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# APPROACH TO ASSESSMENT OF FINANCIAL STABILITY OF INDUSTRIAL ENTERPRISES AS A BASIS OF SUSTAINABLE DEVELOPMENT

**N.S. Lukashevich, E.A. Konnikov**

Peter the Great St. Petersburg Polytechnic University, St. Petersburg, Russian Federation

Management of sustainable development of industrial enterprises is the basis of the strategy of sustainable development of Russian economy. Industry is a strategically important sector, which makes it necessary to assess the sustainability of its development. The purpose of this study is to develop tools for assessing the financial stability as a basis of sustainable development of industrial enterprises (using the example of the manufacturing industry) that support the decision-making process. The sustainability depends on the financial status of industrial enterprises. A system of indicators for assessing the financial status of an industrial enterprise was formed. Each indicator was assigned a normative value reflecting the specifics of the industry. A toolkit for forecasting the indicators was created, based on the hypothesis that the level of financial stability is associated with a real option. The approach provides a finite number of states characterized by the ratio of these indicators. The whole set of possible outcomes can be divided discretely depending on the ratio of the studied indicators and their normative values. It is expedient to compare two graphic images: one reflecting the ratio of current indicators and one reflecting the ratio of future indicators. The formulated fixed descriptions of the octant are recommendations for making managerial decisions and serve as tools for the executive staff of the enterprise. The formulated approach is aimed more at assessing sustainability in the short term, as it describes two conditions of financial stability of the enterprise. In this case, development is also characterized by a vector of dynamics of the studied indicators. The distinctive features of the proposed toolkit are as follows: the possibility of obtaining specific recommendations based on assessing the sustainability of the enterprise; the ability to qualitatively evaluate the vector of sustainable development of the enterprise taking into account the external environment, the dynamics of the industry and the current and forecast the financial status of the enterprise; the ability to customize the parameters of the toolkit by changing the regulatory indicators, the depth of retrospection of accounting and financial reporting data, which allows the manager to adapt the toolkit for different categories of tasks and users. However, it is necessary to take into account the limitations of the developed toolkit that can form the basis for further research: the specifics depends on the manufacturing industry, which necessitates industrial diversification of the toolkit; further formalization of the tool by finding approaches to estimating the probability of the sustainable development scenario; taking into account the time factor in the model and constructing a vector of sustainable development.

**Keywords:** financial stability; sustainable development; industry; octant; financial state; real option

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# О ПОДХОДЕ К ОЦЕНКЕ ФИНАНСОВОГО СОСТОЯНИЯ ПРОМЫШЛЕННЫХ ПРЕДПРИЯТИЙ КАК ОСНОВЫ УСТОЙЧИВОГО РАЗВИТИЯ

**Н.С. Лукашевич, Е.А. Конников**

Санкт-Петербургский политехнический университет Петра Великого,
Санкт-Петербург, Российская Федерация

Управление устойчивостью развития предприятий является основой стратегии устойчивого развития экономики России. Системообразующий характер промышленности порождает необходимость оценки устойчивости ее развития. Цель исследования – разра-

ботка инструментария оценки финансового состояния как основы устойчивого развития промышленного предприятия (на примере обрабатывающей промышленности), обеспечивающего поддержку принятия управленческих решений. Устойчивость развития промышленности зависит от финансового состояния промышленных предприятий. Сформирована система индикативных показателей оценки финансового состояния промышленного предприятия, каждому из показателей присвоены нормативные значения, отражающие отраслевую специфику. Сформирован инструментарий прогнозирования индикативных показателей, который базировался на гипотезе, согласно которой уровню финансовой устойчивости промышленного предприятия присущи свойства реального опциона. Подход обеспечивает конечное число состояний, характеризующихся соотношением данных показателей. Все множество возможных исходов можно разделить дискретно в зависимости от отношения исследуемых показателей и их нормативных значений. Рациональным для восприятия является сопоставление двух графических изображений: отражающего соотношение текущих показателей и отражающего соотношение будущих показателей. Сформулированные фиксированные описания октанта являются рекомендациями к принятию управленческих решений и служат инструментами управленческого аппарата предприятия. Сформулированный подход в большей степени направлен на оценку устойчивости в краткосрочной перспективе, так как описывает два состояния финансовой устойчивости предприятия. В данном случае развитие также характеризуется вектором динамики исследуемых показателей. Отличительными особенностями предложенного инструментария являются: возможность качественно оценить вектор устойчивого развития предприятия с учетом внешней среды, динамики отрасли и текущего и прогнозного финансового состояния предприятия; возможность настраивать параметры инструментария за счет изменения нормативных показателей, глубины ретроспекции данных бухгалтерской и финансовой отчетности, что позволяет адаптировать инструментарий для различной категории решаемых задач и пользователей. Необходимо учитывать ограничения разработанного инструментария, которые могут стать основой для дальнейших исследований: отраслевая специфика определяется обрабатывающий промышленностью, в связи с чем возникает необходимость отраслевой диверсификации инструментария; целесообразным является дальнейшая формализация инструментария за счет поиска подходов к оценке вероятности сценария устойчивого развития предприятия; учет фактора времени в модели и построение вектора устойчивого развития.

**Ключевые слова:** устойчивое развитие; промышленность; октант; финансовое состояние; реальный опцион

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*Introduction.* Management of sustainable development of industrial enterprises is the basis of the strategy of sustainable development of Russian economy. Nowadays, despite the emerging concept of post-industrial economy, industry is still the backbone of Russian economy [5]. The total share of industrial enterprises at the end of 2014 was 23.87 %, and its gross value added was 29.3 % at the end of 2014. The strategically important nature of industry gives reason to assess the sustainability of its development. One of the most significant indicators in this case is the industrial production index. The industrial production index reflects the change in the value created in the production process as a result of real (physical) growth (decrease) in the release of goods, performance of work and the provision of services.[1] Fig. 1 shows the dynamics of this indicator from 1992 to 2015.

It is clear that in 2015 this indicator fell to a level comparable with that of 2009. In addition, a steady decline of this indicator has been observed since 2010. This dynamics indicates a decline in the level of production and, consequently, a certain degradation of the Russian industry. This statement correlates with the dynamics of depreciation of fixed (production) assets, which has been steadily increasing since 2012.

The manufacturing industry was selected for the study. Bankruptcy of the representatives of the given branch leads to the release of demand in their respective market sectors, which creates opportunities for increased imports or level of monopolization [12]. Despite technological diversity, a significant proportion of industries is characterized by high asset turnover (particularly inventory) and the need for urgent and absolute liquidity, which makes the factor structure of the models for evaluating the financial state an important subject.

[1] The official statistical methodology for calculating the index of industrial production (approved by the order of the Federal State Statistics Service No. 301 of May 8, 2014).

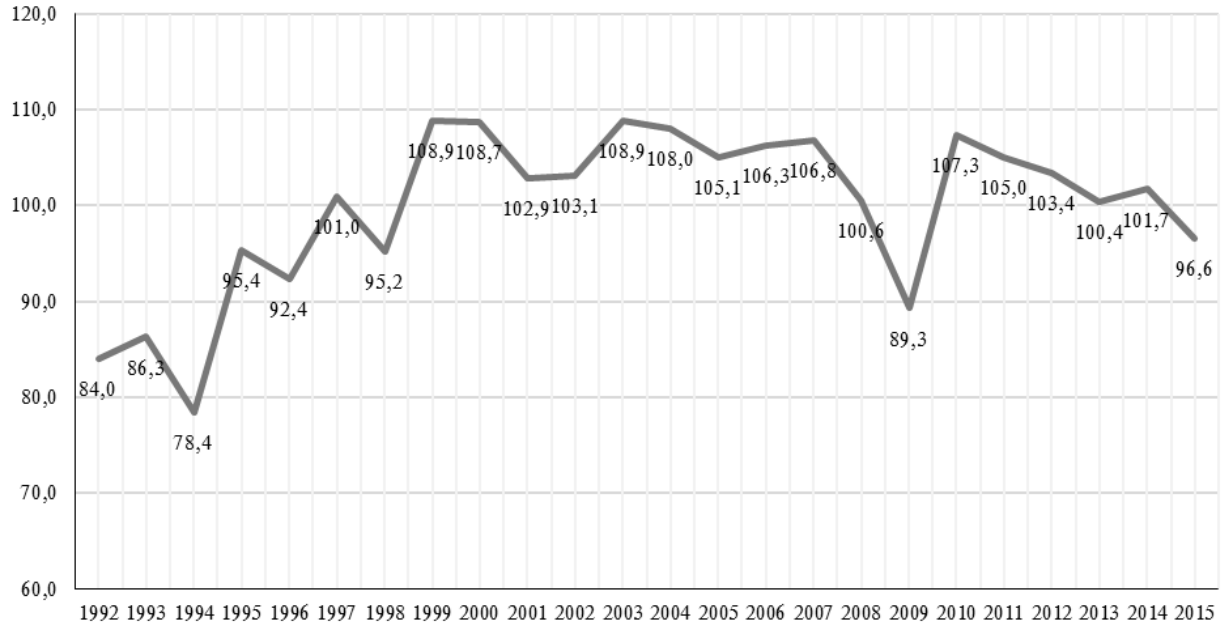


**Fig. 1.** Dynamics of industrial production index (1992–2015)

The goal of this study is to develop the tools for assessing financial stability as a basis of sustainable development of industrial enterprises (using the example of the manufacturing industry) that support the decision-making process.

*The methodology and results of the study*. There are many articles considering the analysis of problems and assessment of sustainable development of enterprises [1–4, 7, 13, 15, 16, 18, 20]. For example, Ref. [18] devised and tested a methodology for assessing the sustainability of the development of industrial enterprises by using a generalized indicator. Ref. [20] constructed the economic and mathematical models for planning the sustainable development of industrial enterprises for two types of markets: stable and dynamically changing. The methodological principles of sustainable development of industry and economy are laid down in [16].

In our opinion, the sustainability of the industry depends on the financial state of industrial enterprises. To confirm this assertion, the current study analyzes the correlation between the dynamics of the number of financially insolvent enterprises and the dynamics of the index that objectively reflects the state of the manufacturing industry, for example, using the official statistics on the volume of shipped goods of own production. A significant correlation coefficient value amounted to −0.738.

We can assume that the tools for assessing the sustainability of industrial enterprises should be based on the models for evaluating financial stability. There are many methods and models for evaluating the financial state of the company; the accuracy of classification and applicability of these models and methods was analyzed in many articles [8–10, 19].

In most articles, researchers based on the collected financial statements of small enterprises (for some industries) to test traditional models of bankruptcy diagnostics of, finding a strong variation of bankruptcy probability estimates. The models of bankruptcy probability estimates based on the traditional ratio analysis may help in diagnosing the financial state, however, with some significant reservations: 1) not only the formally obtained indicator, but a combination of factors (both quantitative and qualitative) that may affect the financial state should be considered; 2) the choice of the model has to take into account the industry specifics of the enterprise; 3) the methodology of evaluation should primarily use such indicators as the level of gearing (debt-to-equity ratio), current assets and current liabilities.

Since none of the classic rating models take into account the characteristics of the external environment in the estimations or use a specialized forecasting method, the scenarios for

sustainable development of the enterprise are constructed by extrapolation.

The following system of indicators has been formed for assessing the sustainability:

– asset turnover ratio for estimating the level of business activity of the enterprise;

– current liquidity ratio for estimating the solvency level of the enterprise;

– ratio of own and borrowed capital for estimating the gearing level.

Each of the indicators in the constructed system yielded lower values for financially insolvent enterprises than for solvent ones, and, according to the review of the literature we have performed [8-10], can be used for estimating the potential bankruptcy of an enterprise.

Current indicators cannot predict the financial strength of the organization with a sufficient degree of probability. The future level of indicators can be predicted identically to calculation of the future option price. It is proposed to use Black-Scholes model as a method of calculation. This approach was proposed and substantiated in [11, 17].

This model was chosen because it allows to take into account the fluctuations of the underlying asset, which in this case is the level of indicators. Moreover, the risk-free interest rate expressing the minimum level of profitability is used within the framework of this model. In real market conditions the inflation indicator determines the minimum level of profitability. Consequently, the price growth index for the goods produced or sold by the enterprise can act as a risk-free interest rate. The mathematical model has the following form [17]

$$C = \frac{SN(d_1)}{Ee^{-rN(d_2)}},$$

$$d_1 = \frac{\frac{\ln S}{E} + \left(r + \frac{\partial^2}{2}\right)}{\partial},$$

$$d_2 = d_1 - \partial,$$

where $C$ is the forecast value of the indicator; $S$ is the numerator (revenue; equity; working capital assets); $E$ is the denominator (total assets; short-term liabilities; loan capital); $r$ is the rate of return (price index); $\partial$ is the variance of indicator values; $N(d)$ is the cumulative (standard) normal probability distribution; $d_1$ and $d_2$ are the standardized normal variables.

According to the model, the external environment is estimated through the indicator of potential profitability (price index) and the risk indicator (of coefficient variance). It is important to determine the number of years for which the accounting data have to be analyzed. This parameter is necessary for determining the level of risk of deterioration of financial state within the framework of forecasting the indicator values under consideration. The price index reflects the minimal growth in profitability in the industry during the current period.

Assessment of risk of losing financial stability of the industrial enterprises is primarily aimed at identifying the current levels and predicting the future levels of the indicators. The transition from estimating the values to making recommendations based on these values will enable a shift from the concept of financial state to the concept of sustainable development. This transition is due to the fact that the vectors of the changes in the key financial indicators can describe the sustainable development of industrial enterprises in a simplified form. The sustainable development (or degradation) of an industrial enterprise could be characterized by the relationship between these vectors for a certain period.

If these vectors are represented in the form of a time series of relative indicators characterizing the change of some characteristic of the financial state of the enterprise, and the derivative functions describing this time series will be greater or equal to zero that means that the enterprise is developing steadily. Otherwise, there has been a steady degradation of the enterprise. Thus, the variance of values plays a considerable role in each time series. Significant fluctuations of a negative nature mean that the development of the enterprise cannot be described as stable. Consequently, the sustainability of the enterprise for a certain period can be characterized by the following elements: functions describing the dynamics of the parameters and their variances (fluctuations). Sustainable development reflects the dynamics taking into account the external environment instead of a momentary state.

The assessment of sustainable development of an industrial enterprise in the short-term period is significantly different, since a time series consisting of two indicators (values) is statistically insignificant. The developed approach is aimed rather at assessing sustainability in the short-term

period, as it describes two conditions of financial stability of the enterprise. In that case, a vector of the dynamics of the indicators under consideration also characterizes sustainable development.

The approach operates with the data of the current and future periods, therefore, the current and future level of financial state is characterized by an identical (in terms of content) set of indicators. Since this technique implies correlating identical indicators and their normative values, sustainable development can be characterized by three relationships:

– ratio of the current and the future level of asset turnover and its normative value;

– ratio of the current and the future level of current liquidity and its normative value;

– ratio of the current and the future level of ratio of own and borrowed capital and its normative value.

The normative values of the indicators are determined empirically for each industry (based on statistics) and can be adjusted depending on the category of enterprise, industry, risk preferences, decision-making process in the company and other factors. Based on cluster analysis, a method was developed for finding the 'average' (normative) recommended values of financial indicators for different groups (clusters) of organizations [19].

Thus, the formulated approach has a finite number of states characterized by a correlation of these indicators. The whole set of possible outcomes can be divided discretely depending on the ratio of the studied indicators and their normative values. The comparison of two graphic images reflecting the ratio of current indicators and reflecting the ratio of future indicators is rational for perception. The approach regards the financial stability of an industrial enterprise as a set of its three characteristics, expressed by three indicators. Therefore, the generated graphical toolkit assumes three dimensions. Each of the axes is divided by a perpendicular into two areas. This perpendicular is determined by the normative values of the indicators. Thus, each of the two graphic tools forms eight sectors that characterize one of the states of financial stability in the current or future period. Since the sectors are formed by dividing the space into three mutually perpendicular planes, from a geometric point of view they can be called *octants*.

Comparing the current and projected octants of financial stability allows to make a transition to the characteristic of sustainable development of the enterprise. Graphically, this comparison is possible by extending the formed axes to their negative areas, thus forming the same set of octants. Inserting the current octant of financial stability into area I ($x$ is positive, $y$ is positive, $z$ is positive), and the octant of predicted financial stability into area VII ($x$ is negative, $y$ is negative, $z$ is negative), we obtain a graphical tool reflecting the predicted change in financial stability for the current period.

If the dynamics is recorded discretely in accordance with the normative values, there are 64 states in total. Since each of the conditions is characterized by certain characteristics of both the external and internal environment of the enterprise, recommendations can be formulated regarding the decisions needed to improve the current situation and the possible change in the projected level of financial stability. Fig. 2 shows the octant of sustainable development.

The areas colored in red (dark gray) indicate the values below the normative ones. Green areas (gray) constitute the entire set of values of the studied indicators that are above the normative ones. Plotting the data on the axis of the octant generates new areas characterizing the current and projected level of financial stability of the industrial enterprise. These areas are colored in yellow (light gray). Current values of the studied indicators are denoted by the letters $A$, $B$ and $C$, while their predicted values are denoted by $A'$, $B'$ and $C'$. The point that characterizes the financial stability of an enterprise in the current or future period is the vertex of the formed parallelepiped, the diagonal to which can be drawn from point *0*.

According to the data of the example shown in Fig. 2, it can be seen that the current values of financial stability indicators of an enterprise exceed normative ones, which makes it possible to characterize the enterprise as financially stable. However, all predicted values of the considered indicators are below the normative ones, therefore, the enterprise (in accordance with the environmental conditions) will lose its financial stability in the forthcoming period. Consequently, in that case it is not a question of sustainable development, but of sustainable degradation of the enterprise

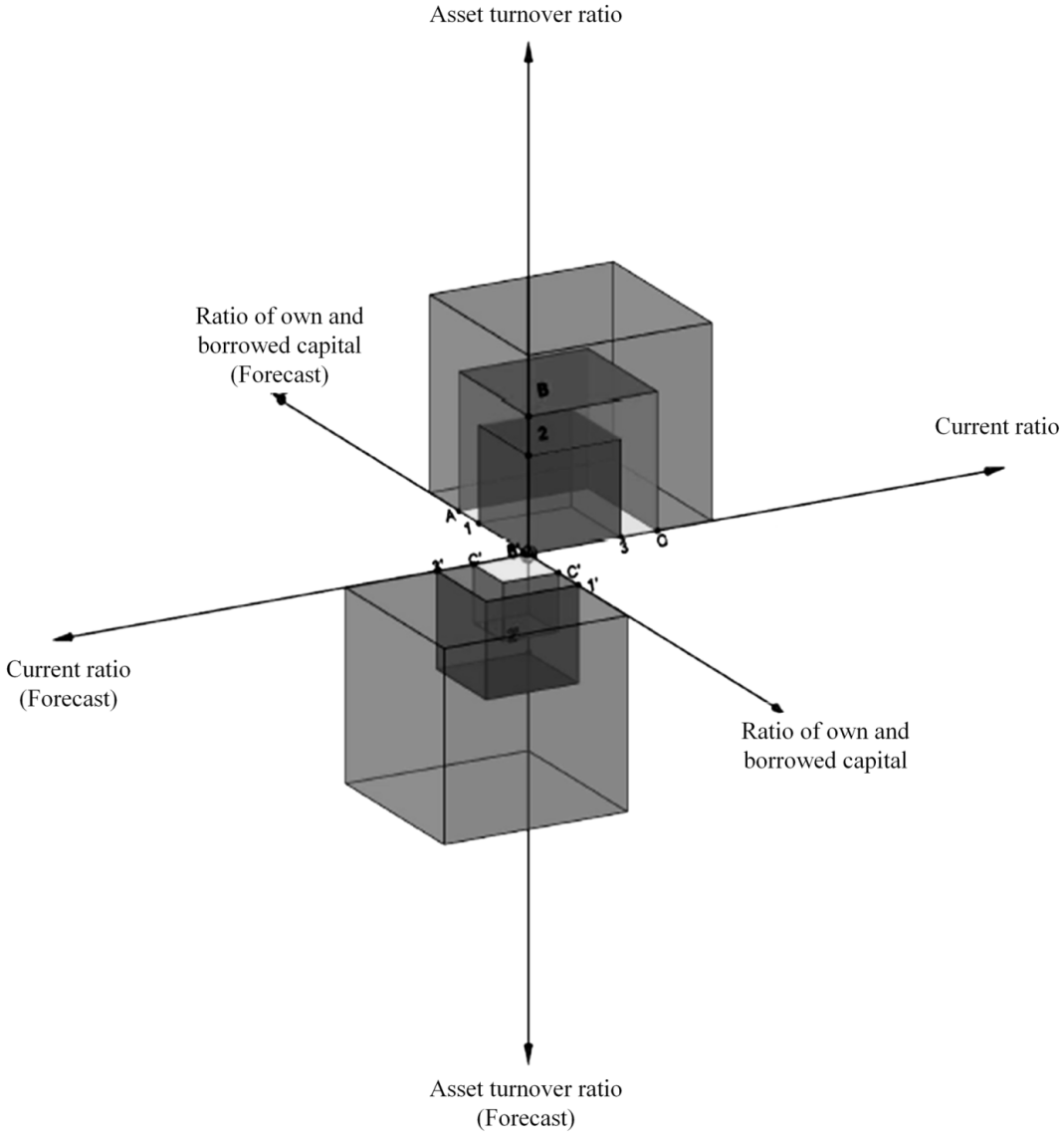


**Fig. 2.** Octant of industrial enterprise sustainability

The formulated recommendations can be divided into several groups taking into account the obtained state of sustainable development:

1. First-order recommendations. The enterprise should strengthen control and increase the level of current liquidity, the level of asset turnover and debt-to-equity ratio.

2. Second-order recommendations. The enterprise should increase revenues with a relatively smaller increase in current assets, reduce short-term and long-term liabilities and increase own capital.

3. Third-order recommendations. The enterprise should reduce the overall duration of the production cycle, improve the production technology and its organization, reduce labor intensity at all stages of the production process, improve supply and demand conditions, improve the system of payment, reduce the share of profits directed at unproductive purposes, reduce the number of investment projects financed by borrowed capital, replace short-term loans attracted for investment purposes, minimize the stock of unfinished production, revalue non-current assets, sell parts of unclaimed non-current assets and increase the contributions of founders to the assets of the enterprise.

Thus, the applied graphic tool allows to characterize the level of stability of the development of an industrial enterprise and to formulate a set of recommendations for each state.

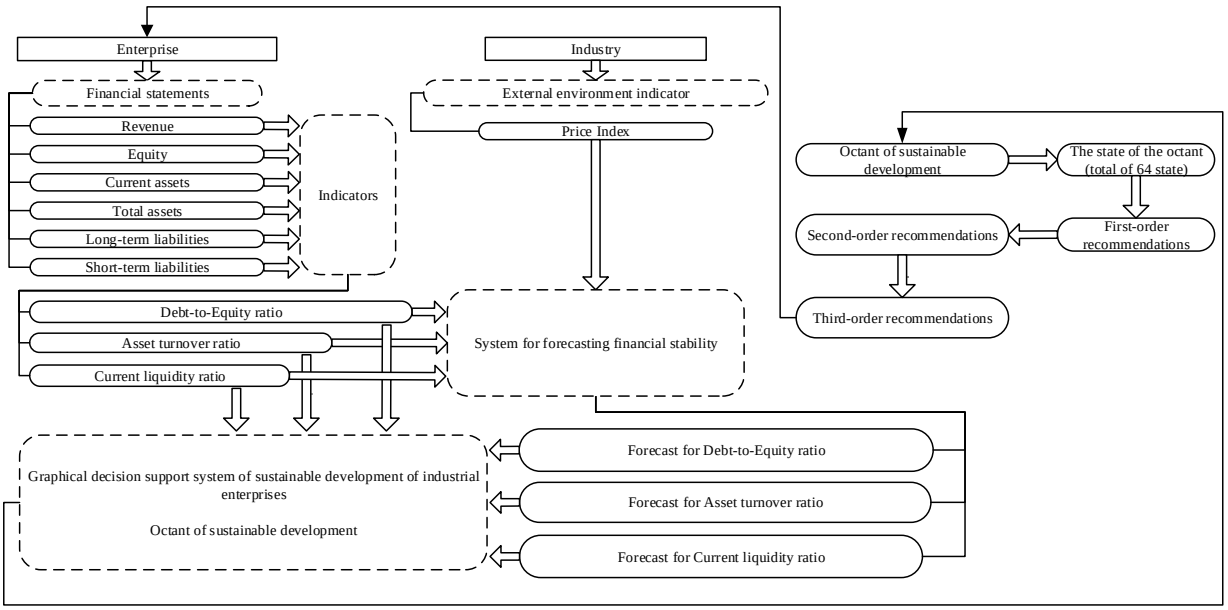


**Fig. 3.** Algorithm for assessment of sustainable development

The set of recommendations consists of four consecutive elements:

1. Description of the state of the octant. Description of the state of the octant. At this level, the sustainability of enterprise development is characterized by a description of the current and projected levels of financial sustainability.

2. First-order recommendations. The direction of increasing the stability of the enterprise within the context of considered indicators is specified.

3. Second-order recommendations. These recommendations are aimed at determining specific financial indicators of the enterprise, which require strengthening the control and effort towards increasing or decreasing these indicators quantitatively.

4. Third-order recommendations. These recommendations are final. Within this block, specific actions are taken to implement the second-order recommendations.

The formulated fixed descriptions of the octant are recommendations for making managerial decisions and serve as tools for decisions support. Fig. 3 shows the algorithm for developing recommendations for the sustainability of an industrial enterprise.

*Conclusions.* The practical importance of the developed approach is in solving the following tasks from the point of view of various users of the tool: 1) with respect to the debtors of the enterprise, the toolkit allows assessing the risk of losing their financial stability; 2) with respect to the management of the enterprise, the toolkit allows obtaining a qualitative assessment of the vector of sustainable development and recommendations for developing the enterprise and minimizing the impact of crisis situations; 3) with respect to the banking sector, the toolkit can be the basis or an additional tool for credit risk assessment.

The distinctive features of the proposed toolkit are as follows: 1) the possibility of obtaining specific recommendations based on assessing the sustainability of the enterprise; 2) the possibility of qualitatively evaluating the vector of sustainable development of the enterprise, taking into account the external environment, the dynamics of the industry and the current and the predicted financial state of the enterprise; 3) visualization of the results, allowing to present the directions of changes graphically; 4) the possibility to customizing the parameters of the toolkit by changing the regulatory indicators, the depth of retrospection of accounting and financial reporting data, which allows to adapt the toolkit for different categories of tasks and users.

However, it is necessary to take into account the limitations of the developed toolkit, which can form the basis for further research: 1) the specifics is determined by the manufacturing industry, which necessitates industrial diversification of the toolkit; 2) further formalization of the tool

by finding approaches to estimating the probability of the sustainable development scenario; 3) taking into account the time factor in the model and constructing a vector of sustainable development; 4) expansion of the pool of factors by adding factors that are non-financial in nature to the toolkit.

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**LUKASHEVICH Nikita S.** E-mail: lukashevich@spbstu.ru
**KONNIKOV Evginii A.** E-mail: konnikov.evgeniy@gmail.com

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**ЛУКАШЕВИЧ Никита Сергеевич.** E-mail: lukashevich@spbstu.ru
**КОННИКОВ Евгений Александрович.** E-mail: konnikov.evgeniy@gmail.com

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