

*The choice of project management methodology affects both the implementation of projects and their economic efficiency. Quantitative assessment of such an impact substantiates the relevance of this paper's research topic. The object of the study is the activity of companies in the field of engineering of innovative developments under the conditions of change in project management methodology. The study solved the problem of identifying the impact of research and development costs on the income of companies in the field of innovative development engineering in the context of a change in project management methodology. A change in project management methodology can significantly affect the costs, timelines, and bottom line associated with research and development, and determine their effectiveness in the context of achieving business goals. A change in project management methodology can affect the use of resources allocated for research and development, which ultimately affects the company's performance. Regression analysis was used to determine the impact of changes in project management methodology on the amount of investment in research and development. The results of the study show that the use of project management methodologies, such as Waterfall and Agile, has a positive effect on the quality of project management and financial indicators of companies. Projects implemented according to the Agile methodology are more effective, reducing the number of canceled and closed projects. Both methodologies lead to the successful completion of most projects but the percentage of successfully completed projects with the Waterfall methodology is higher than with Agile. The use of Agile makes it possible to achieve a significant reduction in the terms of project implementation and improve the efficiency of costs and resources. The results can be used by companies at the stage of choosing a project management methodology to decide on the implementation of the Waterfall or Agile methodology*

*Keywords: Waterfall, Agile, R&D, innovation engineering, management efficiency, project management, flexible management*

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# ESTIMATING THE INFLUENCE OF RESEARCH AND DEVELOPMENT EXPENDITURES ON THE INCOME OF COMPANIES REVENUE IN THE FIELD OF ENGINEERING OF INNOVATIVE DEVELOPMENTS UNDER THE CONDITIONS OF CHANGING PROJECT MANAGEMENT METHODOLOGY

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## 1. Introduction

The study of the impact of research and development costs on the income of companies in the field of innovative development engineering in the context of a change in project management methodology is an urgent and important task in the modern business environment. Increasing competition, rapid technological changes, and unpredictable economic conditions present enterprises with the challenges of effective resource management, in particular, in the field of research and development.

A change in project management methodology can significantly affect the costs and resources associated with research and development and determine their effectiveness in the context of achieving business goals. In order to remain competitive, today's companies are constantly adapting their approaches to project management to ensure optimal use of resources, maximize innovation, and ensure high levels of product quality.

In addition, under the conditions of a global competitive environment and competitive developments, where technological shifts occur rapidly, understanding the impact of costs on income becomes an integral part of the strategic planning of the enterprise. The study of this topic can contribute to the formulation of effective cost management strategies, which has a direct impact on the financial results of companies in the medium and long term.

## 2. Literature review and problem statement

Study [1] found that the business model that the company chooses for conducting business directly affects the efficiency of its use of resources. In many ways, the chosen business model would influence the choice of project management methodology in the company and the development of innovations. Adaptation of the business model for the de-

velopment of innovations is a guarantee of maintaining competitive advantages in the long term. The study completely actualizes the issue of the effectiveness of not only business models but also project management methodologies from the point of view of their impact on the company's performance indicators. But the questions of the criteria for choosing a project management methodology and assessing the consequences of such a choice remain unresolved. In the context of this, it is interesting to compare the effects of the transition from Waterfall to Agile methodology. As evidenced by the results reported in [2], the transition to Agile provided the studied companies with a faster increase in ROI (Return on Investments) compared to the use of Waterfall. The results of the study indicate the advantages of using the Agile methodology specifically in the field of innovation, research and development. Based on indicators of faster return on investment, the impact of changing the project management methodology on the impact of research and development costs on income needs to be carefully studied.

The importance of research and development management is also noted in study [3]. Based on the research results [3], it can be concluded that flexible approaches contribute to more effective development of innovations within the framework of research and development. It is especially important to evaluate not only the effectiveness of the organization of research and development work but also the effectiveness of the use of funds and the impact on certain resulting financial indicators – income, net income, profit, etc. In view of this, the results of study [4] are interesting, in which the authors examine the impact of research and development on the income of companies engaged in information technology. The authors found that when research and development spending reaches its peak, companies that spend more on research and development generate more revenue than those that spend less. In addition, investors evaluate companies differently depending on the intensity of research and development expenditures. Compared to companies that invest less of their revenue in research and development, investors pay more attention and value higher those companies that invest more of their revenue in research and development. However, the authors ignore the issue of the methodology of managing such projects. In another study [5], the results also indicate a statistically significant impact of investments on company revenues. At the same time, the aspect of the practical impact of the project management methodology on the performance of companies remains unexplored. This may be related to the complexity of choosing a research object, where a change in project management methodology was taking place.

Study [6] revealed the impact of project management on its economic efficiency. The authors established that the higher the complexity of the project, the greater the risks regarding its profitability. However, as the complexity of the project increases, so does its margin, which ultimately leads to higher profits from more complex projects. In another study [7], it is noted that the indicator of research and development costs is positively correlated with the company's financial performance (turnover, net profit, equity, and ROE). The results of the study also indicate a negative relationship between the level of research and development expenditures and operating income and financial indicators. Such results give reason to assume that the final indicators of the company's financial activity (profit or operating income) depend mainly not on research and development costs, but on other items of the company's costs for carrying out its activities.

However, the authors do not consider the impact on financial results of project management methodology itself.

The purpose of another study [8] was to show that R&D expenditures have a positive effect on market performance and company profits, and this relationship becomes stronger when prior R&D expenditures are taken into account. The impact of R&D spending on the company's market performance (market capitalization) and profit (operating income) was also revealed. Research and development expenditures are positively related to operating income and market capitalization. In addition, research and development costs from previous periods correlate more strongly with the above variables. This is logical, as the results for the company from investments in research and development are not immediately apparent, as projects take several years to complete and be ready for commercialization. But the question of the impact of project management methodology on market indicators of companies' profitability remains unresolved. Similar results are observed for companies from developing countries [9, 10]. It should be noted that the project management methodology should also be taken into account in such studies because it affects the terms of project implementation, which is related to the volume of necessary investments. The lack of such studies can be explained by the concentration of business precisely on the parametric factors of the effectiveness of investment projects and the neglect of other groups of factors, in particular, the methodology of project management. However, in these studies, project management methodology and its impact on the company's performance are also not considered.

Forbes authors have detailed the advantages and disadvantages of each methodology: Agile and Waterfall are two different management methodologies that are best suited for different types of projects. If the project deliverables are clear from the start, Waterfall may be the best fit. Waterfall is the best method when the project has to meet strict rules, because each stage requires results before moving on to the next. Agile is best for teams that plan to move quickly, experiment with direction, and don't know what the final project will look like before it starts. Agile is flexible and requires a collaborative and focused team, as well as frequent reviews of progress with business owners and stakeholders [11].

According to paper [12], the key to unlocking the true potential of projects is to apply a diverse set of tools to each initiative – an assortment of approaches, methods, and techniques that can be adapted and applied to the unique requirements of each project. Hybrid project management methodologies are a promising step in this direction, embracing the strengths of both Waterfall and Agile while compensating for their weaknesses. Owing to hybrid methods as a tool in the toolbox, we can increase the success rate of projects, provide greater value for organizations, and more effectively navigate the complexities of the project economy.

The author of [13] noted that flexible project management is an innovative approach not only for software development projects but also for projects of all kinds. By providing the flexibility to respond to changes throughout the development lifecycle, Agile enables teams to deliver higher quality products that meet customer needs. Agile empowers teams, increases accountability, and encourages innovation while fostering continuous improvement. Agile makes it possible to respond to changes.

According to the authors of work [14], before starting the case, it is necessary to find time to think about how

best to proceed. You need to clearly understand the goals of your project and identify the variables, dependences, and activities that are critical to the project. The most important metrics and success factors should be identified, and each approach reviewed for best fit. Involve your team in the decision-making process and assess their knowledge and experience with different project management approaches and structures.

However, in the reviewed studies little attention is paid specifically to the change in the project management methodology exerting the impact on research and development costs on the performance of the company, which predetermines the need for research in this area. The above review of literature indicates insufficiently developed research on the impact of project management methodology on research and development costs and company income. Therefore, there are reasons to believe that such a study is a logical continuation of research on the impact of investments in research and development on the income of companies because the methodology of project management directly affects the duration of project implementation.

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

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The purpose of this study is to identify the impact of research and development costs on the income of companies in the field of innovative development engineering in the context of a change in project management methodology. This will make it possible to determine the practical impact of project management methodologies on the financial performance of companies.

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 and the duration of the project as a result of the change in the project management methodology;
- to analyze the dynamics of the number and completion of projects for each priority level as a result of the change in project management methodology;
- to determine the impact of the transition from Waterfall to Agile methodology on the amount of investment in research and development and the amount of income;
- to test the regression of the dependence of Revenue on research and development costs using Waterfall and Agile methodologies.

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### 4. The study materials and methods

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The object of this study is the activity of companies in the field of engineering of innovative developments under the conditions of changes in project management methodology. The first hypothesis of the study was the assumption that a change in project management methodology could have a significant impact on the costs, deadlines, and final results associated with research and development, as well as determine their effectiveness in relation to the achievement of business goals. The second hypothesis was the assumption that a change in the methodology of project management could have an impact on the use of resources aimed at conducting research and development, which, ultimately, affects the main indicators of the company's activity. The key accepted assumption of the study is the assumption that

the choice of project management methodology affects the implementation of such projects, as well as their economic efficiency. An accepted simplification of the study is the limitation of the research sample to one subject, on which the calculations were performed.

The research was conducted on the basis of the company Hokord Ltd. [15], 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 has changed the waterfall project management methodology to agile in its activities. In the period from 2018 to the end of 2019, this company used the Waterfall project management methodology, and starting from 2020, the transition to the Agile methodology took place. Such a feature of the change in project management principles makes it possible to compare the effect of the change in project management methodology. Based on the data on the projects that the company carried out, the impact of the change in the project management methodology on a number of indicators was analyzed:

- 1) number of projects in each status (Cancelled, Closing, Completed, In Progress, On Hold, Planning & Initiation) according to Waterfall and Agile methodologies;
- 2) the average term of projects according to Waterfall and Agile methodologies;
- 3) number of projects for each priority level (Very High, High, Medium, Low, Very Low, Not Scored) according to Waterfall and Agile methodologies;
- 4) percentage of completion of projects according to Waterfall and Agile methodologies. To compare the percentage of project success, a *t*-test was used to compare average values;
- 5) the impact of the transition from Waterfall to Agile methodology on the amount of investment in research and development (R&D).

To determine the impact of a change in project management methodology on the amount of investment in research and development, regression analysis was used, and the change in methodology was indicated by a dummy variable:

$$\text{Model 1: } R\&D = \beta_0 \text{ const} + \beta_1 \text{ Change} + \varepsilon_t,$$

where *R&D* is the amount of research and development costs, USD;

*Change* – change of project management methodology from Waterfall to Agile;

6) impact of transition from Waterfall to Agile methodology on revenue.

To determine the impact of a change in project management methodology on revenue, regression analysis was used, and the change in methodology was indicated by a dummy variable:

$$\text{Model 2: Revenue} = \beta_0 \text{ const} + \beta_1 \text{ Change} + \varepsilon_t,$$

where *Revenue* is the volume of income, USD;

*Change* – change of project management methodology from Waterfall to Agile;

7) the impact of research and development costs on the amount of income using the Waterfall and Agile methodologies.

Regression analysis was used to determine the impact of changes in research and development investments on revenue:

$$\text{Model 3: } \text{Revenue}_{\text{waterfall}} = \beta_0 \text{ const} + \beta_1 \text{ R\&D}_{\text{waterfall}} + \varepsilon_t,$$

where  $Revenue\_waterfall$  is the volume of income according to the Waterfall methodology, USD;

$R\&D\_waterfall$  – the amount of research and development costs according to the Waterfall methodology, USD:

$$\text{Model 4: } Revenue\_agile = \beta_0 \text{ const} + \beta_1 R\&D\_agile + \epsilon_t,$$

where  $Revenue\_agile$  is the amount of revenue according to the Agile methodology, USD;

$R\&D\_agile$  – the amount of research and development costs according to the Agile methodology, USD.

Information on projects and financial indicators of the company Hokord Ltd. for the period 2018–2023 was used as the initial data for the study 157 projects are included in the sample.

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 the Waterfall methodology and includes 74 projects. The test group includes projects that were implemented using the Agile methodology and includes 83 projects.

Data processing and calculation of descriptive statistics and regression analysis were carried out in Python software (Netherlands), plots were constructed using Microsoft Excel (USA).

## 5. Results of investigating the impact of research and development costs on the income of companies

### 5.1. Studying change in the share of projects depending on the status and duration of the project as a result of the change in project management methodology

The results of the study showed that the transition from the Waterfall project management methodology to the Agile methodology gave a number of positive results in terms of project management indicators. In particular, there is a 10% reduction in the number of canceled projects and a 12% reduction in the number of closed projects. At the same time, projects with On Hold and Planning & Initiation status appeared, which indicates the development of detailing of project management information sections. The distribution of projects by each status using different management methodologies is shown in Fig. 1.

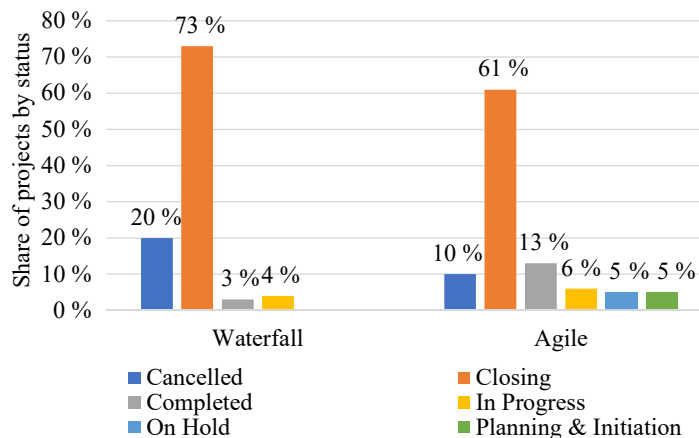


Fig. 1. Distribution of projects by status according to the Waterfall and Agile methodologies

When using the Waterfall methodology, I note a higher percentage of canceled projects (20%), compared to Agile (10%). For both methodologies, most projects are completed successfully, but for Waterfall this percentage is higher (73%) while for agile it is 61%. Waterfall has a smaller percentage of projects under development (4%) compared to Agile (6%). The percentage of On Hold projects is lower than Waterfall (3%), while it is 13% for Agile. Project statuses Closing and Planning & Initiation are present only in Agile, which indicates a more detailed project management process according to this methodology.

At the same time, the average duration of projects according to the Waterfall methodology was 269 days, and according to the Agile methodology, it was 214 days. Thus, the transition to Agile led to a reduction in project completion times by an average of 20%.

### 5.2. Studying the dynamics of the number and completion of projects for each priority level as a result of the change in project management methodology

When analyzing the number of projects by each priority level (Very High, High, Medium, Low, Very Low, Not Scored), I can say that after the transition to agile, the number of projects without a priority level has increased. This is due to the fact that projects with the status of Planning & Initiation have appeared. In addition, the number of projects with Very High and High status decreased (Fig. 2).

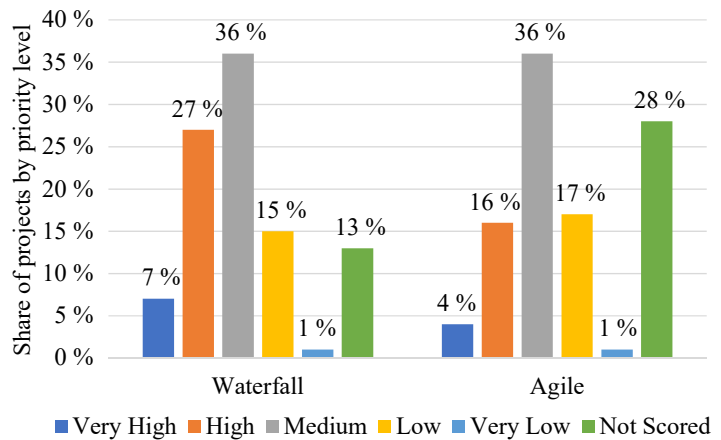


Fig. 2. Share of projects by priority level according to the Waterfall and Agile methodology

The share of medium-priority projects is the same for both methodologies (36% in Waterfall and 36% in Agile). High priority projects are 27% for Waterfall and 16% for Agile. Low-priority projects also occupy roughly the same percentage for both methodologies (15% for Waterfall and 17% for Agile). Quite a significant difference in the share of projects without a defined priority: 13% for Waterfall and 28% for Agile. Using the Waterfall methodology, there were more projects with a very high priority (7%) compared to using Agile (4%).

Analyzing the average percentage of project completion under the conditions of application of different project management methodologies, the following results were obtained. During the use of the Waterfall methodology, a higher average percentage of completion is observed (70%), compared to projects using the Agile methodology (63%). This may indicate that

projects implemented according to the waterfall methodology, on average, are completed more successfully.

Overall, based on these results, it can be argued that there is insufficient evidence at this level of significance to reject the null hypothesis that the mean project completion percentages for the different methodologies (Waterfall and Agile) do not differ at a statistically significant level. Therefore, it can be assumed that both methodologies have a similar effect on the success of completing projects within the chosen research concept.

### 5. 3. Studying the impact of transition from Waterfall to Agile methodology on the amount of investment in research and development and the amount of income

Analyzing the impact of the transition from Waterfall to Agile methodology on the amount of research and development (R&D) costs, the corresponding regression was tested (Table 1).

Table 1

Results of linear regression of R&D dependence on change in project management methodology from Waterfall to Agile  
Model 1:  $R\&D = \beta_0 \text{ const} + \beta_1 \text{ Change} + \varepsilon_t$

–	Coefficient	Std. Error	t-ratio	p-value
const	2.038e+04	1,083.725	18.809	0.000
Change	-1,266.3427	1,322.765	-0.957	0.342
R-squared	0.013	×	Adj. R-squared	-0.001
F-statistic	0.9165		Prob (F-statistic)	0.342
Log-Likelihood	-728.70		AIC	1461
×			BIC	1466
Omnibus	11.469		Durbin-Watson	1.963
Prob (Omnibus)	0.003		Jarque-Bera (JB)	4.618
Skew	0.346		Prob(JB)	0.0994
Kurtosis	1.981		Cond. No.	3.25

The obtained data of model 1 can be interpreted as follows.

$R^2$  indicates the proportion of variation in the R&D variable that can be explained by the project management methodology variable. In this case,  $R^2$  is 0.013, which means that approximately 1.3 % of the change in R&D can be explained by a change in project management methodology. A low value of  $R^2$  may indicate that the model is not very effective in explaining changes in the amount of R&D due to changes in project management methodology.

P-value ( $P > |t|$ ) for change in project management methodology: P-value for change in project management methodology is 0.342, which is greater than the standard significance level of 0.05. This may indicate that there is no statistically significant evidence of the impact of a change in project management methodology on R&D.

The coefficient const indicates the approximate average value of Revenue, in the absence of a change in project management methodology. In this case, it is approximately USD 20,380.

The Change coefficient indicates a change in R&D due to a change in project management methodology. In this case, the change in project management methodology reduced research and development costs by approximately USD 1,266 per month.

Prob (F-statistic) indicates the probability that all regression coefficients are equal to zero. A value of 0.342 may indicate that the model may not be efficient compared to the null model.

In general, the results may indicate the absence of a statistically significant impact of the change in project management methodology on R&D at this level of significance.

Analyzing the impact of the transition from Waterfall to Agile methodology on the amount of income (Revenue), the corresponding regression was tested (Table 2).

The obtained data of model 2 can be interpreted as follows.

$R^2$  indicates the proportion of variation in the Revenue variable that can be explained by the project management methodology variable. In this case,  $R^2$  is 0.053, which means that approximately 5.3 % of the change in Revenue can be explained by a change in project management methodology.

The P-value for the change in project management methodology is 0.05, which is equal to the chosen significance level of 0.05. This may indicate the statistical significance of the impact of a change in project management methodology on Revenue. However, it is important to note that the p-value is close to 0.05 and may be the limit of statistical significance.

The coefficient const indicates the approximate average value of Revenue, provided there is no change in the project management methodology. In this case, the amount of income would be approximately USD 37,900.

The Change coefficient indicates a change in Revenue as a result of a change in project management methodology. In this case, the change in project management methodology resulted in a decrease in revenue of approximately USD 6,038 per month.

Prob (F-statistic) indicates the probability that all regression coefficients are equal to zero. A value of 0.0501 may indicate that there are statistically significant differences in model performance compared to the null model.

Overall, the resulting model has some statistical significance, but given the low value of  $R^2$ , it is limited in explaining much of the variation in income change.

Table 2

Results of a linear regression of the dependence of Revenue on the change in project management methodology from Waterfall to Agile  
Model 2:  $Revenue = \beta_0 \text{ const} + \beta_1 \text{ Change} + \varepsilon_t$

–	Coefficient	Std. Error	t-ratio	p-value
const	3.79e+04	2,481.799	15.273	0.000
Change	-6,038.0126	3,029.214	-1.993	0.050
R-squared	0.053	×	Adj. R-squared	0.040
F-statistic	3.973		Prob (F-statistic)	0.0501
Log-Likelihood	-789.19		AIC	1582
×			BIC	1587
Omnibus	5.988		Durbin-Watson	2.100
Prob (Omnibus)	0.050		Jarque-Bera (JB)	5.878
Skew	0.695		Prob(JB)	0.0529
Kurtosis	2.949		Cond. No.	3.25

### 5. 4. Regression analysis of the impact of research and development costs on the volume of income using Waterfall and Agile methodologies

Analyzing the impact of research and development costs on the company’s income during the application of the Wa-

terfall project management methodology, the corresponding regression was tested (Table 3).

**Results of a linear regression of the dependence of Revenue on research and development costs during the application of the Waterfall Model 3 project management methodology:**  
 $Revenue\_waterfall = \beta_0 \text{ const} + \beta_1 R\&D\_waterfall + \epsilon_t$

–	Coefficient	Std. Error	t-ratio	p-value
const	-5,865.1260	5,743.776	-1.021	0.318
R&D	2.1472	0.274	7.841	0.000
R-squared	0.736	×	Adj. R-squared	0.724
F-statistic	61.48		Prob (F-statistic)	8.23e-08
Log-Likelihood	-244.18		AIC	492.4
×			BIC	494.7
Omnibus	6.632		Durbin-Watson	1.551
Prob (Omnibus)	0.036		Jarque-Bera (JB)	4.904
Skew	-1.083		Prob(JB)	0.0861
Kurtosis	3.464		Cond. No.	8.91e+0

The obtained data of model 3 can be interpreted as follows.

$R^2$  indicates the proportion of variation in the Revenue variable that can be explained by the R&D variable. In this case,  $R^2$  is 0.736, which means that approximately 73.6 % of the change in Revenue can be explained by the change in R&D. A high value of  $R^2$  indicates that the model is effective in explaining a large part of the variation in Revenue.

The p-value for R&D is 0.000, well below the standard significance level of 0.05. This indicates the statistical significance of the impact of R&D on Revenue.

The const coefficient indicates the approximate average value of Revenue when R&D is 0. In this case, Revenue is approximately – USD 5,865. However, in this case, the R&D ratio is more important, which indicates the change in Revenue per unit of the R&D variable. In this case, with an increase in R&D by USD 1.0, Revenue will increase by approximately USD 2.1472.

Prob (F-statistic) indicates the probability that all regression coefficients are equal to zero. A value of 8.23e-08 (close to zero) indicates that the model is statistically significant compared to the null model.

In general, the obtained model quite effectively explains the changes in Revenue based on R&D since the large value of  $R^2$  and the low value of p-value indicate a high degree of statistical significance and effectiveness of the model.

Analyzing the impact of research and development costs on the company’s revenue during the period of application of the Agile project management methodology, the corresponding regression was tested (Table 4).

The obtained data of model 4 can be interpreted as follows.

$R^2$  indicates the proportion of variation in the Revenue variable that can be explained by the R&D variable. In this case,  $R^2$  is 0.701, which means that approximately 70.1 % of the change in Revenue can be explained by the change in R&D. A high  $R^2$  indicates that the model is effective in explaining a large portion of the variation in Revenue.

The p-value for R&D is 0.000, well below the standard significance level of 0.05. This indicates the statistical significance of the impact of R&D on Revenue. If the p-value is

less than 0.05, I can reject the null hypothesis that the R&D coefficient is zero.

**Table 3**

The const coefficient indicates the approximate average value of Revenue when R&D is 0. In this case, it is approximately – USD 3,278. However, in this case, the R&D ratio is more important, which indicates the change in Revenue per unit of the R&D variable. In this case, with an increase in R&D by USD 1.0, Revenue will increase by approximately USD 1.8383.

Prob (F-statistic) indicates the probability that all regression coefficients are equal to zero. A value of 6.79e-14 (close to zero) indicates that the model is statistically significant compared to the null model.

Overall, the resulting model is very effective in explaining changes in Revenue based on R&D as the large  $R^2$  and low p-value indicate a high degree of statistical significance and effectiveness of the model. The change in Revenue correlates well with the change in R&D, and the model can be useful for forecasting Revenue based on R&D.

**Table 4**

**Results of a linear regression of the dependence of Revenue on research and development costs during the application of the Agile Model 4 project management methodology:**  
 $Revenue\_agile = \beta_0 \text{ const} + \beta_1 R\&D\_agile + \epsilon_t$

–	Coefficient	Std. Error	t-ratio	p-value
const	-3,278.1097	3,481.847	-0.941	0.351
R&D	1.8383	0.175	10.485	0.000
R-squared	0.701	×	Adj. R-squared	0.694
F-statistic	109.9		Prob (F-statistic)	6.79e-14
Log-Likelihood	-499.43		AIC	1003
×			BIC	1007
Omnibus	4.075		Durbin-Watson	2.354
Prob (Omnibus)	0.130		Jarque-Bera (JB)	1.835
Skew	0.054		Prob(JB)	0.400
Kurtosis	2.058		Cond. No.	7.34e+04

The general interpretation of the results of the regression analysis is that the transition from Waterfall to Agile had a positive effect on the quality of project management, which is manifested in a decrease in the share of canceled and closed projects, a decrease in the share of projects with a high priority level. At the same time, the change in the methodology of project management led to a decrease in the impact of investments in innovation, research, and development on the volume of income.

## 6. Discussion of results of the impact of research and development costs on the income of companies during the transformation of project management

The results of the study showed that the transition from the Waterfall project management methodology to the Agile methodology gave a number of positive results in terms of project management indicators, which are shown in Fig. 1, 2. The results differ from similar studies, which show that investments in the field of innovation, research, and development play an important role in the growth and maintenance of competitive positions of enterprises. In particular, this is

confirmed in study [16], in which models of the impact of research and development on such indicators as ROA, ROE are considered. In another study [17], ROA and NPM were the resulting indicators. However, in the study, I demonstrate the impact of research and development costs on the company's revenue under the conditions of using two different project management methodologies – Waterfall and Agile, which significantly distinguishes current research from other studies.

The results reported in [18] are interesting, in which the impact of the Agile methodology on the transformation of companies is considered. The study notes that this methodology can be used as an accelerator of business development. For this purpose, the authors built a model for the implementation of this methodology. The study was conducted on the example of companies with revenue growth of more than 100 %. The results reported by the authors of the study are comparable to the results obtained in terms of the positive impact of the Agile methodology on project management and financial performance of the company. But the study provides broader conclusions in terms of comparing the impact of different project management methodologies on company performance. In particular, it was established that Agile has better results on project management efficiency but worse results on enterprise income. It can be assumed that such influence is due to both the specifics of the projects themselves and other types of activities for which the company spends. The results obtained in this study are explained by the greater optimization of project management, the reduction of time for their implementation, and the increase in the efficiency of the use of resources.

In a number of studies [19–21], the issue of implementing project management on the activities of companies is revealed, but these studies focus on the comparison of indicators before and after the implementation of project management. The study, unlike others, examines the comparison of the impact of two project management methodologies (Waterfall and Agile) on the company's revenue. One of the key aspects of the research is the analysis of how the chosen project management methodology affects the firm's efficiency in terms of financial results. Special emphasis is placed on the comparison of traditional (Waterfall) and flexible (Agile) approaches. The results of the regression models indicate the positive impact of both methodologies on the company's revenue.

It is worth noting that although the current study demonstrates the positive impact of research and development costs on the company's income both for the use of the Waterfall methodology and for the use of Agile, it also has 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 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. In addition, research results may differ depending on the projects implemented in companies and the amount of research and development costs. This is due to the fact that for some types of projects the Waterfall approach will be better, and for others – Agile.

Time range: the study covers the period from 2018 to 2023. Although the period makes it possible to assess the

impact of different project management methodologies, they are not the same in terms of time and number of projects. Thus, the Waterfall methodology was used in the period 2018–2019 and included 74 projects, and Agile was used from 2020 to 2023 and includes 83 projects. In addition, the sample includes different projects with different amounts of research and development costs and profitability, but this limitation is objective and cannot be eliminated.

Limited metrics: the study analyzes the impact of different project management methodologies on metrics such as the number of projects in various statuses, average project completion time, number of projects by priority level, and revenue. Other important aspects, for example, project payback periods, project complexity, etc., are not included in the analysis.

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

These limitations should be taken into account when interpreting the results of the study and applying them to real conditions and situations. Additional research covering a wider range of companies and contexts can complement these findings and deepen understanding of the impact of project management on research and innovation.

The disadvantage of the study is the evaluation of the results based on only one company. Overcoming this shortcoming is possible by increasing the sample of the investigated companies.

The development of this study is possible toward increasing the number of resulting indicators, which are affected by a change in project management methodology. In this aspect, difficulties of an experimental nature may arise in order to identify real cases of such changes in firms in accordance with the research hypothesis.

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## 7. Conclusions

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1. The use of Waterfall and Agile project management methodologies demonstrate a positive impact on the quality of project management and the company's income. However, the degree of this influence is different. Projects implemented according to the Agile methodology demonstrate better indicators of management efficiency, which is reflected in a 10 % reduction in the number of canceled projects and a 12 % reduction in the number of closed projects. With both methodologies, most projects are completed successfully but Waterfall has a higher percentage (73 %) while Agile has 61 %. According to the Agile methodology, the project implementation period is on average 20 % shorter compared to Waterfall.

2. The share of projects with medium priority is the same for both methodologies (36 % in Waterfall and 36 % in Agile). High priority projects are 27 % for Waterfall and 16 % for Agile. Low-priority projects also occupy roughly the same percentage for both methodologies (15 % for Waterfall and 17 % for Agile). Quite a significant difference in the share of projects without a defined priority: 13 % for Waterfall and 28 % for Agile. Using the Waterfall methodology, there were more projects with a very high priority (7 %) compared to using Agile (4 %).

3. The study showed the absence of a statistically significant impact of the change in the project management methodology on research investments and the company's income.

4. During the period of using the Waterfall methodology, an increase in research and development costs by USD 1 led to an increase in income by USD 2.1472, and for the use of the Agile methodology, an increase in research and development costs by USD 1 led to an increase in income by USD 1.8383. This is explained by the reduction of time for the implementation of projects and the increase in the efficiency of the use of resources. However, such a reduction in the impact of research and development costs can be caused not only by a change in project management methodology, but also by other factors – the complexity of projects, their profitability, etc.

It is important to consider that both methodologies lead to the successful completion of most projects but the percentage of successfully completed projects using the Waterfall methodology is higher than Agile. Analysis of research and development costs in the context of both methodologies indicates that a change in methodology can affect the relationship between costs and revenue. The use of Agile makes it possible to achieve a significant reduction in the terms of project implementation and improvement of cost efficiency. In general, the choice of project management methodology should be considered

as a strategic decision that can affect not only the management process itself but also the company's financial results.

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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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#### Funding

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The study was conducted without financial support.

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#### Data availability

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The data will be provided upon reasonable request.

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#### Use of artificial intelligence

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The author confirms that he did not use artificial intelligence technologies when creating the current work.

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