

*This paper investigates the peculiarities and effectiveness of using project management in the field of engineering of innovative developments. The relevance of the topic relates to the fact that the process of innovative development is characterized by its duration and the uncertainty of the probability of obtaining specific results. Such a feature determines the need to build such a project management system for the engineering of innovative developments, which would ensure the definition of sub-stages of this process, the assessment of the degree of their implementation, and the determination of the results of these stages. The object of this study is the project management system of the engineering projects of innovative developments of the company Hokord Ltd. The research used methods of statistical analysis with the distribution of data into control and test groups. This distribution made it possible to reveal the impact of the implementation of project management on the effectiveness of project management. The study solves the problem of determining the effectiveness of project management in comparison with traditional approaches to project management. The results of the study show that the implementation of project management in the field of engineering of innovative developments has led to the improvement of project management and an increase in their efficiency. Implementation of project management made it possible to establish new project statuses and reduce the share of canceled or closed projects, while the share of successfully completed projects increased. Unlike other studies, quantitative indicators of the effectiveness of project management were established – the duration of project implementation was reduced by an average of 11%. The implementation of project management also improved the assessment and allocation of project priorities, a decrease in the share of projects with high priority, and an increase in the share of projects with low and uncertain priority was revealed*

**Keywords:** project management, management efficiency, innovation engineering, project management, flexible management

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# ASSESSING THE EFFICIENCY OF APPLICATION OF PROJECT MANAGEMENT IN THE FIELD OF ENGINEERING OF INNOVATIVE DEVELOPMENTS

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## 1. Introduction

An effective management system of the innovation development process is an important component of the success of this process. Unlike the management of routine business processes, which have clear deadlines and algorithms and can be predicted, the management of innovative developments faces a large number of unpredictable factors. In particular, in the process of development and research, unpredictable delays may occur, it is necessary to repeat certain stages of development and carry out repeated iterations of calculations or testing. All these factors can lead to significant delays in the implementation of stages of innovative developments, which, in turn, leads to higher costs for such developments.

The peculiarity of innovative development engineering is that innovative development is a long-term and complex process. And the management of this process involves the performance of a number of tasks related to the organization of the work of engineers, the calculation of the cost of developments, accounting for the costs of the engineers' working time and the equipment's working time. The use of project management principles for the development of innovations has been studied for a long time. One of the studies [1], published as early as 1986, investigated the innovation development process, which was considered in the context of three stages. Each of these stages had specific goals, the achievement of which was

transformed into the creation of an innovative product. This approach to management actually corresponds to the basic principles of project management. Taking into account the need to perform these tasks, the management system at the enterprise must choose a management approach that would satisfy all stakeholders of the innovation development process as much as possible. Considering this, it is relevant to study the peculiarities of the use of project management in the field of engineering of innovative developments.

## 2. Literature review and problem statement

In the study of the application of project management in the field of mechanics [2], it is noted that the most important advantage of the application of project management is the possibility of dividing the entire development process into separate projects. This division makes it possible to clearly control each stage and highlight the specific results of each stage. However, the authors do not demonstrate an example of practical approbation of the implementation of project management at the company level, which does not allow evaluating the effectiveness and efficiency of the author's proposals and conclusions.

In turn, in the study of the implementation of project management [3], a survey of project managers of three projects lasting from 2 to 4 years was conducted in order to determine

the success factors of the application of this approach. Based on the results of the research, they concluded that the key factors in the success of the implementation of project management are the high degree of qualification of project managers and their ability to apply their knowledge in the real conditions of project management. The authors single out the connection between the parent company and the project as the next success factor, as it determines the authority and responsibility of project managers for the final result. However, the study was based on a survey of project managers, and their answers may be biased in relation to the results of their work. It is necessary to confirm the success of the application of project management based on objective data, for example, the duration of project implementation, changes in the cost of such projects, etc.

In the context of studying the peculiarities of the application of project management in various fields, of interest is study [4]. The authors studied the experience of implementing project management in transport infrastructure development projects and came to the conclusion that such elements of project management as high qualification of project managers and established communication between project executors were the most implemented. Such results confirm the conclusions of study [3] that the qualification of project managers is one of the main factors in the success of project implementation. Such conclusions lead to the idea of the potential possibility of successful implementation of the application of project management in any field, however, there are reasons to believe that the success of projects cannot be guaranteed only by the highest qualification of project managers. Research conclusions [3, 4] are based on surveys of project participants and project managers. It is worth noting that the specifics of project management implementation must be carried out on the basis of more objective data, for example, on the basis of data on the duration of projects, the degree of their success, etc.

A similar questionnaire method was used to study the effect of implementing project management in construction projects [5]. The authors studied the degree of implementation of project management principles and established that integration management has a significant impact on the effectiveness of project management throughout the entire period of their implementation. However, such a conclusion applies specifically to projects that have a certain deadline for implementation. As for innovation engineering, such projects in companies, as a rule, do not have expiration dates since the search and development of innovations takes place on a permanent basis and is an element of the innovative activity of the company. In this aspect, the effect of project management is much more important in terms of the effectiveness of managing such projects on a permanent basis, and not only at the stage of launching such projects and building a functional hierarchy of project participants.

Study [6] deserves special attention, in which the authors investigate the role of design thinking as a tool for meeting the requirements for the project management system. There are reasons to believe that the use of design thinking is an innovation that can potentially have a positive impact on the effectiveness of projects in the field of innovation engineering, as it conceptually changes the approach to the management of innovation development projects. But the issue of practical implementation of this concept in the enterprise management system remains unresolved. Such a concept is easier to implement in a new project where there is no established management system, but it is rather difficult to impose on already established management models. In this context, it is necessary to first investigate the features of the application of project

management in comparison with traditional approaches to management, to identify its advantages and disadvantages. On the basis of the received data, it is possible to identify potential areas of management where it is advisable to implement design thinking. In the development of this opinion, it is worth mentioning study [7], which considers the search for practical areas of application of project management in the development of innovations in the service sector. The authors cite a number of models of development of innovations in the field of services, which are possible thanks to the use of project management. This example can be considered indicative and one that actualizes the research topic because the areas of application of project management can be quite diverse.

The answer to the question of the practical application of project management techniques and tools to create dynamic opportunities in companies is given in study [8]. After conducting interviews with 22 project participants from 9 companies, the authors draw conclusions about how project managers implemented certain tools, but the effect of implementing such tools remains overlooked. A study also considers the practical implementation of project management in product development [9]. The authors describe in detail how project management was implemented and how approaches to its application were transformed in various cases, but they do not reveal the consequences and effects for the company's activities and product development in particular.

The reviewed studies ignore the issue of the effect of using project management and its consequences for the company. To get an answer to this question, it is necessary to compare the activity of the company or project before and after the implementation of project management, which will make it possible to determine such an effect quantitatively on the basis of objective indicators of the activity of the company or project. In this aspect, study [10], which compared the approaches of manufacturing enterprises to the development and attraction of investments and innovations with the use of project management and without it, deserves special attention. As a result, the study showed that companies that use the principles and approaches of project management attract more investments and innovations than companies that use classic management models. However, such results may be caused by a number of other factors that are not directly related to the use of project management (for example, the size of the enterprise, market position, access to resources, etc.). It should be noted that it is possible to objectively establish the features and consequences of the implementation of project management on the example of an enterprise that used classical management models and then switched to using project management. Under such conditions, it is possible to compare the performance indicators of the management and the company for different periods and determine exactly the effect of project management, leveling the influence of such factors that are present in study [10].

The insufficient degree of research into the impact and features of the application of project management in the field of innovative developments necessitates research in this area.

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### 3. The aim and objectives of the study

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The purpose of this study is to determine the effectiveness of the application of project management in the field of engineering of innovative developments. This will enable a practical substantiation of the feasibility of transitioning from tra-

ditional project management methods to project management and evaluating the effectiveness of using project management.

To achieve the goal, the following tasks were solved:

- to analyze the dynamics of changes in the share of projects depending on the status of the project as a result of the implementation of project management;
- to analyze the dynamics of changes in the duration of project implementation as a result of the implementation of project management;
- to analyze the dynamics of the number of projects for each priority level due to the implementation of project management;
- to analyze the dynamics of the number of projects in terms of the Project Health indicator due to the implementation of project management;
- to determine the impact of transition to project management on Duration and Project Health indicators.

#### 4. The study materials and methods

The object of this study is the project management system for the management of innovative development engineering projects. The hypothesis of the study is the assumption that the transition from traditional project management methods to project management makes it possible to increase the efficiency of project management in the field of engineering of innovative developments. The research was conducted on the basis of the company [11], which is engaged in the development of innovations in the field of vaping and is based in Hong Kong. The choice of this company is related to the fact that this company directly specializes in the engineering of innovative developments and is an ideal object for determining the specifics of the implementation of project management. In this company, in the period from 2016 to the end of 2017, classical methods of project management for the development of innovations were used, and starting from 2018, the transition to project management took place. Such a feature of the change in project management principles makes it possible to compare the effect of the transition to project management on project management indicators. Based on the data on the projects that the company carried out, the impact of the implementation of project management on a number of indicators was analyzed:

- 1) number of projects in each status (Cancelled, Closing, Completed, In Progress, On Hold, Planning & Initiation);
- 2) the average term of projects;
- 3) number of projects for each priority level (Very High, High, Medium, Low, Very Low, Not Scored);
- 4) the number of projects in terms of Project Health (Good, Caution, At Risk, Not Set);
- 5) the impact of transition to project management on Duration and Project Health indicators.

Information about the projects of Hokord Ltd., which were implemented during the period of the company’s existence, was used as the initial data for the research. The sample includes 284 projects with implementation beginning on January 4, 2016, and ending on March 13, 2024.

The research used methods of statistical analysis of data with a division into control and test groups. The control group of data includes projects that were implemented using traditional management tools and includes 127 projects. The test group includes projects that were implemented using project management and includes 157 projects.

Regression analysis was used to determine the impact of the transition to project management on the Duration and Project Health indicators. The fact of implementing project management is entered into the data as a dummy variable (Dummy Variable) and is designated as *PM*:

– Model 1:

$$Duration = \beta_0 \text{const} + \beta_1 PM + \varepsilon_t,$$

where *Duration* – project duration (days); *PM* – project management;

– Model 2:

$$Project\ Health = \beta_0 \text{const} + \beta_1 PM + \varepsilon_t,$$

where *Project Health* – assessment of the state of the project; *PM* – project management.

Data processing and calculation of descriptive statistics and regression analysis were carried out in the software product Python (the Netherlands).

#### 5. Results of studying the effectiveness of the implementation of project management in the field of innovation engineering

##### 5.1. Results of studying changes in the share of projects depending on the status due to the implementation of project management

The results of the study showed that the transition to project management gave a number of positive results regarding project management indicators. In particular, before the introduction of project management, projects with the statuses of Closing, In Progress, and Planning & Initiation were not recorded. Only projects with Completed, Canceled, and On Hold status were at the management’s disposal. Thus, the implementation of project management contributed to highlighting three new project statuses, which increased the informativeness of the project management system. The distribution of projects by each status before and after the implementation of project management is shown in Fig. 1.

The results of the analysis of the distribution of projects by status indicate that after the implementation of project management, the share of projects with the status of Canceled decreased from 16% to 15%, the share of projects with the status of Closing decreased from 83% to 67%, and the share of projects with the status of Completed increased from 1% to 8%.

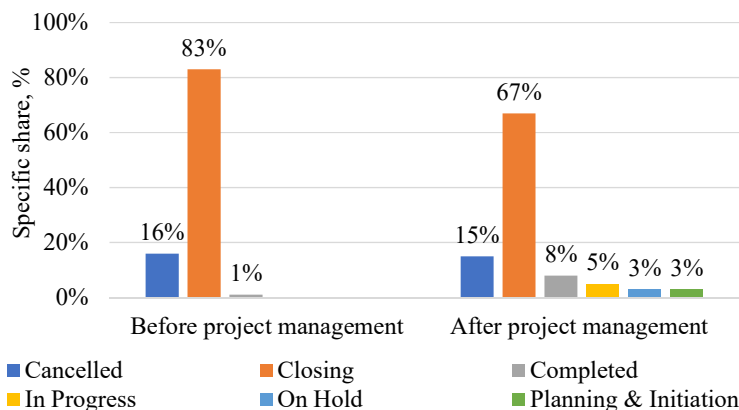


Fig. 1. Distribution of projects by status before and after project management implementation

**5.2. Results of studying the dynamics of changes in the duration of project implementation as a result of the implementation of project management**

The study showed that the average duration of projects before the implementation of project management was 269 days, and after the implementation of project management, this indicator decreased to 240 days (Fig. 2). Thus, the transition to project management led to a reduction in project completion times by an average of 11 %.

Separately, it is worth paying attention to the deadlines for projects with the status of Closing and Completed. That is, these are projects that have been officially completed with a certain assigned status, which indicates the end of the project's life cycle. Before the implementation of project management, the average duration of a project with the Completed status was 280 days, and after the implementation of project management it was already 223 days, that is, it was reduced by 20 %. Before the implementation of project management, the status of Closing projects was not defined, and after the implementation of project management, projects with this status lasted an average of 187 days.

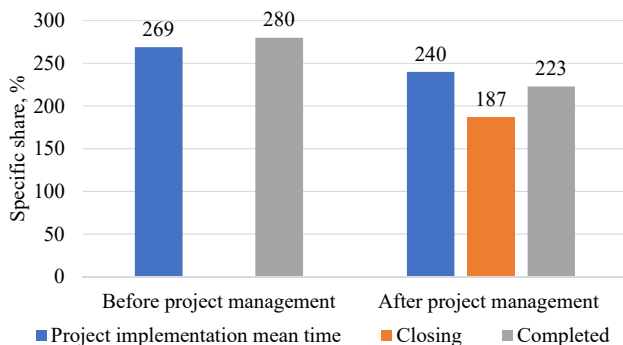


Fig. 2. Duration of projects before and after project management implementation

**5.3. Results of studying the number of projects for each priority level due to the implementation of project management**

Analysis of the number of projects by each priority level (Very High, High, Medium, Low, Very Low, Not Scored) showed that after the implementation of project management, the number of projects with the status of Very High and High decreased and the share of projects with the status of Low and Not Scored increased (Fig. 3).

The decrease in the share of projects with high priority and the increase with low and uncertain priority indicates the streamlining of the priority of projects and the reduction of the workload on engineers.

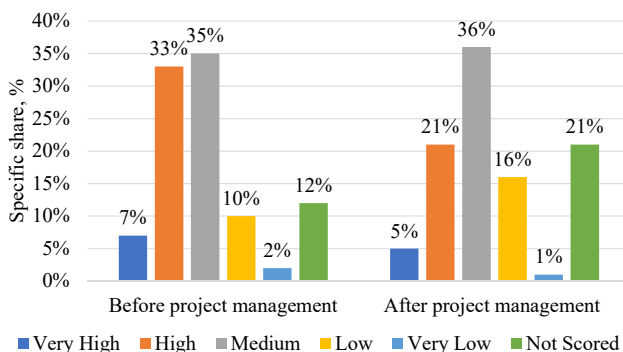


Fig. 3. Share of projects by priority level

**5.4. Results of studying the number of projects in the context of Project Health as a result of the implementation of project management**

The analysis of the status of projects according to the Project Health indicator showed that before the introduction of project management, no projects with At Risk status were identified (Fig. 4).

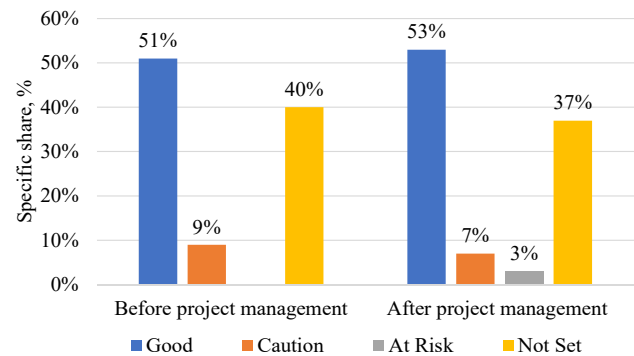


Fig. 4. Share of projects by Project Health

After the implementation of project management, the share of projects with Good status increased, the share of projects with Caution and Not Set status decreased, and projects that are in the risk zone (At Risk) began to be highlighted.

**5.5. Results of studying the impact of project management on Duration and Project Health indicators**

Analysis of the impact of the transition to project management on Duration and Project Health indicators: corresponding regressions were tested. Testing regression model 1 showed that the transition to project management did not have a statistically significant effect on the duration of project implementation (Table 1).

Table 1

Results of linear regression of Duration dependence on project management implementation Model 1. Model 1:

$$Duration = \beta_0 \text{const} + \beta_1 PM + \varepsilon_t$$

| Parameter          | Coefficient | Std. Error         | t-ratio   | p-value |
|--------------------|-------------|--------------------|-----------|---------|
| const              | 269.1753    | 29.035             | 9.271     | 0.000   |
| Project Management | -28.8950    | 36.930             | -0.782    | 0.435   |
| R-squared          | 0.002       | Adj. R-squared     | -0.002    |         |
| F-statistic        | 0.6122      | Prob (F-statistic) | 0.435     |         |
| Log-Likelihood     | -1796.0     | AIC                | 3596      |         |
|                    |             | BIC                | 3603      |         |
| Omnibus            | 118.920     | Durbin-Watson      | 1.971     |         |
| Prob (Omnibus)     | 0.000       | Jarque-Bera (JB)   | 456.184   |         |
| Skew               | 2.002       | Prob(JB)           | 8.73e-100 |         |
| Kurtosis           | 8.203       | Cond. No.          | 3.00      |         |

The obtained data on model 1 can be interpreted as follows:

– R-squared (R<sup>2</sup>): This is a coefficient of determination that measures the proportion of changes in the dependent variable (Duration) that is explained by the model. The R-squared is 0.002, which means that only 0.2 % of the variation in the dependent variable can be explained by the transition to project management;

– coefficients (coef): Each coefficient represents the change in the average value of the dependent variable, when the independent variable changes by one unit, provided that all other variables remain unchanged. The coefficient for the independent variable of the transition to project management is  $-28.8950$ , which means that the transition to project management on average reduces the duration of the project by  $28.8950$  days.

Since the p-value for the project management variable is  $0.435$ , which is greater than the significance level of  $0.05$ , this variable does not have a statistically significant effect on the duration of project implementation. This means that the implementation of project management did not affect the duration of project implementation.

In general, the obtained regression data show that the transition to project management is not statistically significant for changing the duration of project implementation.

Testing of regression model 2 showed that the transition to project management is statistically significant in assessing the Project Health indicator (Table 2).

Table 2

Results of linear regression of dependence Project Health.  
Model 2:  $Project\ Health = \beta_0 const + \beta_1 PM + \varepsilon_t$

| Parameter          | Coefficient | Std. Error         | t-ratio  | p-value |
|--------------------|-------------|--------------------|----------|---------|
| const              | 0.5876      | 0.067              | 8.803    | 0.000   |
| Project Management | 0.7563      | 0.085              | 8.907    | 0.000   |
| R-squared          | 0.239       | Adj. R-squared     | 0.236    |         |
| F-statistic        | 79.34       | Prob (F-statistic) | 1.07e-16 |         |
| Log-Likelihood     | -252.89     | AIC                | 509.8    |         |
|                    |             | BIC                | 516.9    |         |
| Omnibus            | 4.859       | Durbin-Watson      | 2.204    |         |
| Prob (Omnibus)     | 0.088       | Jarque-Bera (JB)   | 4.667    |         |
| Skew               | 0.283       | Prob (JB)          | 0.0970   |         |
| Kurtosis           | 2.652       | Cond. No.          | 3.00     |         |

The results of the regression analysis can be interpreted as follows:

– R-squared (coefficient of determination): In this case, R-squared is  $0.239$ , which means that approximately  $23.9\%$  of the variation in the dependent variable (Project Health) can be explained by the transition to project management;

– P-value ( $P > |t|$ ): For both coefficients in the model, the P-value is less than  $0.05$ , which means that both coefficients are statistically significant;

– Prob (F-statistic): Prob (F-statistic) is  $1.07e-16$ , which is a very small value. This means that the model as a whole is statistically significant, that is, the linear regression approximation to the observations is significant;

– Omnibus, Prob(Omnibus), Jarque-Bera (JB), Skewness, and Kurtosis: These values indicate the normality of the distribution of model errors. The closer the values for Omnibus, Jarque-Bera (JB), Skewness, and Kurtosis to zero, the more normal the error distribution;

– Durbin-Watson: The Durbin-Watson value is  $2.204$ . Typically, the Durbin-Watson value is in the range of  $0$  to  $4$ . A value close to  $2$  indicates no autocorrelation in the model errors;

– Conditioning (Cond. No.): Value of Cond. No. is equal to  $3.00$ . This number indicates the presence of multicollinearity between the independent variables. Typically, a value greater than  $10$  indicates a multicollinearity problem.

In this case, the value of Cond. No. less than  $10$ , which indicates the absence of serious multicollinearity.

The general interpretation of the regression analysis results is that the transition to project management has a statistically significant effect on the Project Health indicator.

## 6. Discussion of results of studying the effectiveness of project management implementation in the field of innovation engineering

The results of the study indicate that after the transition to project management, additional sections of information about projects were introduced. This can be explained by the fact that project management uses flexible management with an individual approach to each project. This is confirmed by the increase in sections of information about the status of projects (Fig. 1). A set of methods and tools of project management is applied in a unique combination to each individual project. This advantage of project management is also confirmed in study [12], which examines the process of implementing project management and highlights its advantages compared to traditional approaches to project management. It is important to take into account other factors that can affect the results, and to conduct a comparative analysis with similar companies or projects that remained on classical management models.

The decrease in the average term of project implementation shows the positive impact and the degree of successful implementation of innovative development engineering projects. This can be explained by the fact that the flexibility of project management tools allows reducing the use of employees' working time and reducing material costs for project development. This is confirmed by a decrease in the average term of project completion and a decrease in the average term of completion of projects with the Completed status (Fig. 2). The conclusions coincide with the conclusions of the study on the positive impact of project management on the number of successfully completed projects in the field of construction [13, 14].

The potential of using project management is confirmed by the fact that its use significantly expands the informativeness of the data of the management system for the effective implementation of projects. This is evidenced by the increase in project gradation cuts by priority level (Fig. 3). This is explained by a change in the approach to the management of innovation engineering, in which this process is considered as a set of separate independent projects. In support of this, it is possible to cite the results of research [15, 16], where project management is positioned as capable of ensuring the implementation of Industry 4.0 technologies. This confirms the conclusions about the positive impact of project management in the field of engineering of innovative developments. In particular, this influence is confirmed by the data on the tested model, which is shown in Table 2.

The assessment of the effectiveness of project management applications in the field of engineering of innovative developments is based on the analysis of the projects of the enterprise, which is average in size. However, the results of study [17] indicate that project management can also be effectively applied to small enterprises. This partially eliminates the limitations of the conducted research in terms of the size of the company, on the main data of which the research was based and allows extrapolation of the obtained results.

The study covered 100 % of the company’s projects, that is, the entire general population of projects was used. This ensures the reliability and validity of the obtained results compared to the use of a sample population.

It is worth noting that although the conducted research demonstrates the positive impact of using project management in the engineering of innovative developments, it has the following limitations.

**Limited sample:** the study was conducted only on Hokord Ltd., a vaping innovation company based in Hong Kong. Such a limitation may affect the generalizability of the results to other areas of innovation development and location. In particular, the obtained results may differ in the case of conducting a similar study on the example of companies that are under the influence of sanctions or that are located in jurisdictions with certain restrictions of the competitive environment.

**Time interval:** the study covers the period from 2016 to 2024 since it is from 2016 that all project management information is recorded in the company, and the study used information on 100 % of the company’s projects. Although this period allows us to evaluate the impact of the transition to project management, it is important to consider that the results may be dependent on the specific period and context.

**Limited metrics:** the study analyzes the impact of the transition to project management on metrics such as the number of projects in various statuses, the average duration of projects, the number of projects by priority level, and project health. Other important aspects of project management, such as project costs, risks, and performance, are not included in the analysis.

**Methodological limitations:** regression analysis was used for the analysis, using a dummy variable to determine the fact of project management implementation. Other methods of analysis and consideration of possible factors affecting results can provide a deeper understanding of the relationship between project management and performance.

These limitations should be taken into account when interpreting the research results and their application to real conditions and situations in the field of innovative development and project management. Additional research covering a wider range of companies and contexts could complement these findings and deepen understanding of the impact of project management on innovation development.

The further development of this study consists in determining the impact of project management on the operational efficiency of the innovation engineering company.

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## 7. Conclusions

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1. The introduction of project management contributed to the allocation of three new project statuses (In Progresse, On Hold, Planning & Initiation), which increased the informativeness of the project management system. As a result of the implementation of project management, the share of

projects with the status of Canceled decreased from 16 % to 15 %, the share of projects with the status of Closing decreased from 83 % to 67 %, and the share of projects with the status of Completed increased from 1 % to 8 %. Such results are explained by the fact that the use of project management tools made it possible to increase the level of project management organization and highlight previously unobvious states of project implementation.

2. The transition to project management led to a reduction in project completion times by an average of 11 %. Before the implementation of project management, the average duration of a project with the Completed status was 280 days, and after the implementation of project management it was already 223 days, that is, it was reduced by 20 %. This reduction in the duration of project implementation is explained by the increase in management flexibility and the optimization of the work of employees.

3. After the implementation of project management, the number of projects with the status of Very High and High decreased and the share of projects with the status of Low and Not Scored increased. The decrease in the share of high-priority projects is a consequence of the improvement in the quality of the organization of project management information support as a result of the transition to project management.

4. After the implementation of project management, the share of projects with Good status increased, the share of projects with Caution and Not Set status decreased. This is explained by the increase in the efficiency of project management information support. They also began to highlight projects that are in the risk zone (At Risk), which provides additional information about the state of project implementation.

5. The transition to project management did not affect the Duration indicator but had a statistically significant effect on the change in project status indicators according to the Project Health criterion. This is explained by the increase in the level of information support for the implementation of projects after the transition to project management.

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### Conflicts of interest

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The author declares that he has no conflicts of interest in relation to the current study, including financial, personal, authorship, or any other, that could affect the study and the results reported in this paper.

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### Data availability

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The data will be provided upon reasonable request.

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