency is the company's ability to meet a specific need of consumers in the market, which also represents a comparative advantage of the company compared to other companies in the market. The company's core competency is achieved through a unique combination of internal and external parameters.
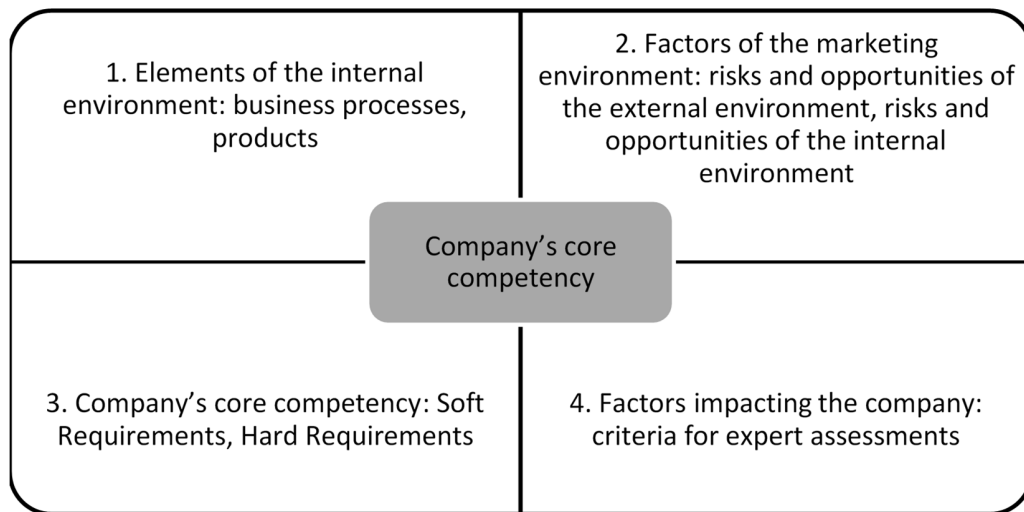
Fig. 1 Parameterization objects for machine learning-based marketing stress testing

The first element to be parameterized are the elements of the internal environment. These include the company's business processes and the products it creates. Business processes are a set of actions that produce a certain result. Parameterization involves the formulation of the subject of the business process and the procedures it performs. The digital model of the subject's actions should reflect all stages of such actions. All products created by the company are subject to parameterization. These can be goods, services, works, etc. If the product has intermediate

stages of creation, all these stages must also be reflected in the digital model.

The second element that is subject to parameterization are factors of the marketing environment. The marketing environment includes mega-environment, macro-environment, meso-environment and micro-environment. For the parameterization of the mega and macro environment, the parameters of the national economy and the world economy are included, which have a significant impact on the company's activities. These parameters are defined through the formation of the Opportunity Risk Matrix. The parameters of the meso- and microenvironment reflect the factors of the industry level and the level of the company, which have a direct impact on the company. To determine such parameters, market research, Porter's Five Forces competitive analysis, SWOT analysis, and the Opportunity Risk Matrix are used.

The third element to be parameterized is the company's core competencies. The company's core competency is a set of the company's unique functions that determine its efficiency. Each function is an element of the company's core competencies, which can fall into two categories: Hard Requirements and Soft Requirements. Hard Requirements is a set of the company's unique characteristics that determine its viability. Soft Requirements are a set of the company's characteristics that may change over time, but currently determine and maintain the company's competitiveness. The detailed structure of the company's core competencies is presented in Figure 2.
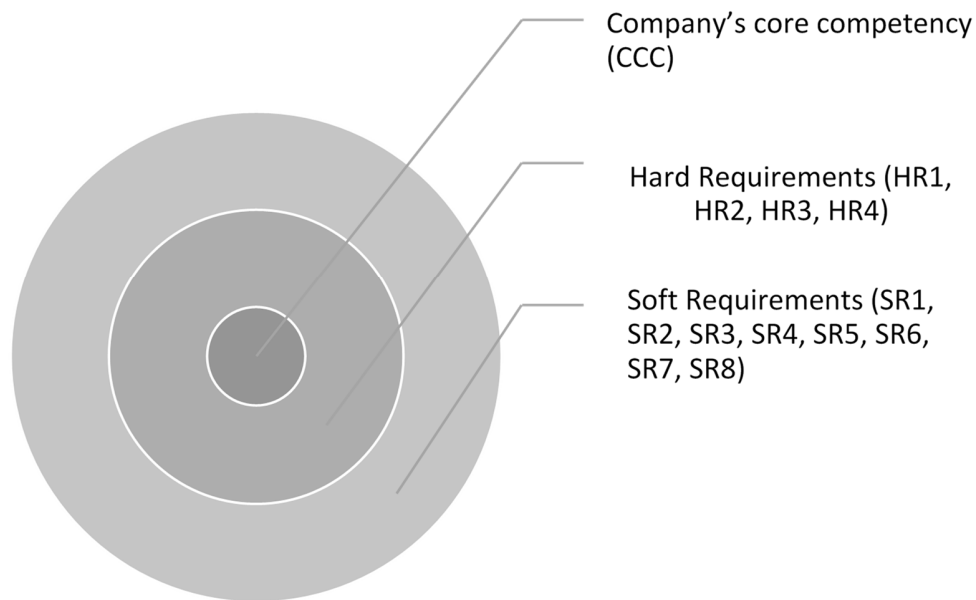

Fig. 2 Structure of the company's core competencies

The structure of the company's core competencies, the number and content of its elements are determined on the basis of an expert survey. As a rule, experts are the company's top management, which is well informed about the factors of the marketing environment that affect the company. However, the services of external experts can be used if it is necessary to assess the parameters of the macro- and mega-environment. It is important to determine not only the limits of each factor, but also its impact on each element of the company's core competencies, so that when receiving information about fluctuations and changes in factors in the future, one can determine which element is most subject to fluctuations and its impact on specific core elements, and the overall impact on the core itself. When conducting and forming the core of the company's competence, 2 matrices are made (Table 1, Table 2).

Table 1: Matrix of the weights of the company's core competence for Hard Requirements

W	HR1	HR2	HR3
HR1	W...HR1/HR1	W...HR2/HR1	W...HR3/HR1
HR2	W...HR1/HR2	W...HR2/HR2	W...HR3/HR2
HR3	W...HR1/HR3	W...HR2/HR3	W...HR3/HR3

Table 2: Matrix of the weights of the company's core competence for Soft Requirements

W	SR1	SR2	SR3
SR1	W...SR1/SR1	W...SR2/SR1	W...SR3/SR1
SR2	W...SR1/SR2	W...SR2/SR2	W...SR3/SR2
SR3	W...SR1/SR3	W...SR2/SR3	W...SR3/SR3

The following matrix is made to determine the weights of the company's core competencies for both Hard Requirements and Soft Requirements (Table 3).

Table 3: Matrix of the weights of the company's core competence for Hard Requirements and Soft Requirements

W	W...SR1/ SR1	W...SR1/ SR2	W...SR1/ SR3	W...SR2/ SR1	W...SR2/ SR2	W...SR2/ SR3	W...SR3/ SR1	W...SR3/ SR2	W...SR3/ SR3
W...HR1/ HR1	W1	W2	W3	W4	W5	W6	W7	W7	W9
W...HR1/ HR2	W10	W11	W12	W13	W14	W15	W16	W17	W18
W...HR1/ HR3	W19	W20	W21	W22	W23	W24	W25	W26	W27
W...HR2/ HR1	W28	W29	W30	W31	W32	W33	W34	W35	W36
W...HR2/ HR2	W37	W38	W39	W40	W41	W42	W43	W44	W45
W...HR2/ HR3	W46	W47	W48	W49	W50	W51	W52	W53	W54
W...HR3/ HR1	W55	W56	W57	W58	W59	W60	W61	W62	W63
W...HR3/ HR2	W64	W65	W66	W67	W68	W69	W70	W71	W72
W...HR3/ HR3	W73	W74	W75	W76	W77	W78	W79	W80	W81

This type of matrix allows assessing the dependence and impact of the company's core competencies, Hard Requirements and Soft Requirements on each other. Analytical representation of the matrix is necessary for the convenience of forming the input data set to create a digital matrix of the company. The degree of impact will be interpreted by artificial intelligence in pre-formulated conclusions that will provide a qualitative description of such impact.

The fourth element that is subject to parameterization are the factors impacting the company. Depending on the company's specifics, such factors can be quite different, so the experts make their list and the degree of impact. A matrix of evaluation results of the work of the expert group at each level of the marketing environment is made for this purpose (Table 4).

Table 4: Matrix of results of evaluation of the work of the expert group to determine the degree of impact of factors of the marketing environment

Optimistic/Pessimistic/Realistic forecasts								
Mega-level								
CCF	Concordance coefficient	Factor change limit T1….Tn upperT1	Factor change limit lowerT1	Factor change limit ….Tn upper	Factor change limit ….Tn lower	Weak Signal factor	Strong Signal factor	The list of EKP impacted by CCF
	n1	$n1_1$	$n1_2$	$n1_3$	$n1_4$	$n1_5$	$n1_6$	
Macro-level								
CCF	Concordance coefficient	Factor change limit T1….Tn upperT1	Factor change limit lowerT1	Factor change limit ….Tn upper	Factor change limit ….Tn lower	Weak Signal factor	Strong Signal factor	The list of EKP impacted by CCF
	n2	$n2_1$	$n2_2$	$n2_3$	$n2_4$	$n2_5$	$n2_6$	
Meso-revel								
CCF	Concordance coefficient	Factor change limit T1….Tn upperT1	Factor change limit lowerT1	Factor change limit ….Tn upper	Factor change limit ….Tn lower	Weak Signal factor	Strong Signal factor	The list of EKP impacted by CCF
	n3	$n3_1$	$n3_2$	$n3_3$	$n3_4$	$n3_5$	$n3_6$	
Micro-level								
CCF	Concordance coefficient	Factor change limit T1….Tn upper T1	Factor change limit lowerT1	Factor change limit ….Tn upper	Factor change limit ….Tn lower	Weak Signal factor	Strong Signal factor	The list of EKP impacted by CCF
	n4	$n4_1$	$n4_2$	$n4_3$	$n4_4$	$n4_5$	$n4_6$	

External factors are divided depending on the level. Mega-level is a global factor that takes place in the world and affects the economy as a whole, and therefore the company. Macro-level — factors that occur at the national level, that is at the level of the national economy, and affect the company's activities. Meso-level — factors that affect the company at the industry level. Micro-level - factors that affect the company at the level of a particular market in which the company is represented.

CCF is a complex combined factor selected by experts, which is then used to conduct stress testing of the company's business model.

Concordance coefficient is designed to determine the level of agreement of experts.

Limits of change of factors T1… .Tn is the period during which the factors will change. In each case, it will be

different for a particular market and industry. The upper limit is the limit value of the factor change; the lower limit is the least likely change in the factor limits. The limits of change of factors in each case have different units of measurement, so a percentage scale (%/100) is introduced for convenience, which indicates the limit of change of the factor compared to the current value.

Weak Signal factor include factors that do not directly affect the company, but indirectly affect other factors and affect the company in case of a significant change.

Strong Signal factor include factors that have a direct strong impact on the company's activities.

Experts have the following objectives that they must fulfil in their expert work:

1) Determine an independent variable. In this case, it is necessary to identify those market situations that may pose a threat to the company, as well as to quantify them. This will determine the level of materiality of the impact on the company and develop possible scenarios of the consequences of such impact. The degree of risk can be assessed as high risk, medium risk, low risk, low-stability risk, medium-stability risk, high-stability risk.

2) Identify and model which factors pose a threat to the company when changing limits of the action. In this case, they determine the possible changes in the specific situation in which the impact on the company is transformed. This will create a list of potential threats and develop scenarios of potential impact.

3. Determination and modelling of company parameters that must be stable at already set risk parameters. This involves increasing the company's resilience to certain risks.

4. Discussion

Experts of the Committee of European Banking Managers [13] conducted a study of stress testing with the involvement of managers. The results showed that stress testing, as an internal process, largely depends on management. In particular, managers also act as experts whose opinions are taken into account in the process of stress testing. We believe that the use of machine learning in marketing stress testing can eliminate the factors of subjective evaluation. This is especially true for domestic stakeholders who have prejudices in relation to the company.

In a study of marketing analytics in the age of machine learning Booth [14] notes that the digital age opens up great opportunities for improving the effectiveness of marketing campaigns. Note that conducting quality and effective marketing campaigns is impossible without quality market

research. In this context, machine learning improves the quality of the methods used, as the reliability of the input data of stress testing models increases. In some cases, it is even possible to transform the models themselves in accordance with the conditions of the company's operating environment.

In his study, Brei [15] concludes that the use of machine learning in marketing is inevitable. Machine learning allows creating complex testing models for different scenarios, the use of which was previously limited by technical capabilities. The results of our study confirm the author's conclusion, and also offer a parameterized model of marketing stress testing, which can be used for further machine learning.

Sundsøy, Bjelland, Iqbal, Pentland, de Montjoye [16] studied the implications of using big data in marketing. The results show significant benefits of using machine learning and big data, as it opens up opportunities to take into account a large number of factors and determine the functional relationships between them. However, an important aspect of the benefits of big data and machine learning is the initial baseline model that underlies marketing stress testing. Our study proposes to use this model for use in machine learning. Besides, it is proposed model is adaptive and can be used for any company.

Mari also explores the use of machine learning in marketing [17]. The author also emphasizes the importance of developing parameterized and formalized business models of companies for their further use in marketing stress tests. Properly designed model can significantly improve the quality of forecasts in modelling the future state of the system depending on changes in independent factors of the environment.

In his study of the use of artificial intelligence in marketing, Cannella [18] notes that information technology not only increases the effectiveness of marketing activities of companies, but also opens up new opportunities for its implementation. In particular, artificial intelligence is able to detect hidden patterns and trends. The use of large data sets provides more reliable results that are critical to forecasting. But the quality of the company's digital business model is no less critical, which underlies the work of artificial intelligence. In this sense, the parameterized business model is primary in relation to the application of artificial intelligence, and therefore requires careful development. The same results were obtained in the Vertical Leap study [19].

The development of models of artificial intelligence-based marketing stress testing requires close cooperation between marketers and software developers, as evidenced

by the results of the study [20]. Such cooperation aims to create a digital model of the company's business processes and its use to build algorithms for machine learning and its further transformation. Parametrized business model is the basis for further work of software developers, but such a model should include all factors of internal, external environment and key quality competence of the company, which is the basis of the whole system [21]. As our research has shown, in some cases the key qualitative competence of the company can transform with a significant shift in the factors of internal and external environment. As a result, there may be a need to completely restructure the digital business process model [22].

5. Conclusions

Adapting the company to the changing conditions of the marketing environment requires the development of tools. The digitalization of the company's activities opens up prospects for the use of artificial intelligence and machine learning for marketing stress testing. This research resulted in the developed author's approach to the parameterization of the company's business processes for machine learning-based marketing stress testing. The author's approach provides that the elements of the internal environment (the company's business processes and products), factors of the marketing environment (risks and opportunities of the external environment, risks and opportunities of the internal environment), the company's core competencies (Soft Requirements, Hard Requirements), and factors impacting the company.

Weight matrices, which allow to digitally present qualitative assessments of expert groups, were developed to parameterize the proposed objects. The developed proposals provide the formation of a conceptual basis for the parameterization of business processes for marketing stress testing based on machine learning. The methodological limitation of the study is the use of modelling method only. At this stage, the use of other methods is not possible due to the fact that this is only the first phase of work on the parameterization of the company's business processes. The implementation limitation is that the proposed approach can only be used if the company plans to use machine learning for marketing stress testing. Otherwise, the initial marketing conditions will quickly lose relevance and the model will not give reliable forecast results.

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