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Graduate School of Management

Master in Corporate Finance

REAL OPTIONS ANALYSIS AS A METHOD OF IT PROJECTS VALUATION. CASE OF THE RUSSIAN OIL COMPANY

Master's Thesis by the 2nd year student

Maria V. Sedova

Research advisor

Head of Department, Department of Finance and Accounting. Professor Aleksandr V. Bukhvalov

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ЗАЯВЛЕНИЕ О САМОСТОЯТЕЛЬНОМ ХАРАКТЕРЕ ВЫПУСКНОЙ КВАЛИФИКАЦИОННОЙ РАБОТЫ

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АННОТАЦИЯ

Автор	Седова Мария Валериевна
Название магистерской диссертации	«Анализ реальных опционов как метод оценивания ИТ проектов. Кейс российской нефтяной компании»
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Научный руководитель	Бухвалов Александр Васильевич
Описание цели, задач и основных результатов	Цель: предложить компании Газпром нефть альтернативный способ оценки инвестиционных IT-проектов. Задачи: анализ текущего метода оценки IT-проектов в компании Газпром нефть; оценка IT-проектов компании Газпром нефть при помощи метода реальных опционов. Основные результаты: модель оценки IT-проектов методом реальных опционов, апробированная на реальных данных компании.
Ключевые слова	Реальные опционы, нефтяная отрасль, Газпром нефть, IT, проекты.

ABSTRACT

Master Student's Name	Maria V. Sedova
Master Thesis Title	Real options analysis as a method of it projects valuation. Case of the Russian oil company
Educational Program	Master in Corporate Finance (MCF)
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Academic Advisor’s Name	Aleksandr V. Bukhvalov
Description of the goal, tasks and main results	Goal: to offer Gazprom Neft an alternative way of IT projects valuation. Tasks: analysis of the current method of Gazprom Neft IT projects valuation; evaluation of IT projects of Gazprom Neft using the method of real options. Main results: a model for evaluating IT projects using the real options method tested on real company data.
Keywords	Real options, oil industry, Gazprom Neft, IT, projects.

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INTRODUCTION

Today, there is a variety of methods that companies use for the valuation of investment projects in order to make profitable decisions. Such methods can be grouped into three types: static, dynamic and alternative ones (see Figure 1 below).

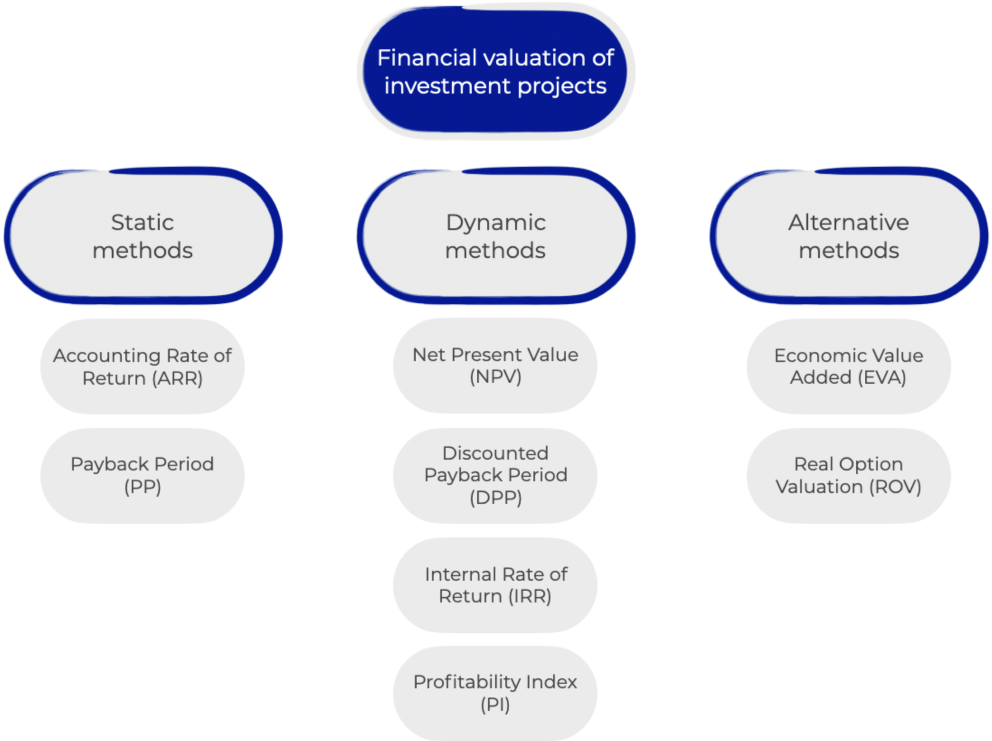

Figure 1. *Methods of investment projects financial valuation*

Source: compiled by the author

Static approaches include calculation of Accounting Rate of Return (ARR), Payback Period (PP). The dynamic methods are analysing the project's Net Present Value (NPV), Discounted Payback Period (DPP), Internal Rate of Return (IRR), Profitability Index (PI). Together with static methods, dynamic ones are considered to be traditional and most used ones, but for some projects (e.g. with the high level of uncertainty) they can be not enough. Also, there are alternative ways of investment project valuation (e.g. estimation of Economic Value Added (EVA), Real Option Valuation (ROV)), which are far more complex but help to take into account more factors influencing investment decisions.

The aim of this master thesis is to propose and to test the alternative method of investment project valuation for one of the Russian largest oil companies, Gazprom Neft. Also, this research is aimed at valuation of not all company investment initiatives, but only of IT projects of Gazprom Neft Upstream (Exploration and Production Block, BRD in Russian).

Investment project is "a set of investment modules, united by organizational, territorial, functional or other principle in order to effectively implement investments"[1]. And IT project is defined by the company as "a set of project stages, as a rule, defined as costs, aimed at the development and implementation of information systems and means of automation of activities and telecommunications in the divisions of the company (at mining and production facilities, as well as in administrative centers)". So, **the object of this master thesis** is the IT project of the Gazprom Neft Upstream, which is currently needed to be evaluated for the investment attractiveness in order to be continued or to be terminated. **And the tasks are** to conduct the "as is" analysis of the IT projects valuation process in Gazprom Neft; to find the gap in the "as is" process; to elaborate the model.

And when it comes to the valuation of IT projects, traditional approaches (static and dynamic, *see the Figure 1 above*) might not work. The reason is that they either ignore or cannot properly capture the need of management to be flexible and to adapt/revise the decision based on uncertainties following every IT project. IT projects are lying very closely to R&D ones, as both of groups are characterized by the high rate of volatility, innovativeness and uncertainty. Currently, Gazprom Neft Upstream uses DCF method to evaluate its projects. The managers responsible for making the investment decision miss the opportunity to evaluate the project from probabilistic point of view, which often leads to "false negative" or "false positive" result: many projects happen to be less or more promising that they really are. It leads to the wrong investment decision making and, as a consequence, the company is missing out on potential benefits. Among alternative methods of investment valuation, EVA is not the best tool to use in this case, as IT projects of the company are usually evaluated through implementation costs. So, ROV is the instrument of analysis that could bring the company closer to making more accurate investment decisions in case of highly volatile IT projects.

So, this master thesis observes and analyzes the opportunity of valuation of Upstream IT projects portfolio of one of the biggest Russian oil company "Gazprom Neft" based on the method of Real Option Valuation. The paper proposes the model based on the ROV (using Black-Scholes model as a basis). The format of the thesis is the applied project, so the results of the work might be used by the company's managers in order to assess the investment IT projects with the higher prediction chances. All the data used in the work is provided by the company or taken from the public sources.

[1] Source: provided by the company

CHAPTER 1. BACKGROUNG AND RELEVANCE OF THE RESEARCH

1.1. About the company

PJSC Gazprom Neft, a subsidiary of Gazprom, is a vertically integrated oil company engaged in the exploration and production of oil and gas, refining, production and sale of petroleum products. The company also produces fuel cards and motor fuels, jet fuels, bunkering, lubricants and other petroleum products. Its services include the exploration and production of oil and gas, oil and gas refining, the marketing of crude oil and oil products for export, and the retail sale of oil products. The company is ranked among the leaders in the Russian oil industry in terms of efficiency. The largest shareholder of Gazprom Neft is PJSC Gazprom (95.68%)[2]. The rest of the shares are in free float.

With headquarter in Russia, St. Petersburg, **the company operates in 15 countries all over the world**. The structure of Gazprom Neft includes more than 70 oil producing, refining and distribution subsidiaries in Russia, CIS and non-CIS countries. The main operation regions of Gazprom Neft are represented in the Figure 2 below.

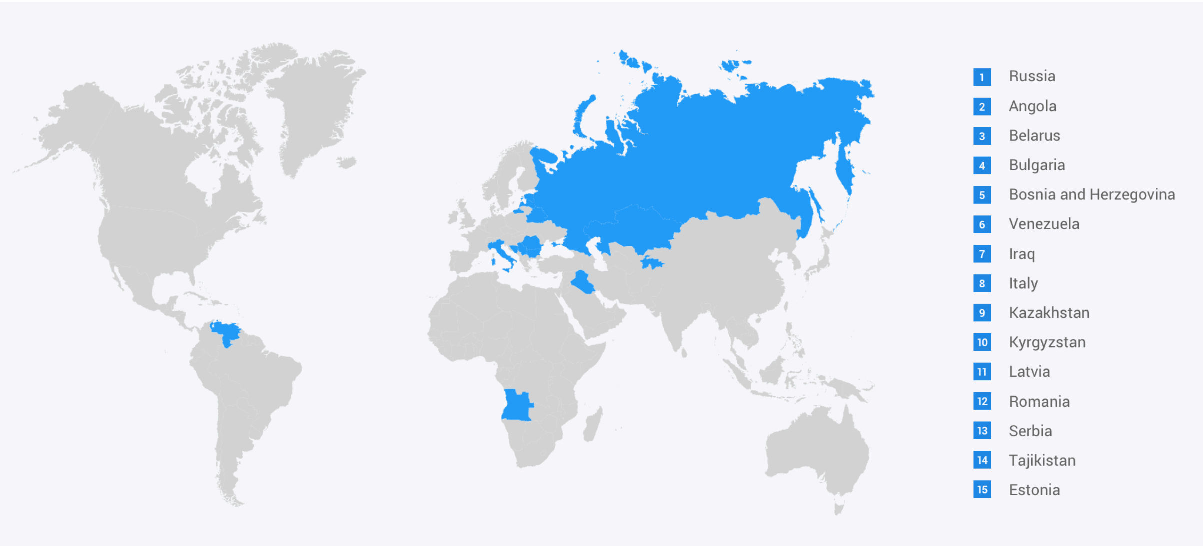

Figure 2. *The geography of the company activities*

Source: Gazprom-neft official website

[2] "Gazprom Neft at a glance". Gazprom Neft official website (2021), https://www.gazprom-neft.ru/company/about/at-a-glance/

The company demonstrates one of the best mining and processing ratio in the Russian industry. In terms of hydrocarbon production, Gazprom Neft is one of the three largest companies in Russia.

Gazprom Neft seeks to implement advanced oil exploration, production and refining techniques in its work. Thanks to this, the company sets the momentum for the technological development of the entire Russian oil industry.Gazprom Neft operates in the largest Russian oil and gas regions: Khanty-Mansiysk and Yamalo-Nenets Autonomous Districts, Tomsk, Omsk, and Orenburg Regions. The main processing facilities of the company are located in Omsk, Moscow and Yaroslavl, as well as in the Serbian city of Pancevo. In addition, Gazprom Neft implements production projects outside of Russia, e.g. in Iraq, Venezuela and other countries. Also, the company implements a large-scale program of technological and environmental modernization of its refineries, aimed at improving the efficiency and safety of oil refining.

The company manages its business activities through two operation segments: upstream[3] and downstream[4].

The downstream (Refining and Marketing) segment processes crude oil into refined products and buys, sells and transports crude oil and refined products. The company's refinery includes the Omsk Refinery, the Moscow Refinery and the NIS Refinery. The NIS refinery complex in Serbia consists of two refineries in Pancevo and Novi Sad. During the 2019 financial year, the installed capacity of the Omsk Refinery amounted to 22.23 million tons of oil per year, the installed capacity of the Moscow Refinery reached 12.76 million tons of oil per year, and the installed capacity of Pancevo 4.6 million tons. During the 2019 financial year, the segment produced 40.23 million tons of petroleum products. The marketing and distribution business includes the sale of petroleum products and export. In terms of marketing, in 2019, the company operated about 1,500 filling stations throughout Russia, 200 in the CIS and 400 in Europe. In the 2019 financial year, the revenue of the Downstream segment amounted to RUB 2,336,425 million, which was 94% of the company's total revenue.[5]

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[3] "Guide to investing in oil markets. Upstream", Investopedia.com website (April 2021), https://www.investopedia.com/terms/u/upstream.asp

[4] "Guide to investing in oil markets. Downstream", Investopedia.com website (April 2021), https://www.investopedia.com/terms/d/downstream.asp

[5] Source: GlobalData Report (March 2021)

The upstream (exploration and production) segment includes the following operations of the company:

- exploration,
- development and production of crude oil and natural gas (including results of joint ventures),
- oilfield services.

The company has production rights in eight oil-producing regions of Russia. Internationally, the company is involved in exploration and production projects in Angola, Bosnia and Herzegovina, Hungary, Iraq, Romania, Serbia and Venezuela. In fiscal 2019, the revenue of the Exploration and Production segment was RUB 148,883 million, which was 6% of the company's total revenue.[6]

The scope of this master thesis includes only the projects of Gazprom Neft Upstream, so the next analysis is conducted according to this limitation.

In 2019, Gazprom Neft ensured stable financial results despite negative price dynamics and market trends. The company's net profit in 2019 exceeded 400 billion rubles for the first time[7]. The company relies on technological development, implements advanced solutions to achieve strategic goals.

1.2. SWOT analysis of the company

As far as the thesis is concentrated on the Upstream projects of the company, the SWOT analysis of Gazprom Neft Upstream is represented in the Table 1 below.

Table 1. *SWOT analysis for GPN Upstream*

Strengths 1. Leadership in the market 2. Vertically integrated operations 3. State protection	***Weaknesses*** 1. Geographically concentrated operations 2. Poor acceptance of changes within the company 3. Not optimized costs
Opportunities 1. Strategic agreements 2. Global NG consumption	***Threads*** 1. Intense competition 2. Environmental risks

Source: compiled by the author with the use of external sources

[6] Source: GlobalData Report (March 2021)

[7] "Gazprom Neft at a glance", Gazprom Neft official website (2021), https://www.gazprom-neft.ru/company/about/at-a-glance/

Strengths.

1. *Leadership in the market.*

   Gazprom Neft is competitive in both the Russian and international markets and is considered to be one of the fastest growing oil companies all over the world. At the end of 2019, the company was the third largest oil company in Russia in terms of refining and the fourth in terms of production. According to SPE standards (PRMS), the company's proven hydrocarbon reserves amount to 1.583 million tones of oil equivalent (toe), which makes Gazprom Neft one of the largest oil companies in the world. A company's strong market position gives it a competitive edge. Gazprom Neft (Gazprom is primary beneficiary of Gazprom Neft), is competitive in both the Russian and international markets and is one of the fastest growing oil companies in Russia. At the end of 2019, the company is the third largest oil company in Russia in terms of refining and fourth in terms of production. According to SPE standards (PRMS), the company's proven hydrocarbon reserves amount to 1.583 million tonnes of oil equivalent (toe), which makes Gazprom Neft one of the largest oil companies in the world. A company's strong market position provides it with a strong competitive advantage.

2. *Vertically integrated operations.*

   Gazprom Neft is one of the world's leading vertically integrated oil and gas companies. It operates in a wide variety of businesses across the energy value chain. The main activities of the company include the exploration, development, production and sale of crude oil and gas, as well as refining and marketing of petroleum products. The Upstream division of the company is engaged in the exploration, development and production of crude oil and natural gas. The company's vertically integrated business provides it with opportunities to optimize its business while minimizing business risks.

3. *State protection.*

   The government, as a major shareholder, has a huge impact on the company's internationalization strategy. On the one hand, this can be a negative factor because politics can influence lucrative deals, as happened with sanctions and offshore projects, but on the other hand, the protection of the state guarantees the access to the fields unavailable to other players or the unique market terms (e.g., tax regime).

Weaknesses.

1. *Geographically concentrated operations.*

Gazprom Neft operates primarily in the oil and gas regions of Russia. The company's dependence on the Russian region to meet most production requirements and other operations increases the business risk for the company, as disruptions to the company's operations in the region could have serious consequences for the company's overall financial performance.

2. *Poor acceptance of changes within the company.*

   When it comes to changes, there can be difficulties within the company personnel. There is a high level of resistance among people inside the company: most of them would not like any of changes to be implemented as fast as they are usually needed. It is a common thing for the business in the production sector: any technological or organizational change that should be implemented faces difficulties, as people would like to leave the processes as they are. Employees and heads of departments related to financial functions (taxes, accounting, lawyers, investment activities, etc.) are especially resistant to changes.

3. *Not optimized costs.*

   The process of project budgeting in the Upstream often does not encourage the efficiency increase, but only aimed at the very process of budget allocation. Quite often, employees do not try to optimize the amount of funding for projects. So, for example, the assessment of investment projects in a general manner is carried out by the DCF method, without taking into account the uncertainties that arise during the progressive project development. Since probabilities (scenarios) are not taken into account, sometimes funding between projects is distributed in a non-optimal way. Managers responsible for project evaluation and budget allocation act according to the methodologies approved by the Company. Since the Upstream budget is quite extensive and there are many projects, possible optimization has not been the main focus of the managers. But at the moment, in conditions of particular instability of the economy and the oil business, managers have begun to pay more attention to this problem.

Opportunities.

1. *Strategic agreements*[8].

In last few years, the company has signed a number of agreements to support its growth. For example, in August 2020, Gazprom Neft entered into the agreement with Zarubezhneft to establish a joint venture to extract hard-to-recover oil reserves in the Russian region. This joint venture will serve as a testing and development platform for hard-to-recover oil recovery technologies. In June 2020, the company entered into an agreement with Lukoil and Tatneft and announced the creation of a joint venture for the production of hard-to-recover hydrocarbons in the Orenburg region, Russia. In January 2020, the company and Shell agreed to expand the Salym Petroleum Development JV. Gazprom Neft's asset portfolio will include a license for geological exploration, production and exploration of contingent hydrocarbon reserves at the Salymsky-2 block in the Khanty-Mansiysk Autonomous Okrug.

The solution of urgent production problems in the changed external conditions, the search for answers to the global challenges associated with the need to enter remote regions of production, involve in the development of hard-to-recover hydrocarbon reserves, increase the efficiency of oil refining requires the formation of an industry innovation environment. The creation of strategic partnerships is one of the most important areas of technological development for Gazprom Neft. Together with Yokogawa Electric Corporation[9], Gazprom Neft is creating an international innovation center in the field of oil refinery automation in St. Petersburg. Specialists of Russian and Japanese companies will work on the creation and implementation of new generation information systems that solve the problems of optimization planning, modeling technological processes, continuous quality control and quantity of products along the entire value chain, and managing oil refining assets. New solutions will be based on innovative technologies such as predictive control, mathematical modeling of production, artificial intelligence, big data, and the industrial Internet of things.

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[8] Source: MarketLine Report (March 2021)

[9] "Gazprom Neft and Yokogawa join forces to create a refinery control center", Gazprom Neft official website (2019), https://www.gazprom-neft.ru/press-center/news/gazprom-neft-i-yokogawa-obedinyayut-usiliya-dlya-sozdaniya-tsentra-upravleniya-neftepererabotkoy/

2. *Global NG consumption.*

   The growing demand for natural gas globally could provide the company growth opportunities. According to the World Oil Outlook 2019 (WOO 2019)[10], the global demand for natural gas is expected to increase to almost 90.3 million barrels of oil equivalent per day (MMboe/d) in 2040. Such growth, at an average of 1.5% per annum, accounts for the largest increase among all energy sources. Non-OECD regions are expected to account for the major share of the demand for natural gas in 2040, which would stand at about 58.2 MMboe/d. In the OECD region, led by the US and Europe, the demand is expected to be around 32.1 MMboe/d.

Threads.

1. *Intense competition.*

   There is intense competition in the Russian oil and gas industry between the leading Russian oil and gas companies in the main areas of production and economic activities, including the acquisition of licenses for the right to use subsoil resources to produce hydrocarbons at auctions organized by the government authorities. The competition is also there in the acquisition of other companies that own licenses for the right to use subsoil resources to produce hydrocarbons or that own existing assets associated with production raw hydrocarbons. The company also face competition in implementation of foreign projects, hiring of leading independent service companies, acquisition of high-tech equipment and the hiring of experienced and the most qualified specialists. Gazprom Neft face competition in access to critical transportation infrastructure, in the acquisition of existing retail sales network enterprises and land plots for the construction of new ones and in the expansion of sales markets and sales volumes. Intense competition would dilute the market share of the business.

2. *Environmental risks.*

   The production activities of Gazprom Neft are fraught with the potential risk of environmental damage or pollution, which may result in civil liability and the need for work to eliminate such damage. The company is fully aware of its social responsibility to create safe working conditions and maintain a favorable environment, continuously monitors its activities to ensure compliance with the

[10] "OPEC's World Oil Outlook 2019 launched in Vienna", Organization of the Petroleum Exporting Companies official website (2019), https://www.opec.org/opec_web/en/press_room/5731.htm

relevant environmental standards and is implementing an environmental protection program. In the future, costs associated with observing environmental requirements or obligations may increase. The environmental protection policy of Gazprom Neft aims to ensure compliance with the requirements of current environmental legislation by investing substantial funds in environmental measures, including the use of technologies that ensure minimal negative impact on the environment.

Overall, the competition is very intense, and the technology is the key factor that the company uses to obtain the competitive advantage in the market: both Russian and international. It leads to the increasing number of IT projects in the investment portfolio of Gazprom Neft Upstream and, therefore, the company needs to make more thorough financial decisions.

1.3. IT project as a kind of investment projects in Gazprom Neft. Evaluation "as is".

To give the full understanding of what IT project is and why its evaluation might be conducted in the alternative way, this section of the chapter provides you with:

- The definition of "Investment Project" and "IT project" settled in the company;
- The phases of IT project before its final implementation (simply, the description of the business process of project implementation)[11];
- The description of the "Evaluation" phases including drawbacks of the current valuation method[12].

So, investment project is "a set of investment modules, united by organizational, territorial, functional or other principle in order to effectively implement investments"[13]. And IT project is defined by the company as "a set of project stages, as a rule, defined as costs, aimed at the development and implementation of information systems and means of automation of activities and telecommunications in the divisions of the company (at mining and production facilities, as well as in administrative centers)". In other words, IT project is any technological project that a company is going to implement into its activity in order to cut the costs in the business processes of the Upstream and Downstream. As far as the thesis aims to evaluate only IT projects of Gazprom Neft Upstream, there are two main types of IT projects for this division:

[11] Source: interviews conducted by the author with the company managers

[12] Source: interviews conducted by the author with the company managers

[13] Source: provided by the company

- Development and implementation of information systems;
- Automation of drilling and production facilities.

This master thesis evaluates only projects of the second type (automation of drilling and production facilities).

Every IT projects of the company goes through next phases in order to be successfully launched:

1. *Primary evaluation of the investment project.*

The step-by-step process of primary valuation of IT projects is described in the Table 2 below. The important thing to mention on this phase is that step 4 “Calculating business effects” is the input for the investment evaluation of IT project on the Phase 3 “Implementation plan approval”.

Table 2. *Primary evaluation of the project*

#	Name of the step	Step description	Result
1	Receiving a request for a business process change from business representatives in the company	The business representative (head of direction / department responsible for the implementation of a specific business process of the company) claims the need for change in their core business process. Usually, business representatives come directly to the specialists from IT function.	A well-defined business problem in the company's processes. Possible wishes for its resolution. The list of primary business requirements.
2	Examination of the company's business process	The list of primary business requirements is received by the business analyst. By interviewing main business and technical participants of the certain business process, the analyst is either proves or denies the need for change. In case if changes are needed, the analyst identifies the zones for improvement and filles the gaps in the list of primary business requirements.	The final version of the list of business requirements.
3	Proposing a solution (IT solution)	The expert group is formed on this stage. This expert group proposes “the view” of possible solution of business process optimization based on the list of the business requirements.	The “view” of the IT solution.

4	Calculating business effects	Based on the list of business requirements and the "view" of IT solution, the business analyst proposes and calculates business effects of the IT projects.	The list of metrics (both in natural and financial units), which IT project implementation improves.

Source: compiled by the author

2. *Selection of the implementation method and performer.*

The step-by-step process of is described in the Table 3 below.

Table 3. *Selection of method and performer*

#	Name of the step	Step description	Result
1	Elaboration of functional and technical requirements to the solution	Based on the business requirements and the "view" of the IT solution formed in Phase 1, the project team, together with experts in the subject area, works out the functional requirements for this IT solution. The document details the functionality that developers must build to enable users/performers to complete their tasks within the business requirements.	The list of functional and technical requirements to the solution.
2	Defining performer for implementing business and technical requirements	According to the previously developed documentation, a longlist of potential performers is compiled. Then there is a selection to the shortlist and a contractor is pre-selected for development and subsequent work.	A performer for the development and implementation of an IT project is selected and pre-approved.
3	Preparing a project implementation plan	At this stage, all technical documentation is revised for the last time (with the participation of a pre-selected performer). Together, all team members draw up a concept for an IT solution and a strategy for implementing an IT project. On the base of these documents, which are compiled taking into account the metrics laid down in Phase 1, investment attractiveness of the project is calculated.	Approved functional and technical requirements, the concept of the IT solution, the implementation strategy.

Source: compiled by the author

3. Implementation plan approval.

This phase of the project launch consists primarily of the investment valuation of the project. Both types of IT projects in Gazprom Neft Upstream are evaluated now with the model of Discounted Cash Flow (DCF). Also, the important thing to mention is that all investment projects (no matter the type – IT/infrastructure/exploration/logistic/etc.) of the company are evaluated based on DCF, which does not take into account specifics of different investment project types and the

The step-by-step process of is described in the Table 4 below.

Table 4. *Implementation plan approval*

#	Name of the step	Step description	Result
1	Valuation of the project investment attractiveness	An economic model of the project is built for 10 years. The first 5 years - MVP for one field, the second five years - scaling to the rest. A list of project costs is compiled (each of the cost categories corresponds to a specific business effect identified in Phase 1), then free cash flow is built, which is then discounted at the rate approved by the company (the rate is the same for all types of company projects). Thus, the assessment of an IT project is carried out at the costs incurred by the company's divisions: if the project can save the costs of a specific business process of the company (drilling, pumping, etc.) during MVP and 5 years after (positive NPV in the horizon of 10 years), it is scaled to the rest of the fields chosen for the project implementation.	Financial model of the project. The decision about the MVP launch.

Source: compiled by the author

The use of the traditional DCF method leads to the fact that during the implementation of the project it is difficult for management to abandon the planned actions and see new opportunities that will save the company's costs. The advantage of using an alternative method, option models, while evaluating IT projects is that the cost of the estimated projects is often a variable that depends on a number of conditions external to their production and financial characteristics. It is these variables that are advisable to evaluate using the technique of real options.

4. *Development of MVP (minimal version of the product).*

Table 5. *MVP development*

#	Name of the step	Step description	Result
1	Preparing of terms of reference	Terms of Reference - an initial document for the design of a technical object. The TK establishes the main purpose of the developed object, its technical characteristics, quality indicators and technical and economic requirements, instructions for completing the necessary stages of creating documentation and its composition, as well as special requirements. In the company, according to this document, the MVP is being developed.	The terms of reference for the MVP development. Start of the development (start of the project implementation).

Source: compiled by the author

5. *Piloting of MVP.*

Table 6. *MVP piloting*

#	Name of the step	Step description	Result
1	Launching the minimal version of a product	The project begins to be piloted on the volume of one of the fields/subsidiaries in accordance with the drawn up technical task. All stages of the pilot operation of the project are recorded, a register of comments to the project is drawn up, in parallel, the product is being finalized according to these comments.	The register of comments after MVP pilot. The improved solution.

Source: compiled by the author

6. *Evaluation of MVP results.*

Table 7. *MVP results*

#	Name of the step	Step description	Result
1	Valuation of the MVP results	In Phase 3, a financial model of the project was built based on planned costs and planned savings for the company. At this stage, the plan is replaced by the fact. the expectations are compared with the actual results, and based on whether the NPV is positive, a decision is made to expand the project (scale it up) or remain the same.	Financial model of the project. The decision about scaling the project.

Source: compiled by the author

7. *Implementation of FP (full product).*

Table 8. *Full product implementation*

#	Name of the step	Step description	Result
1	Scaling the MVP	If at the previous Phase a decision is made to continue the project, the IT solution is implemented on the rest of the initially selected fields. The project ends.	The project has been implemented throughout the initially defined organizational scope.

Source: compiled by the author

Thus, each IT project is evaluated twice: before the launch of the minimum product and after. As a method of assessment, the company uses cost based NPV (DCF method). The managers responsible for making the investment decision miss the opportunity to evaluate the project from probabilistic point of view, which often leads to "false negative" or "false positive" result: many projects happen to be less or more promising that they really are. It leads to the wrong investment decision making and, as a consequence, the company is missing out on potential benefits. **And as far as if the project can save the costs of a specific business process of the company (drilling, pumping, etc.) during MVP and 5 years after (positive NPV in the horizon of 10 years), it is scaled to the rest of the fields chosen for the project implementation, the European call option (to expand) appears to be here.** Currently, the company evaluates it with the help of DCF, while there is an opportunity to evaluate it by the method, which was basically created for this, with the ROV. The ROV method in comparison with the traditional DCF method has the following advantages:

- the use of such a tool as real options by the company management allows them to pay less attention to creating "ideal" forecasts and direct more efforts to identification of alternative ways of company development. The use of the traditional DCF method leads to the fact that it is difficult for the management during the implementation of the project to abandon the planned actions and see new opportunities;
- in contrast to the DCF method, which takes into account only the inflow and outflow of funds, the RO method allows to take into account a larger number of factors. These include the period during which the investment opportunity remains, the uncertainty of future inflows, the value lost during the life of the investment opportunity, etc.

- unlike traditional methods of business valuation, the RO method allows to take into account high market volatility to a greater extent as a positive factor.

So, this master thesis offers the alternative way of valuation of IT projects in Gazprom Neft, by the ROV. As the method, the Black–Scholes model has been chosen.

CHAPTER 2. LITERATURE REVIEW

2.1. Real options concept

The term "real options," coined by Myers (1977), corresponds to the application of financial options theory to investment decisions made by firms. A financial option is the right, but not the obligation, to buy (or sell) a stock (the "underlying asset") at a fixed price (the "exercise price") within or at the end of a fixed period ("maturity")[14]. And a real option itself, is the right, but also not the obligation, to undertake certain business initiatives, such as deferring, abandoning, expanding, staging, or contracting a capital investment project[15].

In their article "Real Options and Strategic Investment Decisions: Can They Be of Use to Scholars?", Charlotte Krychowski and Bertrand V. Que´lin also state that options provide the right but not the obligation to invest in a project. Authors claim that options' value, therefore, is driven by the possibility of achieving a large upside gain combined with the fact that companies can usually abandon their projects before their investment in them has cost too much, thus limiting the downside. The value of an option must therefore increase as the uncertainty (and therefore the potential upside) surrounding the underlying asset increases, whether that asset is financial or "real".[16] Real options analysis (ROA) has been of growing interest to the academic community as a promising approach to supporting investment decisions under uncertainty.[17]

Real options usually differ from regular financial options in that they are not usually traded like securities and usually do not involve making decisions on the underlying asset that is being traded like a financial security. Another difference is that option holders, that is, management, can directly influence the value of the underlying option project; whereas this is not a consideration for the underlying security of a financial option. Moreover, management

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[14] Charlotte Krychowski and Bertrand V. Quélin, "Real Options and Strategic Investment Decisions: Can They Be of Use to Scholars?", Academy of Management Journal (November 2017), https://journals.aom.org/doi/10.5465/amp.24.2.65

[15] Giorgio Locatelli, Mauro Mancini and Giovanni Lotti, "A simple-to-implement real options method for the energy sector", Shared open access repository from the Universities of Leeds, Sheffield and York "White Rose" (April 2020), https://eprints.whiterose.ac.uk/157998/

[16] Alexander B. van Putten and Ian MacMillan, "Making Real Options Really Work", Harvard Business Review Journal (December 2004), https://hbr.org/2004/12/making-real-options-really-work

[17] Charlotte Krychowski and Bertrand V. Quélin, "Real Options and Strategic Investment Decisions: Can They Be of Use to Scholars?", Academy of Management Journal (November 2017), https://journals.aom.org/doi/10.5465/amp.24.2.65

cannot measure uncertainty in terms of volatility and must instead rely on its perception of uncertainty. Unlike financial options, leadership must also create or discover real options, and this creation and discovery process involves an entrepreneurial or business challenge. Real options are most valuable when uncertainty is high; management has considerable flexibility to change the course of the project in a favorable direction and is willing to seize opportunities[18]. So, the real options approach (ROA or ROV) is an extension of financial options theory to options on real/non-financial assets[19]. Options are contingent decisions that provide the opportunity to make a decision after uncertainty unfolds. Uncertainty and the agent's ability to respond to it (flexibility) are the source of the option value. Most investments are subject to options valuation.

Real options analysis, as a discipline, extends from its application in corporate finance to decision-making under uncertainty in general, adapting the methods developed for financial options to "real" decisions. For example, R & D managers can use the valuation of real options to help them deal with various uncertainties when making decisions about the allocation of resources between R & D projects. ROV forces decision makers to clearly articulate the assumptions underlying their protection, and for this reason it is increasingly used as a tool in business strategy development[20]. This extension of real options to real projects often requires individual decision support systems, as otherwise complex complex real options will become too difficult to manage[21].

According to the Capmbell R. Harvey, "Identifying Real Options"[22], there are several types of real options, which are described in the Table 9 below.

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[18] Giorgio Locatelli, Sara Boarin, Francesco Pellegrino and Marco E. Ricotti, "Load following with Small Modular Reactors: a real option analysis", Shared open access repository from the Universities of Leeds, Sheffield and York "White Rose" (2015), https://eprints.whiterose.ac.uk/91139/1/Accpeted%20version.pdf

[19] Eduardo Schwartz, "The real options approach to valuation: challenges and opportunities", Latin American Journal of Economics (November 2013), https://www.jstor.org/stable/90003512?seq=1

[20] Justin Pettit, "Applications in Real Options and Value-based Strategy", Damodaran Online (1996), http://people.stern.nyu.edu/adamodar/New_Home_Page/home1.htm

[21] Stephen X. Zhang and Vladan Babovic, "An Evolutionary Real Options Framework for the Design and Management of Projects and Systems with Complex Real Options and Exercising Conditions", ResearchGate (December 2010), https://www.researchgate.net/publication/220197192_An_Evolutionary_Real_Options_Framework_for_the_Design_and_Management_of_Projects_and_Systems_with_Complex_Real_Options_and_Exercising_Conditions

[22] Capmbell R. Harvey, "Identifying Real Options", National Bureau of Economic Research, Cambridge, MA (1999), https://faculty.fuqua.duke.edu/~charvey/Teaching/BA456_2002/Identifying_real_options.htm

Table 9. *Types of real options*

Options related to	Option type	Description of option type
Project size	Option to expand	The project is built with a capacity that exceeds the expected level of production, so that it can produce at a higher speed if necessary. Management then has the ability (but not the obligation) to expand, i.e. exercise the option if conditions are favorable. The expandable project will cost more to install, the excess is the premium for the option, but is worth more than the same without the expandable. This is equivalent to a call option.
	Option to contract	The project is designed in such a way that production can be reduced in the future if conditions are unfavorable. Waiving these future costs represents the exercise of an option. This is equivalent to a put option, and again, the excess upfront cost is a premium on the option.
	Option to expand or contract	The project is designed in such a way that its work can be dynamically turned on and off. Management may close part or all of the operation under unfavorable conditions (put option) and may resume operations when conditions improve (call option). The Flexible Manufacturing System (FMS) is a good example of this option. This option is also known as the toggle option.
Project life and timing	Initiation or deferment option	Management has the flexibility to decide when to start a project. For example, in natural resource exploration, a firm may postpone production of a field until market conditions are favorable. This is an American-style call option.
	Delay option with a product patent	A company that has a patent right for a product has the right to develop and sell the product exclusively until the expiration of the patent. The firm will sell and develop the product only if the present value of the expected cash flows from the sale of the product exceeds the development costs. If this does not happen, the firm can postpone the patent and not incur any additional costs.
	Option to abandon	Management may have the option to terminate the project during its lifetime and possibly realize its life-saving value. When the present value of the remaining cash flows falls below the liquidation value, the asset can be sold, and this act is effectively the exercise of a put option. This option is also

		known as a Termination option. Abandonment options are American styled.
	Sequencing option	This option is related to the above-mentioned initiation option, although it implies flexibility in terms of the timing of more than one interrelated project: the analysis here is whether it is profitable to implement them sequentially or in parallel. By observing the results associated with the first project, the firm can eliminate some of the uncertainty associated with the enterprise as a whole. After the decision is made, the management has the option to continue or not to continue the development of other projects. If this were done in parallel, management would have already spent resources, and the value of not spending them is lost. Project consistency is an important issue in corporate strategy.
	Option to prototype	New energy production and storage systems are constantly being developed due to climate change, resource scarcity, and environmental laws. Some systems are incremental innovations of existing systems, while others are radical innovations. Radical innovation systems are risky investments because of their corresponding technical and economic uncertainties. Prototyping can hedge these risks by spending part of the cost of a full-scale system and in return obtaining economic and technical information about the system. From an economic point of view, prototyping is an opportunity to hedge the risks associated with costs that need to be properly evaluated.
Projects orientation	Output mix option	The ability to get different results from the same object is known as the combination of results option or product flexibility. These options are particularly valuable in industries where demand is volatile or where the total quantity required for a particular product is usually small and management would like to move quickly to another product if needed.
	Input mix option	The input mixing option, process flexibility, allows management to use different input data to produce the same result as needed. For example, an electric utility company may be able to switch between different fuel sources to generate electricity, and therefore a flexible installation, although more expensive may actually be more valuable.

	Operating scale option	Management may have the option to change the rate of output per unit of time or to change the overall length of the production cycle, for example, in response to market conditions. These parameters are also known as intensity parameters.

Source: compiled by the author

Based on the above, the option to expand a project is valuable when a firm may want to invest in a project with a negative net present value (NPV) if it provides the firm with the opportunity to develop a new project. In the article, the author considers the evaluation of the mine, of which, at current commodity prices, only half is economically feasible for development. This investment makes it possible to develop the remaining part of the mine when and if market prices change. In this case, the possibility of expansion is valuable and should be taken into account when quantifying the cost of the mine. On the other hand, even with a positive NPV project, the opportunity to postpone or expand the project right now is valuable, because it gives the firm the opportunity to wait for additional market information or make an investment at this very moment. In addition, project rejection or expansion options are important and valuable in research and development (R&D) investments, as they provide the flexibility to reject or expand a project when there are negative or positive outcomes[23].

ROV is often contrasted with more standard capital budgeting methods, such as discounted cash flow (DCF) / net present value (NPV) analysis[24]. Under this "standard" NPV approach, future expected cash flows are estimated according to an empirical probability measure at a discount rate that reflects the inherent risk in the project; see CAPM, APT, WACC. Only expected cash flows are taken into account here, and the "flexibility" of changing the corporate strategy to reflect actual market realities is "ignored". The NPV concept assumes that management is "passive" in relation to its investments after they are made. In contrast, ROV assumes that management is "active" and can "continuously" respond to market changes. Real options consider "all" scenarios (or "states") and indicate the best corporate actions in each of these conditional events.

In addition, unlike the traditional approach, which uses expected cash flows to evaluate investment projects, the real options approach takes into account the entire distribution of cash

[23] Scott Mathews, "Valuing risky projects with real options", JSTOR (October 2009), https://www.jstor.org/stable/43240438

[24] Capmbell R. Harvey, "Identifying Real Options", National Bureau of Economic Research, Cambridge, MA (1999), https://faculty.fuqua.duke.edu/~charvey/Teaching/BA456_2002/Identifying_real_options.htm

flows, allowing the firm to react/react during the course of the investment. Thus, flexibility can be an important component of value for many investment projects, and the options pricing system provides a powerful tool for analyzing such flexibility.

The main contribution of Real options (RO) is to recognize that investment projects can evolve over time and that this flexibility has value. Myers (1984) believed that RO is a powerful approach to aligning strategic and financial analysis. Indeed, traditional DCF methods often lead to recommendations that contradict strategic analysis, as they do not take into account the value of the growth opportunities created by the project.[25]

In the article "Valuing risky projects with real options" written by Scott Mathews (October 2009), the author also claims that project flexibility is inherently valuable. And the profitability increases with the ability to change the direction of a project as knowledge is accumulated during the design phase. The author also claims that traditional project valuation-modelling methods, such as NPV (net present value), or as it is also named DCF (discounted cash flows), do not appropriately value flexibility or quantify risk. A major shortcoming of NPV analysis is that it fails to recognize that management has flexibility to alter the path of a project, and thus increase overall project value. The author suggests that all these drawbacks of the standard NPV method are improved by the real option valuation method.

The conclusions from the comparative analysis of NPV (DCF) and ROV methods by Giorgio Locatelli, Mauro Mancini and Giovanni Lotti, "A simple-to-implement real options method for the energy sector" (2020)[26] are also represented in the Table 10 below.

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[25] Charlotte Krychowski and Bertrand V. Quélin, "Real Options and Strategic Investment Decisions: Can They Be of Use to Scholars?", Academy of Management Journal (November 2017), https://journals.aom.org/doi/10.5465/amp.24.2.65

[26] Giorgio Locatelli, Mauro Mancini and Giovanni Lotti, "A simple-to-implement real options method for the energy sector", Shared open access repository from the Universities of Leeds, Sheffield and York "White Rose" (April 2020), https://eprints.whiterose.ac.uk/157998/

Table 10. *Comparison of NPV (DCF) and ROV methods*

Discounted Cash Flow	Real Options Valuation
The DCF analysis does not sufficiently take into account uncertainties and risks. Monte Carlo simulations, sensitivity analysis, or discount rate changes are methods to improve DCF analysis by accounting for uncertainties and risks.	Uncertainty is the key factor that creates the value of an option.
All decisions are made at the beginning of the project development.	Decisions can be made at different times.
All decisions are fixed and do not depend on future events. The DCF does not take into account the value of managerial flexibility over the project lifecycle. The DCF does not reflect the dynamic nature of uncertainties.	Flexibility is realized because management / decision makers can take action to change the course of the project.
The expected gain is discounted at a risk-adjusted rate. The level of risk is expressed in terms of the increment of the discount rate.	Risks are expressed in terms of the probability distribution of winning.

Source: compiled by the author

Even though real options are available in many projects, the application of the practice method in practice has a few difficulties[27]:

- The underlying asset in such an option is usually not actively traded in the market, making it difficult to price it. It is possible to measure the underlying asset as the present value of the future cash flows, but this estimate may not be accurate enough because it is difficult to accurately estimate future cash flows;
- It might also be difficult to determine σ2 due to the lack of sufficient statistical data and the lack of similar projects. Scenario analysis can be used, but it is not accurate as it is built on the subjective assessments of specialists;
- The change in the price of the underlying asset (NPV of the project) in reality may not follow the assumptions embedded in the ROV model. This is especially true for the assumption of normal distribution and the immutability of σ2 during the life of the option. For example, an unexpected technological breakthrough can dramatically change the profitability of a project, both up and down;
- There may not be a specific expiration date for the option;
- The easiest way is to take these ambiguities into account by setting more conservative values, which, of course, will lead to an underestimation of the option's value, but this can be taken into account when making a final decision on investing

[27] Zacatsiolo D.Yu., Mikhalyuk E.K. and Pogorelov I.Z., "Using the method of real options to assess the effectiveness of IT projects", Cyberleninka (2011), https://cyberleninka.ru/article/n/ispolzovanie-metoda-realnyh-optsionov-dlya-otsenki-effektivnosti-it-proektov

in a project with such an option. If even with a conservative determination of the option value, the project turns out to be profitable, it is obvious that it can be accepted.

It should also be noted that it is inappropriate to use a more laborious ROV method if the NPV of the project is significantly higher than zero. Perhaps, in this case, it will be enough to evaluate the project using the DCF method. However, if the project is especially important for the company, it makes sense to apply the ROV method and consider in detail all the benefits that can be obtained using real options.

2.2. Real options for valuation IT projects

When it comes to the valuation of IT projects, traditional approaches might not work. The reason is that they either ignore or cannot properly capture the need of management to be flexible and to adapt/revise the decision based on uncertainties following every IT project. The method of real options is becoming increasingly popular in the evaluation of investment projects in general and IT projects in particular. This is due to the fact that when analyzing an investment project, there is uncertainty about the future development of events. The classical methods for determining the effectiveness of investment projects, such a method of discounting cash flows (DCF), are static. They do not take into account the possibility of changes in the external environment and the flexibility of management decisions. An attempt to avoid uncertainty in the analysis leads to several scenarios. As a result, an average version is often adopted, which shows the average development of the project[28].

The Real Options Value (ROV) method offers a fundamentally different approach. The project is being implemented step by step and adjusted depending on the previous results. The method allows us to consider the company's activities as a set of investment projects. This allows you to maintain flexibility in management decisions and achieve goals faster. The use of the ROV method allows management to concentrate on identifying alternative development paths, and not on creating absolutely accurate forecasts (which is almost unrealistic).

IT projects are lying very closely to R&D ones, as both of groups are characterized by the high rate of volatility, innovativeness, and uncertainty. In the article "Making Real Options

[28] Zacatsiolo D.Yu., Mikhalyuk E.K. and Pogorelov I.Z., "Using the method of real options to assess the effectiveness of IT projects", Cyberleninka (2011), https://cyberleninka.ru/article/n/ispolzovanie-metoda-realnyh-optsionov-dlya-otsenki-effektivnosti-it-proektov

Really Work"[29], Alexander B. van Putten and Ian MacMillan describe interesting case of large industrial company (also can be compared with the oil company observed in this master thesis), which decided to invest millions of dollars in R&D. The company had developed a new compound that held great promise as an additive for a few consumer products. At the time we became involved, project managers had already spent money on toxicity testing and had made other large safety-related expenditures, followed by sophisticated consumer testing, all of which indicated that the compound held considerable potential to command high prices. But the firm had not yet tried to ramp up manufacturing to produce the compound in commercial quantities. Based on long years of experience, management simply guessed that it could be produced for approximately $20 per unit and paid no more attention to the costs of commercial production. It turned out, though, that the manufacturing process was hugely more difficult than anticipated. The cost to produce the compound would be in the order of hundreds of dollars per unit, which put it outside the range of commercial viability. Had company managers taken cost volatility into account effectively, they would have managed the project differently. First, they would have realized sooner that the manufacturing process represented the greatest part of the uncertainty surrounding the project. That would have encouraged them to switch the business development effort from product R&D toward process R&D, so that they would first have understood manufacturing feasibility and only afterwards have investigated consumer demand. Second, taking into account cost volatility would also have produced a much smaller total project value, which would have led them to curtail investment in the project at an earlier stage, saving them millions of dollars. So, sometimes ROV is a really good tool, especially for uncertain and highly volatile IT (R&D) projects.

Overall, among all alternative approaches for estimation investment projects, ROV appears to be promising: the flexibility and adaptability of the method allow to use it with IT projects as specific ones.

2.3. Methods of ROV

The valuation methods commonly used are also adapted to the methods developed for the valuation of financial options[30]. In general, while most" real-world " problems allow for

[29] Alexander B. van Putten and Ian MacMillan, "Making Real Options Really Work", Harvard Business Review Journal (December 2004), https://hbr.org/2004/12/making-real-options-really-work

[30] Gonzalo Cortazar, "Simulation and Numerical Methods in Real Options Valuation", SSRN (2000), https://papers.ssrn.com/sol3/papers.cfm?abstract_id=251653

American-style exercises at any point (at many points) in the project's life, and depend on a variety of underlying variables, standard methods are limited either with respect to dimensionality, early exercises, or both. Therefore, when choosing a model, analysts must find a compromise between these considerations. The model must also be flexible enough that the corresponding decision rule can be appropriately encoded at each decision point[31].

To evaluate real options, modified methods of evaluating financial options, such as the Black - Scholes model or, for example, the binomial model, can be used. Option pricing models were initially used in the valuation of tangible assets, but were later extended to intangible assets - R&D and IT projects. The Table 11 below contains the description of different ROV methods.

Table 10. *ROV methods description*

Method name	Description
Black–Scholes-like solutions	Closed form, solutions similar to Black-Scholes are used[32]. They are only applicable for European-style options[33] or the eternal American options. The application of Black–Scholes assumes deterministic costs: in cases where the project costs, as well as its income, are also considered stochastic, the Margraf formula[34] instead, you can apply it by evaluating the ability to "exchange" expenses for revenue[35].
Binominal lattices	The most common methods are binomial lattices[36]. They are more widely used, given that most real options are designed in the American style. In addition, in particular, lattice-based models provide flexibility for exercises where appropriate and different rules can be encoded in each node[37]. Lattices cannot readily solve

31 “Real options valuation”, Wikipedia (May 2021), https://en.wikipedia.org/wiki/Real_options_valuation

32 Aswath Damodaran, “The Promise and Peril of Real Options”, Damodaran Online (2005), http://people.stern.nyu.edu/adamodar/pdfiles/papers/realopt.pdf

33 “American and European options”, Wikipedia (May 2021), https://en.wikipedia.org/wiki/Option_style#American_and_European_options

34 “Margrabe's formula”, Wikipedia (February 2021), https://en.wikipedia.org/wiki/Margrabe%27s_formula

35 Frank Kelly Reilly and Keith C. Brown, “Investment Analysis and Portfolio Management”, https://www.researchgate.net/publication/31745765_Investment_Analysis_and_Portfolio_Management_FK_Reilly_KC_Brown

36 Michael J. Mauboussin, “Using Real Options in Security Analysis”, Security Analysis and Value Investing Courses at The Graduate School of Business, Columbia University (June 1999), http://www.capatcolumbia.com/Articles/FoFinance/Fof10.pdf

37 Tom Copeland and Peter Tufano, “A Real-World Way to Manage Real Options”, Harvard Business Review (March 2004), https://hbr.org/2004/03/a-real-world-way-to-manage-real-options

	multidimensional problems; treating project costs as stochastic would add at least one dimension to the grid, increasing the number of end nodes per square.
Specialized Monte-Carlo methods	Specialized Monte Carlo methods have been developed, which are increasingly and especially applied to high-dimensional problems [38]. For real American-style options, this application is somewhat more complex; although recent research combines a least-squares approach with modeling, which allows you to evaluate real options that are multidimensional and American-style[39].
Alternative methods	When a Real option can be modeled using a partial differential equation, finite difference methods are sometimes used to price options. Although many early ROV papers discussed this method, its use today is relatively rare due to the required mathematical complexity; they also cannot be easily used for high-dimensional problems[40]. Various other methods have been developed to evaluate real options, mainly for practitioners (see table 11 below). They typically use cash flow scenarios to predict the future distribution of payouts and are not based on restrictive assumptions similar to those that underlie the closed-door decisions discussed.

Source: compiled by the author

In the article "Investment Opportunities as Real Options: Getting Started on the Numbers" written by Timothy A. Luehrman (1998), the author combines two approaches: classic Black-Scholes model with the "Option Space". Option space is defined by two option-value metrics, each of which captures a different part of the value associated with being able to defer an investment. Option space can help address the issues an active decision maker will care about: whether to invest or not, when to invest, and what to do in the meantime. The first metric contains all the usual data captured in net present value (NPV) but adds the time value of being able to defer the investment. The second metric is volatility metric. It measures how much things can change before an investment decision must finally be made. Option space is defined by these two metrics, with value-to-cost on the horizontal axis and volatility on the vertical axis. In the Figure 3 below, you can see the graph:

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[38] "Real Options with Monte Carlo Simulation", Internet archive "Wayback Machine" (May 2021), https://web.archive.org/web/20100318060412/http://www.puc-rio.br/marco.ind/monte-carlo.html

[39] Gonzalo Cortazar, Miguel Gravet and Jorge Urzua, "The valuation of multidimensional American real options using the LSM simulation method", Elsevier (2008), http://www.gonzalocortazar.com/CortazarGravetUrzua2008.pdf

[40] Michael J. Brennan and Eduardo S. Schwartz, "Evaluating Natural Resource Investments", JSTOR (April 1985), https://www.jstor.org/stable/2352967?seq=1

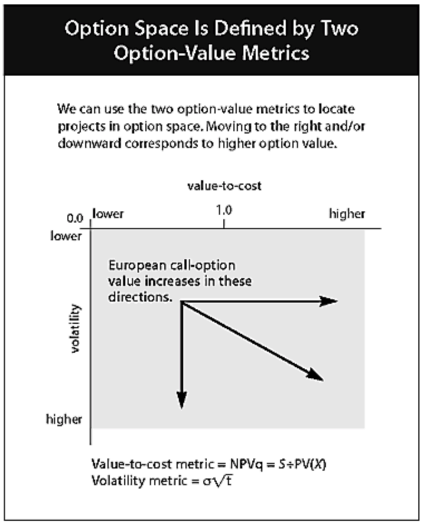

Figure 3. *Option Space*

Source: "Investment Opportunities as Real Options: Getting Started on the Numbers" (Timothy A. Luehrman), HBR

Linking it to the Black-Scholes Model results in five variables in the Black-Scholes model (see the Figure 4 below). Combining five variables into two lets us locate opportunities in two-dimensional space.

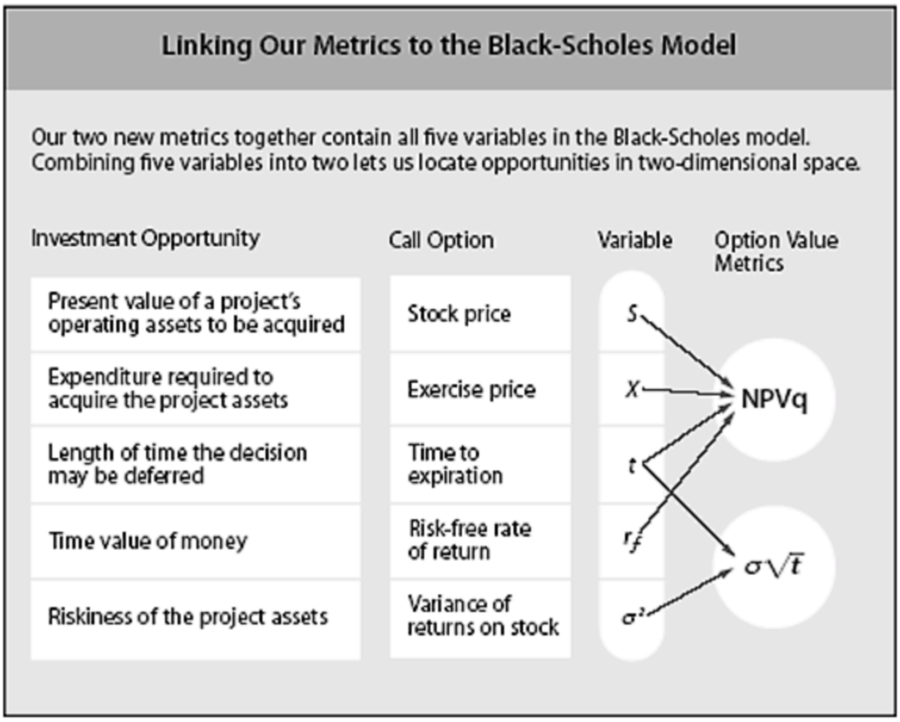

Figure 4*. Linking two models*

Source: "Investment Opportunities as Real Options: Getting Started on the Numbers" (Timothy A. Luehrman), HBR

Another technique is demonstrated by authors already mentioned in this review (Alexander B. van Putten and Ian MacMillan, “Making Real Options Really Work”, HBR 2004). Its is based on the simple formula represented in the Figure 5 below:

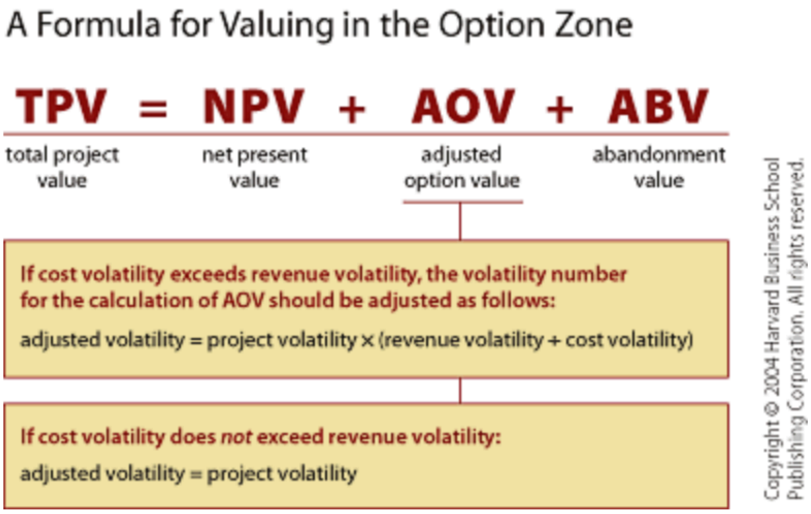

***Figure 5**. TPV formula*

Source: "Making Real Options Really Work"
(Alexander B. van Putten and Ian MacMillan), HBR

The main idea is that total project value consists of NPV (net present value), AOV (adjusted option value) and ABV (abandonment value). If it is very clear what NPV is, then AOV and ABV are not two commonly used for the project valuation metrics. AOV reflects the negative nature of cost uncertainty by separately calculating the option value of the revenues and then subtracting the option “value” of the costs. And ABV is the abandonment value of a project. In searching for ways to reduce cost volatility, managers often find they can recoup some of the investments they have made, in the event of failure. These opportunities for creating extra value when halting a project can be seen as the equivalent of the put options familiar to financial investors, which serve as a hedge against drops in the price of the underlying asset. After calculating NPV, the standard “decision tree” concept is used for the evaluation of risks determining the options.

To make a conclusion, there are several main methods of real options valuation that can be implemented by the management of any company that needs more complex way of estimating their investment projects. But (considering the scope of this master thesis) the most suitable for the European call option is standard Black-Scholes model of RO valuation.

2.4. Applicability for the oil industry

ROV, as far as traditional methods of investment analysis, can be applied to any field or market. IT projects have been actively implemented by companies of different industries in Russia. Still, one of the most attractive for the research areas is the oil production. In Russia, oil companies generate incredibly huge cash flows, which, still, are influenced by some serious not to take into account factors: increased international competition, unfavourable uncertainty in political and macroeconomic situation, active development of IT and infrastructure projects related to it. Combined all together, these factors make largest Russian oil companies think of more flexible and detailed way of their investment decision analysis. It is also applicable for IT: nowadays, these companies spend significant part of their budget for programs in IT field, aimed at more efficient process of mining, industrial security, digitalization, etc. And as far as such projects' effects are often hard to predict, traditional methods of valuation, which these companies use to estimate their IT investment decisions, might not work. So, ROV can become a real working solution in this case.

As much as these conclusions should be supported by some credible sources, there is almost no information available for the real options for IT projects in oil. But all in all, ROV is commonly used for the analysis of the investment projects in the petroleum industry. As B. Jafarizadeh and R. B. Bratvold from the Uneversity of Stavanger (Norway) claim in their article "Real Options Analysis in Petroleum Exploration and Production: A New Paradigm in Investment Analysis" (2009), "the concept of real options is new way of thinking for the investment analysis in the petroleum industry". And it is true as it is a paradigm in investment analysis which associates value creation with the upside aspect of uncertainty. In this way of thinking a conscious effort is made to appreciate the impact of uncertainty on investments, and to create value from favourable outcomes. For this reason, the real options way of thinking has a promise to over-perform the traditional discounted cash flow techniques (which neglect the possible upcoming opportunities). This mindset appreciates the ever-changing future and tries to adapt to evolving conditions[41].

[41] Babak Jafarizadeh and Reidar Brumer Bratvold, "Real Options Analysis in Petroleum Exploration and Production: A New Paradigm in Investment Analysis", OnePetro Journal, https://onepetro.org/SPEEURO/proceedings-abstract/09EURO/All-09EURO/SPE-121426-MS/146271

2.5. Conclusion

So, the concept of real options not only allows to evaluate the investment in IT projects more accurately and correctly, but what is probably more important, to structure the decision-making process within the framework of the investment project. That is exactly what Russian oil companies need.

CHAPTER 3. MODEL DESCRIPTION

3.1. Choice of the model for the valuation of Gazprom Neft IT projects

Currently, each IT project of the company is evaluated twice: before the launch of the minimum product and after. As a method of assessment, the company uses cost based NPV (DCF method). The managers responsible for making the investment decision miss the opportunity to evaluate the project from probabilistic point of view, which often leads to “false negative” or “false positive” result: many projects happen to be less or more promising that they really are. It leads to the wrong investment decision making and, consequently, the company is missing out on potential benefits. **And as far as if the project can save the costs of a specific business process of the company (drilling, pumping, etc.) during MVP and 5 years after (positive NPV in the horizon of 10 years), it is scaled to the rest of the fields chosen for the project implementation, the European call option (to expand) appears to be here.**

The amount of this saved costs in calculated by the next formula:

Saved costs = R – C, where

R = E(1) * [V(1)+Vadd(1)] * P + E(2) * [V(2)+Vadd(2)] * P + E(3) * [V(3)+Vadd(3)] * P + … + E(n) * [V(n)+Vadd(n)] * P;

C = [CAPEX(1)+ OPEX(1)] + [CAPEX(2) + OPEX(2)] + [CAPEX(2) + OPEX(3)] + … + [CAPEX(n) + OPEX(n)], where

R – revenues calculated on the basis of business effects of the project;

C – costs of the realization of the project;

E(n) - effect of the project (which is the the volume of the alternative costs) in the period n;

V(n) - volume of oil extraction (tones) in the period n;

Vadd(n) – additional volume of the oil extraction due to the project realization in the period n;

P – price of the oil per tone;

CAPEX(n) - CAPEX for the realization of the Effect n;

OPEX(n) - CAPEX for the realization of the Effect n.

Now, the company evaluates it with the help of DCF (in the year 0 – the year of making investment in MVP, and in the year 5 – the year of making a decision whether to expand or not), while there is an opportunity to evaluate it by the method, which was basically created for this, with the ROV.

A real option is the ability to make flexible decisions in conditions of uncertainty.[42] The ROV method, which is widespread in countries with a developed financial infrastructure, is rarely used in Russia. The application of the RO method to the assessment of projects (business) makes it possible to model and estimate the cost of the most complex financial and economic objects with a variable level of risk. Estimation and modeling of such objects using other approaches are in some cases incorrect or practically impossible.[43] Gazprom Neft IT projects are just such a case.

So, **the basic uncertainty of Gazprom Neft IT projects is the amount of money that the project saves the company's budget for a specific business process if the developed IT solution is implemented**. This amount of money is an uncertainty since the effect that is included in the financial model of the project does not always justify itself. Quite often (according to the company's employees, in more than 20% of cases), the implementation and scaling of a project turns out to be economically ineffective as a result. The fact that the company, according to the current model, cannot identify such projects earlier, deceives its financial result.

As was mentioned in the Chapter 1 of this master thesis, ROV is appropriate for the project in terms of its uncertainty and high volatility of IT (R&D). The ROV method in comparison with the traditional DCF method has the following advantages (in case of It projects valuation):

- the use of such a tool as real options by the company management allows them to pay less attention to creating “ideal” forecasts and direct more efforts to identification of alternative ways of company development. The use of the traditional DCF method leads to the fact that it is difficult for the management during the implementation of the project to abandon the planned actions and see new opportunities;
- in contrast to the DCF method, which considers only the inflow and outflow of funds, the RO method allows to consider a larger number of factors. These include

[42] Alexander V. Bukhvalov, “Are Real Options Real?”, Russian Management Journal (vol. 4 no.3 (2006)), https://rjm.spbu.ru/article/view/632

[43] Yury V. Kozyr, “Application of option theory in valuation practice”, Corporate Management by Alt-Invest (2000), https://www.cfin.ru/finanalysis/value_options.shtml

the period during which the investment opportunity remains, the uncertainty of future inflows, the value lost during the life of the investment opportunity, etc.

- unlike traditional methods of business valuation, the RO method allows to consider high market volatility to a greater extent as a positive factor.

The Black-Scholes model has been chosen as a ROV model for evaluating Gazprom Neft's IT projects. The choice of the ROV model is based on the following assumptions:

1. The type of the option: European call option (option to expand);
2. The standard deviation (σ) is known and does not change over the life of the option;
3. Changes in the value of the basic uncertainty can be described by Geometric Brownian Motion[44];
4. There is no opportunity for arbitration.

As all assumptions above are met and the option is the one to expand (as well as it is the European call option), the Black-Scholes model is suitable for assessing the investment attractiveness of such projects as an ROV tool that helps the company's management make a more accurate decision in conditions of high uncertainty at an earlier date, which saves the company's money increasing the net profit of Gazprom Neft Upstream.

In the Figure 6 below, there is a formula for Black-Scholes model, which is used in this paper, and in the Table 12 there is a description of the variables used.

$$C = SN(d_1) - Xe^{-rT}N(d_2)$$

$$d_1 = \frac{\ln(\frac{S}{X}) + (r + \frac{\sigma^2}{2})T}{\sigma\sqrt{T}},$$

$$d_2 = d_1 - \sigma\sqrt{T}.$$

***Figure 6**. Black-Scholes model*

Table 12. Description of the variables for the model

Variable	Meaning	Comments applicable to the Gazprom Neft case
C	Price of call option	Price of the call option: to expand (scale for the rest of chosen fields) the project or not. Price of the option should be positive in order to exercise it.
S	Price of underlying asset	The amount of money (investment) that the project saves the company's budget every

44 "Geometric Brownian motion", Wikipedia (March 2021), https://en.wikipedia.org/wiki/Geometric_Brownian_motion

		certain time for a specific business process if the developed IT solution is implemented.
N(x)	Cumulative standard normal distribition	It is calculated in the model on the base of projects' input.
X	Strike price of option	The price that the option should be exercised with. It might be higher than the price of the underlying asset. As the underlying asset was chosen to be the costs that the project saves the company's budget every certain time for a specific business process if the developed IT solution is implemented, CAPEX of the fields has been chosen as the basis of the strike price calculation. When the strike price (CAPEX of the project) are higher than investment, the option should be exercised.
r	Risk-free rate	The risk-free rate is at stated at the level of 5.5% (defined together with the company managers for the selected scopes of projects).
T	Time until expiration of the option	Based on the specifics of the company's business processes, this time period is 5 years.
σ	The standard deviation of the stock returns	It is a benchmark for the industry that the company uses for the GPN Upstream projects valuation (30.85%).[45]

Source: compiled by the author

Currently, the number of IT projects in the Gazprom Neft portfolio increases 1,000 projects. In order to improve the model of such projects estimation, the unified valuation model for such projects should be presented and used as a template. Before introducing the sequence of the steps modelling, the model is probated and described in details for one of such a projects (the scope is only IT projects of automation).

So, next thesis sections illustrate the results of the modelling for one of the Gazprom Neft IT projects in details.

3.2. Project description

In 2015, the company made a decision to estimate the value of potential IT project in the field of extraction. The goal of the project was to develop the system of reservoir pressure maintenance. In the Table 13 below, you can see the assumptions on effects, which managers of the company had before the project started:

[45] Damodaran online (2021), http://people.stern.nyu.edu/adamodar/New_Home_Page/data.html

Table 13. Assumptions of the project

#	Assumption description
1	The implementation of this IT project will reduce the cost of replacing equipment by reducing the number of premature failures in the long term.
2	The implementation of the reservoir pressure maintenance system will pay for itself within 10 years by increasing the volume of production and other economic effects associated with the implementation of the project.
3	The implementation of this IT project will decrease number of failures during extraction (45% of all failures). The savings potential is defined at 80% of the drilling cost.

Source: compiled by the author

Scope of work was defined as eight fields of the company. The project was planned to be piloted in one of the eight fields of the company (about 7% of the total production). If the implementation was successful, the technology would be scaled to the remaining fields (the remaining 93%).

The project had a high level of uncertainty, thus common evaluation models, such as NPV, might simply be not enough. The decisions were made based on NPV model, the project was not expanded, because at the discounted rate of 16% (the rate was defined by the company), factual NPV for the whole project (0-10 years, including expansion) occurred to be negative, though it was positive for the period 0-5 (MVP stage for the field 1) due to high costs of expansion. But while the NPV model recommended abandoning the project, real option model showed that the project had actual economic potential, and not only the company should have invested into the project, but also expand it to all subsidiaries to gain profit. Therefore, though any model can be used to assess the value of the project, clearly not every model takes into consideration its specifics. The aim of this paper is also to identify whether real option analysis is the better valuation option for IT projects in oil industry company. *The hypothesis is, respectively, that ROV is, indeed, the most appropriate model for the case.*

3.3. Evaluation of the IT project by the ROV

To start financial analysis of the situation, it was needed to evaluate the possible revenue, costs (fixed and variable ones) for the period 0 and till the end of the project life (10 years). The investment decision (whether to invest to the project or not) was postponed until the fifth year of the project: at first, the company decided to lunch a pilot with one of its fields, and then, in case of success, to scale the project up for seven more fields.

1. **Step 1. Evaluation of fixed costs.**

The evaluation started with the analysis of costs. *Starting with fixed ones*, total fixed costs were calculated as a sum of the next items provided below:

- Purchase of optimal pumping units;
- Monitoring and analysis of the operation with equipment for the reservoir pressure maintenance;
- Optimization of operating modes for the reservoir pressure maintenance equipment based on an integrated asset model;
- Analysis of injection wells impact on the extraction fund and optimization of the injection into the mine;
- Cost of the loss control system while injecting working reagent into the mine;
- Monitoring of KPI.

2. **Step 2. Allocation of fixed costs into CAPEX and OPEX.**

Each of the fixed cost items was attributed into CAPEX (capital expenditures) and OPEX (operational expenditures). External consulting attributed to CAPEX, equipment costs and licenses were included in CAPEX of each fixed cost item, while external consulting related to OPEX, all internal consulting (PM, Architects, Business Analysis) and license support were included in OPEX. All initial investments related to those fixed cost items were included in Period 0. In the Figure 6 below, you can see the fixed costs structure for period 0-5.

FIXED COSTS	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Purchase of optimal pumping units	**117775093,7**	**10500000**	**10500000**	**10500000**	**10500000**	**10500000**
Capex	***107000000***	***0***	***0***	***0***	***0***	***0***
External consulting	37000000	-	-	-	-	-
Equipment	70000000	-	-	-	-	-
Opex	***10775093,67***	***10500000***	***10500000***	***10500000***	***10500000***	***10500000***
External consulting	7050000	10500000	10500000	10500000	10500000	10500000
Internal consulting (PM)	1923060,981	-	-	-	-	-
Internal consulting (Architects)	1245782,69	-	-	-	-	-
Internal consulting (Business Analysis)	556250	-	-	-	-	-
Monitoring and analysis of the operation with equipment for the reservoir pressure maintenance	**143561093,7**	**3500000**	**3500000**	**3500000**	**3500000**	**3500000**
Capex	***135000000***	***0***	***0***	***0***	***0***	***0***
External consulting	35000000	-	-	-	-	-
Equipment	50000000	-	-	-	-	-
Licenses	50000000	-	-	-	-	-
Opex	***8561093,671***	***3500000***	***3500000***	***3500000***	***3500000***	***3500000***
External consulting	5250000	3500000	3500000	3500000	3500000	3500000
Internal consulting (PM)	1509060,981	-	-	-	-	-
Internal consulting (Architects)	1245782,69	-	-	-	-	-
Internal consulting (Business Analysis)	556250	-	-	-	-	-
Licenses (support)	0	-	-	-	-	-
Optimization of operating modes for the reservoir pressure maintenance equipment based on an integrated asset model	**231328593,7**	**5000000**	**5000000**	**5000000**	**5000000**	**5000000**
Capex	***220000000***	***0***	***0***	***0***	***0***	***0***
External consulting	50000000	-	-	-	-	-
Equipment	100000000	-	-	-	-	-
Licenses	70000000	-	-	-	-	-
Opex	***11328593,67***	***5000000***	***5000000***	***5000000***	***5000000***	***5000000***
External consulting	7500000	5000000	5000000	5000000	5000000	5000000
Internal consulting (PM)	2026560,981	-	-	-	-	-
Internal consulting (Architects)	1245782,69	-	-	-	-	-
Internal consulting (Business Analysis)	556250	-	-	-	-	-
Licenses (support)	0	-	-	-	-	-
Analysis of injection wells impact on the extraction fund and optimization of the injection into the mine	**86000000**	**2800000**	**2800000**	**2800000**	**2800000**	**2800000**
Capex	***40000000***	***0***	***0***	***0***	***0***	***0***
External consulting	40000000	-	-	-	-	-
Opex	***46000000***	***2800000***	***2800000***	***2800000***	***2800000***	***2800000***
External consulting	6000000	2800000	2800000	2800000	2800000	2800000
Internal consulting (PM)	40000000	-	-	-	-	-
Cost of the loss control system while injecting working reagent into the mine	**65668093,67**	**3430000**	**3430000**	**3430000**	**3430000**	**3430000**
Capex	***56000000***	***0***	***0***	***0***	***0***	***0***
External consulting	41000000	-	-	-	-	-
Equipment	10000000	-	-	-	-	-
Licenses	5000000	-	-	-	-	-
Opex	***9668093,671***	***3430000***	***3430000***	***3430000***	***3430000***	***3430000***
External consulting	6150000	3430000	3430000	3430000	3430000	3430000
Internal consulting (PM)	1716060,981	-	-	-	-	-
Internal consulting (Architects)	1245782,69	-	-	-	-	-
Internal consulting (Business Analysis)	556250	-	-	-	-	-
Licenses (support)	0	-	-	-	-	-
Monitoring of KPI	**37202529,65**	**2100000**	**2100000**	**2100000**	**2100000**	**2100000**
Capex	***30000000***	***0***	***0***	***0***	***0***	***0***
External consulting	20000000	-	-	-	-	-
Licenses	10000000	-	-	-	-	-
Opex	***7202529,651***	***2100000***	***2100000***	***2100000***	***2100000***	***2100000***
External consulting	3000000	2100000	2100000	2100000	2100000	2100000
Internal consulting (PM)	2006746,961	-	-	-	-	-
Internal consulting (Architects)	1245782,69	-	-	-	-	-
Internal consulting (Business Analysis)	950000	-	-	-	-	-
Licenses (support)	0	-	-	-	-	-
TOTAL	**681535404,3**	**27330000**	**27330000**	**27330000**	**27330000**	**27330000**

Figure 6. *Fixed costs of the project*

Source: compiled by the author

3. **Step 3. Evaluation of variable costs.**

<u>*Variable costs of the project*</u> were the product of the following items:

- Expenditures on overhaul and optimization of pumping units;
- Reengineering activities. In the Figure 7 below, you can see the structure of variable costs for years 0-5 of the project.

VARIABLE COSTS	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Expenditures on overhaul and optimization of pumping units	0	27000000	27000000	18000000	9000000	9000000
Reengineering activities	0	200000000	130000000	100000000	100000000	100000000
TOTAL VARIABLE COSTS	**0**	**227000000**	**157000000**	**118000000**	**109000000**	**109000000**

Figure 7. *Variable costs of the project*

Source: compiled by the author

4. **Step 4. Evaluation of revenues. Structuring of flows by business effects.**

Then, *the revenue structure* was determined and the numbers were calculated for period 0-5. The revenue became a product of following:

- Revenue from the extraction (with all costs except for this project);
- Effect from the selection of optimal pumping units;
- Effect from the optimization of operating modes for the reservoir pressure maintenance equipment based on an integrated asset model;
- Impact of injection wells on the extraction fund and optimization of the injection into the mine;
- Effect from the loss control system while injecting working reagent into the mine;
- Effect from monitoring of KPI.

The result of valuation is represented in the Figure 8 below.

REVENUE	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Revenue from the extraction (with all costs except for this project)	21345212,56	22022151,85	23126729,4	23761149,44	23797909,95	23532586,38
Volume of oil extraction (tones)	3448,732838	3538,656362	3725,126573	3841,688249	3847,316821	3805,791215
Additional volume of oil extraction (tones)	0	60,73934082	54,80606104	41,9367394	42,31646431	40,47643791
Price per tone	6189,29142	6118,29142	6118,29142	6118,29142	6118,29142	6118,29142
Effect from the selection of optimal pumping units	-	-	-	30000000	20000000	10000000
Effect from the monitoring and analysis of the operation with equipment for the reservoir pressure maintenance	-	20000000	15000000	10000000	1500000	1500000
Effect from the optimization of operating modes for the reservoir pressure maintenance equipment based on an integrated asset model	-	-	9616355,84	83164550,64	61562944,69	54529832,07
Impact of injection wells on the extraction fund and optimization of the injection into the mine	-	304654223,4	272658202,6	206251778,8	208119328,3	199069776
Effect from the loss control system while injecting working reagent into the mine	-	8583692,765	21459231,91	38626617,44	60085849,36	85836927,65
Effect from monitoring of KPI	-	-	-	-	-	-
TOTAL REVENUE	21345212,56	355260068	341860519,7	391804096,3	375066032,3	374469122,1

Figure 8. *Revenues of the MVP*

Source: compiled by the author

Under the term "Revenue" in this case the "Effect for the extraction" is meant. The implementation of this technology affects the volume of the oil extraction: with new technology, the volume of extracted oil is likely to increase. Also, Revenue includes "effects" (alternative costs) due to the IT project implementation. However, in Period 0, there are no "effects" included into the revenue as it is time of the IT project implementation.

So, future flows of revenue and variable costs are stated as 2 factors of uncertainty. All the categories of costs and revenues are the result of the master thesis analysis, as they were systematized during the research for the use of modelling. All the data used in this master thesis was provided by the company. For better understanding of initial investment volume, in the Figure 9 below the analysis of the *flow for the year 0* is provided.

MAX POSSIBLE REVENUE IN PERIOD 0	21345212,56		CAPEX (Subsidiary 1)	588000000
Revenue from the extraction (with all costs except for this project)	21345212,56		CAPEX (All subsidiaries)	4116000000
Effect from the selection of optimal pumping units	-			
Effect from the monitoring and analysis of the operation with equipment for the reservoir pressure maintenance	-			
Effect from the optimization of operating modes for the reservoir pressure maintenance equipment based on an integrated asset model	-			
Impact of injection wells on the extraction fund and optimization of the injection into the mine	-			
Effect from the loss control system while injecting working reagent into the mine	-			
Effect from monitoring of KPI	-			
FIXED COSTS IN PERIOD 0	**681535404,3**			
Purchase of optimal pumping units	117775093,7			
Monitoring and analysis of the operation with equipment for the reservoir pressure maintenance	143561093,7			
Optimization of operating modes for the reservoir pressure maintenance equipment based on an integrated asset model	231328593,7			
Analysis of injection wells impact on the extraction fund and optimization of the injection into the mine	86000000			
Cost of the loss control system while injecting working reagent into the mine	65668093,67			
Monitoring of KPI	37202529,65			
VARIABLE COSTS IN PERIOD 0	**0**			
Expenditures on overhaul and optimization of pumping units	0			
Reengineering activities	0			

***Figure 9**. Initial investment and revenues*

Source: compiled by the author

5. **Step 5. Calculation of FCF.**

So, on the base of all information mentioned above, *the FCF model was conducted*. FCF and DCF were calculated at the discount rate of 16% (it was fixed by the company for all IT projects, that is why WACC was not calculated). In the Figure 10 below you can see the FCF model for years 0-5.

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
TOTAL REVENUE	**21345212,56**	**355260068**	**341860519,7**	**391804096,3**	**375066032,3**	**374469122,1**
TOTAL COSTS	**681535404,3**	**254330000**	**184330000**	**145330000**	**136330000**	**136330000**
Fixed costs	**681535404,3**	**27330000**	**27330000**	**27330000**	**27330000**	**27330000**
CAPEX	588000000	0	0	0	0	0
OPEX	93535404,33	27330000	27330000	27330000	27330000	27330000
Variable costs	**0**	**227000000**	**157000000**	**118000000**	**109000000**	**109000000**
FCF	**-660190191,8**	**100930068**	**157530519,7**	**246474096,3**	**238736032,3**	**238139122,1**
DCF	-660190191,8	87008679,3	117070838,1	157905521,1	131851785,4	113381135,5
CDCF	-660190191,8	-573181512	-456110674,4	-298205153,3	-166353367,9	-52972232,42
Period	0	1	2	3	4	5

Figure 10. *FCF and DCF model of the MVP*

Also, the Figure11 below represents the FCF model for the whole project (period 0-10):

REVENUE	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Revenue from the extraction (with all costs except for this project)	**39913086,82**	**40377026,11**	**41481603,66**	**42116023,7**	**42152784,21**	**41887460,64**	**120120233,6**	**120298905,2**	**116663779,7**	**106317518,3**	**95971983,26**
Volume of oil extraction (tones)	6448,732838	6538,656362	6725,126573	6841,688249	6847,316821	6805,791215	19497,41864	19516,02531	18923,83656	17279,91517	15586,49837
Additional volume of oil extraction (tones)	0	60,73934082	54,80606104	41,9367394	42,31646431	40,47643791	135,5516435	146,1478222	144,1959559	97,07964869	99,5774746
Price per tone	6189,29142	6118,29142	6118,29142	6118,29142	6118,29142	6118,29142	6118,29142	6118,29142	6118,29142	6118,29142	6118,29142
Effect from the selection of optimal pumping	-	-	-	**30000000**	**20000000**	**10000000**	-	-	**110000000**	**140000000**	**70000000**
Effect from the monitoring and analysis of the operation with equipment for the reservoir pressure maintenance	-	**20000000**	**15000000**	**10000000**	**1500000**	**1500000**	-	**105000000**	**40000000**	**10500000**	**10500000**
Effect from the optimization of operating modes for the reservoir pressure maintenance equipment based on an integrated asset model	-	-	**9616355,84**	**83164550,64**	**61562944,69**	**54529832,07**	-	**67314490,88**	**582151854,5**	**430940612,9**	**381708824,5**
Impact of injection wells on the extraction fund and optimization of the injection into the mine	-	**304654223,4**	**272658202,6**	**206251778,8**	**208119328,3**	**199069776**	-	**1908607418**	**1443762451**	**1456835298**	**1393488432**
Effect from the loss control system while injecting working reagent into the mine	-	**8583692,765**	**21459231,91**	**38626617,44**	**60085849,36**	**85836927,65**	-	**150214623,4**	**170386322,1**	**220600945,5**	**600858493,6**
Effect from monitoring of KPI	-	-	-	-	-	-	-	-	-	-	-
TOTAL REVENUE	**39913086,82**	**373614942,2**	**360215394**	**410158970,6**	**393420906,5**	**392823996,3**	**120120233,6**	**2351435437**	**2462964408**	**2365194375**	**2552527733**
		836,07%	-33,19%	120,40%	-39,74%	-1,42%	-651,04%	1857,57%	92,71%	-83,80%	176,20%

Figure 11. *FCF and DCF model (full project)*

Source: compiled by the author

6. Step 6. Calculation of NPV.

Finally, NPV of the project was calculated (at the rate of 16%), which occurred to be negative for the period 0-5 because of the volume of initial investment and high costs:

DISCOUNTING RATE	16%
NPV (Subsidiary 1)	**25694890,14**
NPV (Subsidiary 2-8), Year 5	-82174244,3
NPV (Subsidiary 2-8), Year 0	**-39124227,24**
CAPEX (Subsidiaries 2-8)	2555000000
CAPEX (Subsidiaries 2-8), discounted, Year 5	2202586207
CAPEX (Subsidiaries 2-8), discounted, Year 1	1048679961

Figure 12. *NPV of the project*

Source: compiled by the author

7. **Step 6. Calculation of strike price and core price of the option. Making a decision.**

As far as NPV of the project for the period 0-5 was negative, the strike and the core price of the option to expand were determined. The ROA showed that the call price of such option was positive, so the company should exercise it (see the Figure 13 below).

Strike price (K)	2202586207
Price of underlying asset (S)	641622317,5
Standard deviation	30,85%
Risk-free rate	5,50%
d(1)	-1,044445195
d(2)	-1,734255195
N(d1)	0,148139731
N(d2)	0,041436407
Call price	**25725692,82**

Figure 13. *ROA of the project*

Source: compiled by the author

The model was conducted in Excel. All formulas for the calculations are provided in the Appendix 1 of this master thesis.

So, the project had a high level of uncertainty, thus common evaluation models, such as NPV, were simply not enough. Initially, the decisions were made by the company based on NPV model, the project was not expanded, because at the discounted rate of 16% (the rate was defined by the company), factual NPV for the whole project (0-10 years, including expansion) occurred to be negative, though it was positive for the period 0-5 (MVP stage for the field 1) due to high costs of expansion. But while the NPV model recommended not expanding the project, the real option model showed that the project had actual economic potential, and not only the company should have invested into the project, but also expand it to all subsidiaries to gain profit. Therefore, though any model can be used to assess the value of the project, clearly not every model takes into consideration its specifics (risk level, uncertainties following the implementation, etc.).

This very project was not expanded in 2020. The most interesting thing was that in 2021, the company started to re-evaluate its portfolio of IT projects and this project was chosen to be scaled up for the rest of the fields even being non-profitable in the future (by the evaluation based on NPV analysis results). The reason was that the company needed to renew its pumping units, as the previous ones were old enough. So, the project was almost the ideal candidate for the probation of ROV approach. And the results were promising: by the ROV, the project should have been decided to expand a year ago, which meant the missed investment opportunity for the company.

CONCLUSION. MANAGERIAL IMPLICATIONS OF THE PAPER

In this master's thesis, the cash flows of 5 IT projects of the company were analyzed (2 out of 5 projects are presented in the Appendix 2 of this master thesis). All of them were chosen for the same organizational scope (piloting and scaling for the same fields of the company), and they were also only projects to automate operations in production (in oil production). These research limitations were introduced to facilitate the analysis tasks and so that it was possible to compare the results of modeling using ROV on a sample of projects.

The result of evaluation for 5 projects are as follows: out of 5 projects, scaling could have been avoided for 1 project. And also, there were 2 projects, which had not been scaled by NPV model, while ROV had shown that those projects should have been expanded. Thus, 3 out of 5 projects could have another scenario of the development.

So, this paper provides the company with the alternative method of IT projects evaluation, which accounts for the risks and uncertainties related to the project, making a decision-making process of the management more flexible. To implement the ROV for the needs of the IT projects valuation in Gazprom-Neft, the next steps should be followed:

1. To identify quantitative business effects from project implementation.
2. To calculate fixed costs of the projects for 10 years (first 5 years for the MVP, second five years for the expansion volume).
3. To allocate fixed costs into CAPEX and OPEX.
4. To calculate variable costs of the projects (first 5 years for the MVP, second five years for the expansion volume).
5. To evaluate the revenues of the project and allocate the flows by business effects.
6. To calculate FCF of the project.
7. To calculate the strike price and core price of the option. To make a decision by comparison of the core price of the option with 0 (if the call price is positive, then the company should exercise the option to expand the project).

To conclude, the aim of this master thesis (to propose and to test the alternative method of investment project valuation for one of the Russian largest oil companies, Gazprom Neft) was achieved. All the tasks (to conduct the "as is" analysis of the IT projects valuation process in Gazprom Neft, to find the gap in the "as is" process and to elaborate the model) were completed, and the conclusions were made.

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APPENDIX 1. PROJECT 1 CALCULATIONS

B23 | fx =B20

	A	B	C	D	E	F	G	H	I	J	K	L
1		Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
2	TOTAL REVENUE	39913086,82	373614942	360215394	410158970,6	393420906,5	392823996,3	120120233,6	2351435437	2462964408	2365194375	2552527733
3	TOTAL COSTS	681535404,3	254330000	184330000	145330000	136330000	136330000	4272310000	1227310000	954310000	891310000	891310000
4	Fixed costs	681535404,3	27330000	27330000	27330000	27330000	27330000	2683310000	128310000	128310000	128310000	128310000
5	CAPEX	588000000	0	0	0	0	0	2555000000	0	0	0	0
6	OPEX	93535404,33	27330000	27330000	27330000	27330000	27330000	128310000	128310000	128310000	128310000	128310000
7	Variable costs	0	227000000	157000000	118000000	109000000	109000000	1589000000	1099000000	826000000	763000000	763000000
8	FCF	-641622317,5	119284942	175885394	264828970,6	257090906,5	256493996,3	-4152189766	1124125437	1508654408	1473884375	1661217733
9	DCF	-641622317,5	102831847	130711499,7	169664712,2	141989019	122120130	-1704234130	397748775	460177999,9	387562288,5	376570821,8
10	CDCF	-641622317,5	-538790471	-408078971,1	-238414258,9	-96425239,88	25694890,14	-1678539239	-1280790464	-820612464,5	-433050176	-56479354,16
11	Period	0	1	2	3	4	5	6	7	8	9	10
12												
13												
14	DISCOUNTING RATE	16%										
15	NPV (Subsidiary 1)	25694890,14										
16	NPV (Subsidiary 2-8), Year 5	-82174244,3										
17	NPV (Subsidiary 2-8), Year 0	-39124227,24										
18												
19	CAPEX (Subsidiaries 2-8)	2555000000										
20	CAPEX (Subsidiaries 2-8), discounted, Year 5	2202586207										
21	CAPEX (Subsidiaries 2-8), discounted, Year 1	1048679961										
22												
23	Strike price (K)	2202586207										
24	Price of underlying asset (S)	641622317,5										
25	Standard deviation	30,85%										
26	Risk-free rate	5,50%										
27												
28	d(1)	-1,044445195										
29	d(2)	-1,734255195										
30	N(d1)	0,148139731										
31	N(d2)	0,041436407										
32	Call price	25725692,82										

The discounting rate of 16% was fixed by the company for all IT projects (that is why WACC was not calculated).

Figure 14. *Strike price calculation*

Source: compiled by the author

B24 | fx =-B9

	A	B	C	D	E	F	G	H	I	J	K	L
1		Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
2	TOTAL REVENUE	39913086,82	373614942	360215394	410158970,6	393420906,5	392823996,3	120120233,6	2351435437	2462964408	2365194375	2552527733
3	TOTAL COSTS	681535404,3	254330000	184330000	145330000	136330000	136330000	4272310000	1227310000	954310000	891310000	891310000
4	Fixed costs	681535404,3	27330000	27330000	27330000	27330000	27330000	2683310000	128310000	128310000	128310000	128310000
5	CAPEX	588000000	0	0	0	0	0	2555000000	0	0	0	0
6	OPEX	93535404,33	27330000	27330000	27330000	27330000	27330000	128310000	128310000	128310000	128310000	128310000
7	Variable costs	0	227000000	157000000	118000000	109000000	109000000	1589000000	1099000000	826000000	763000000	763000000
8	FCF	-641622317,5	119284942	175885394	264828970,6	257090906,5	256493996,3	-4152189766	1124125437	1508654408	1473884375	1661217733
9	DCF	-641622317,5	102831847	130711499,7	169664712,2	141989019	122120130	-1704234130	397748775	460177999,9	387562288,5	376570821,8
10	CDCF	-641622317,5	-538790471	-408078971,1	-238414258,9	-96425239,88	25694890,14	-1678539239	-1280790464	-820612464,5	-433050176	-56479354,16
11	Period	0	1	2	3	4	5	6	7	8	9	10
12												
13												
14	DISCOUNTING RATE	16%										
15	NPV (Subsidiary 1)	25694890,14										
16	NPV (Subsidiary 2-8), Year 5	-82174244,3										
17	NPV (Subsidiary 2-8), Year 0	-39124227,24										
18												
19	CAPEX (Subsidiaries 2-8)	2555000000										
20	CAPEX (Subsidiaries 2-8), discounted, Year 5	2202586207										
21	CAPEX (Subsidiaries 2-8), discounted, Year 1	1048679961										
22												
23	Strike price (K)	2202586207										
24	Price of underlying asset (S)	641622317,5										
25	Standard deviation	30,85%										
26	Risk-free rate	5,50%										
27												
28	d(1)	-1,044445195										
29	d(2)	-1,734255195										
30	N(d1)	0,148139731										
31	N(d2)	0,041436407										
32	Call price	25725692,82										

The discounting rate of 16% was fixed by the company for all IT projects (that is why WACC was not calculated).

Figure 15. *Price of underlying asset calculation*

Source: compiled by the author

B28 =(LN(B24/B23)+(B26+0,5*(B25^2))*5)/(B25*(5)^(1/2))

	A	B	C	D	E	F	G	H	I	J	K	L
1		**Year 0**	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**Year 8**	**Year 9**	**Year 10**
2	**TOTAL REVENUE**	**39913086,82**	**373614942**	**360215394**	**410158970,6**	**393420906,5**	**392823996,3**	**120120233,6**	**2351435437**	**2462964408**	**2365194375**	**2552527733**
3	**TOTAL COSTS**	**681535404,3**	**254330000**	**184330000**	**145330000**	**136330000**	**136330000**	**4272310000**	**1227310000**	**954310000**	**891310000**	**891310000**
4	**Fixed costs**	**681535404,3**	**27330000**	**27330000**	**27330000**	**27330000**	**27330000**	**2683310000**	**128310000**	**128310000**	**128310000**	**128310000**
5	CAPEX	588000000	0	0	0	0	0	2555000000	0	0	0	0
6	OPEX	93535404,33	27330000	27330000	27330000	27330000	27330000	128310000	128310000	128310000	128310000	128310000
7	**Variable costs**	**0**	**227000000**	**157000000**	**118000000**	**109000000**	**109000000**	**1589000000**	**1099000000**	**826000000**	**763000000**	**763000000**
8	**FCF**	**-641622317,5**	**119284942**	**175885394**	**264828970,6**	**257090906,5**	**256493996,3**	**-4152189766**	**1124125437**	**1508654408**	**1473884375**	**1661217733**
9	DCF	-641622317,5	102831847	130711499,7	169664712,2	141989019	122120130	-1704234130	397748775	460177999,9	387562288,5	376570821,8
10	CDCF	-641622317,5	-538790471	-408078971,1	-238414258,9	-96425239,88	25694890,14	-1678539239	-1280790464	-820612464,5	-433050176	-56479354,16
11	Period	0	1	2	3	4	5	6	7	8	9	10
12												
13												
14	DISCOUNTING RATE	16%										
15	**NPV (Subsidiary 1)**	**25694890,14**										
16	NPV (Subsidiary 2-8), Year 5	-82174244,3										
17	**NPV (Subsidiary 2-8), Year 0**	**-39124227,24**										
18												
19	CAPEX (Subsidiaries 2-8)	2555000000										
20	CAPEX (Subsidiaries 2-8), discounted, Year 5	2202586207										
21	CAPEX (Subsidiaries 2-8), discounted, Year 1	1048679961										
22												
23	**Strike price (K)**	**2202586207**										
24	Price of underlying asset (S)	641622317,5										
25	Standard deviation	30,85%										
26	Risk-free rate	5,50%										
27												
28	d(1)	-1,044445195										
29	d(2)	-1,734255195										
30	N(d1)	0,148139731										
31	N(d2)	0,041436407										
32	**Call price**	**25725692,82**										

The discounting rate of 16% was fixed by the company for all IT projects (that is why WACC was not calculated).

***Figure 16.** d1 calculation*

Source: compiled by the author

B29 =B28-B25*5^(1/2)

	A	B	C	D	E	F	G	H	I	J	K	L
1		**Year 0**	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**Year 8**	**Year 9**	**Year 10**
2	**TOTAL REVENUE**	**39913086,82**	**373614942**	**360215394**	**410158970,6**	**393420906,5**	**392823996,3**	**120120233,6**	**2351435437**	**2462964408**	**2365194375**	**2552527733**
3	**TOTAL COSTS**	**681535404,3**	**254330000**	**184330000**	**145330000**	**136330000**	**136330000**	**4272310000**	**1227310000**	**954310000**	**891310000**	**891310000**
4	**Fixed costs**	**681535404,3**	**27330000**	**27330000**	**27330000**	**27330000**	**27330000**	**2683310000**	**128310000**	**128310000**	**128310000**	**128310000**
5	CAPEX	588000000	0	0	0	0	0	2555000000	0	0	0	0
6	OPEX	93535404,33	27330000	27330000	27330000	27330000	27330000	128310000	128310000	128310000	128310000	128310000
7	**Variable costs**	**0**	**227000000**	**157000000**	**118000000**	**109000000**	**109000000**	**1589000000**	**1099000000**	**826000000**	**763000000**	**763000000**
8	**FCF**	**-641622317,5**	**119284942**	**175885394**	**264828970,6**	**257090906,5**	**256493996,3**	**-4152189766**	**1124125437**	**1508654408**	**1473884375**	**1661217733**
9	DCF	-641622317,5	102831847	130711499,7	169664712,2	141989019	122120130	-1704234130	397748775	460177999,9	387562288,5	376570821,8
10	CDCF	-641622317,5	-538790471	-408078971,1	-238414258,9	-96425239,88	25694890,14	-1678539239	-1280790464	-820612464,5	-433050176	-56479354,16
11	Period	0	1	2	3	4	5	6	7	8	9	10
12												
13												
14	DISCOUNTING RATE	16%										
15	**NPV (Subsidiary 1)**	**25694890,14**										
16	NPV (Subsidiary 2-8), Year 5	-82174244,3										
17	**NPV (Subsidiary 2-8), Year 0**	**-39124227,24**										
18												
19	CAPEX (Subsidiaries 2-8)	2555000000										
20	CAPEX (Subsidiaries 2-8), discounted, Year 5	2202586207										
21	CAPEX (Subsidiaries 2-8), discounted, Year 1	1048679961										
22												
23	**Strike price (K)**	**2202586207**										
24	Price of underlying asset (S)	641622317,5										
25	Standard deviation	30,85%										
26	Risk-free rate	5,50%										
27												
28	d(1)	-1,044445195										
29	d(2)	-1,734255195										
30	N(d1)	0,148139731										
31	N(d2)	0,041436407										
32	**Call price**	**25725692,82**										

The discounting rate of 16% was fixed by the company for all IT projects (that is why WACC was not calculated).

***Figure 17.** d2 calculation*

Source: compiled by the author

B30 =NORMSDIST(B28)

	A	B	C	D	E	F	G	H	I	J	K	L
1		Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
2	TOTAL REVENUE	39913086,82	373614942	360215394	410158970,6	393420906,5	392823996,3	120120233,6	2351435437	2462964408	2365194375	2552527733
3	TOTAL COSTS	681535404,3	254330000	184330000	145330000	136330000	136330000	4272310000	1227310000	954310000	891310000	891310000
4	Fixed costs	681535404,3	27330000	27330000	27330000	27330000	27330000	2683310000	128310000	128310000	128310000	128310000
5	CAPEX	588000000	0	0	0	0	0	2555000000	0	0	0	0
6	OPEX	93535404,33	27330000	27330000	27330000	27330000	27330000	128310000	128310000	128310000	128310000	128310000
7	Variable costs	0	227000000	157000000	118000000	109000000	109000000	1589000000	1099000000	826000000	763000000	763000000
8	FCF	-641622317,5	119284942	175885394	264828970,6	257090906,5	256493996,3	-4152189766	1124125437	1508654408	1473884375	1661217733
9	DCF	-641622317,5	102831847	130711499,7	169664712,2	141989019	122120130	-1704234130	397748775	460177999,9	387562288,5	376570821,8
10	CDCF	-641622317,5	-538790471	-408078971,1	-238414258,9	-96425239,88	25694890,14	-1678539239	-1280790464	-820612464,5	-433050176	-56479354,16
11	Period	0	1	2	3	4	5	6	7	8	9	10
12												
13												
14	DISCOUNTING RATE	16%										
15	NPV (Subsidiary 1)	25694890,14										
16	NPV (Subsidiary 2-8), Year 5	-82174244,3										
17	NPV (Subsidiary 2-8), Year 0	-39124227,24										
18												
19	CAPEX (Subsidiaries 2-8)	2555000000										
20	CAPEX (Subsidiaries 2-8), discounted, Year 5	2202586207										
21	CAPEX (Subsidiaries 2-8), discounted, Year 1	1048679961										
22												
23	Strike price (K)	2202586207										
24	Price of underlying asset (S)	641622317,5										
25	Standard deviation	30,85%										
26	Risk-free rate	5,50%										
27												
28	d(1)	-1,044445195										
29	d(2)	-1,734255195										
30	N(d1)	0,148139731										
31	N(d2)	0,041436407										
32	Call price	25725692,82										

The discounting rate of 16% was fixed by the company for all IT projects (that is why WACC was not calculated).

Figure 18. *The probability N(d1) calculation*

Source: compiled by the author

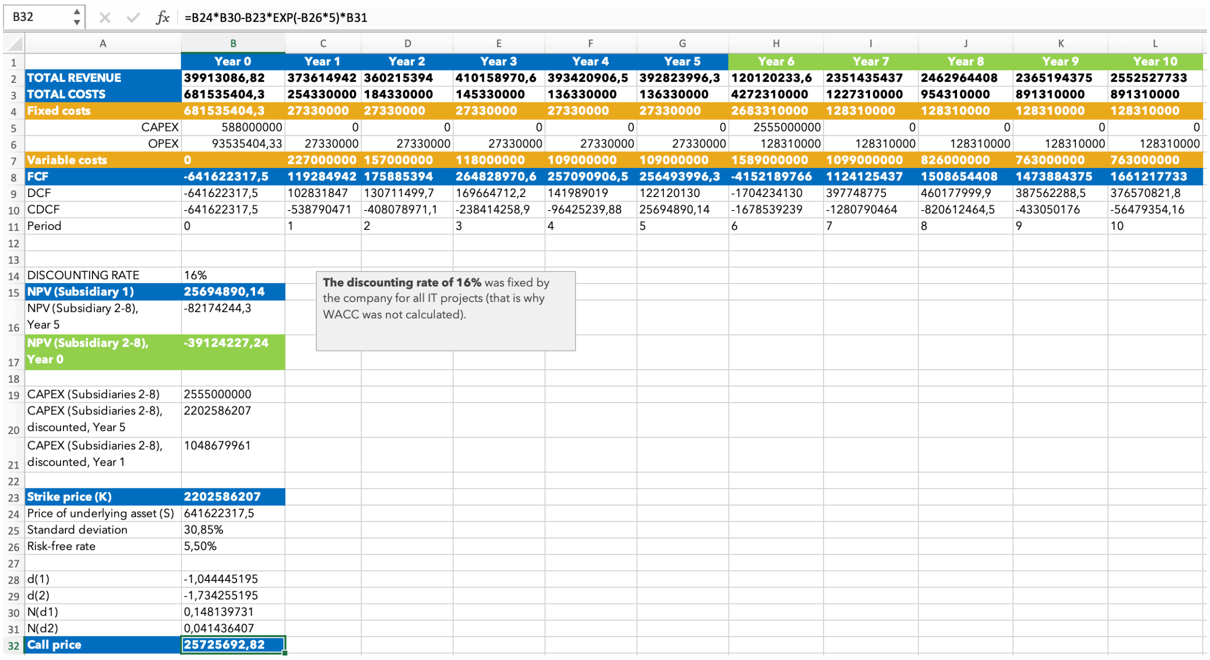
B31 =NORMSDIST(B29)

	A	B	C	D	E	F	G	H	I	J	K	L
1		Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
2	TOTAL REVENUE	39913086,82	373614942	360215394	410158970,6	393420906,5	392823996,3	120120233,6	2351435437	2462964408	2365194375	2552527733
3	TOTAL COSTS	681535404,3	254330000	184330000	145330000	136330000	136330000	4272310000	1227310000	954310000	891310000	891310000
4	Fixed costs	681535404,3	27330000	27330000	27330000	27330000	27330000	2683310000	128310000	128310000	128310000	128310000
5	CAPEX	588000000	0	0	0	0	0	2555000000	0	0	0	0
6	OPEX	93535404,33	27330000	27330000	27330000	27330000	27330000	128310000	128310000	128310000	128310000	128310000
7	Variable costs	0	227000000	157000000	118000000	109000000	109000000	1589000000	1099000000	826000000	763000000	763000000
8	FCF	-641622317,5	119284942	175885394	264828970,6	257090906,5	256493996,3	-4152189766	1124125437	1508654408	1473884375	1661217733
9	DCF	-641622317,5	102831847	130711499,7	169664712,2	141989019	122120130	-1704234130	397748775	460177999,9	387562288,5	376570821,8
10	CDCF	-641622317,5	-538790471	-408078971,1	-238414258,9	-96425239,88	25694890,14	-1678539239	-1280790464	-820612464,5	-433050176	-56479354,16
11	Period	0	1	2	3	4	5	6	7	8	9	10
12												
13												
14	DISCOUNTING RATE	16%										
15	NPV (Subsidiary 1)	25694890,14										
16	NPV (Subsidiary 2-8), Year 5	-82174244,3										
17	NPV (Subsidiary 2-8), Year 0	-39124227,24										
18												
19	CAPEX (Subsidiaries 2-8)	2555000000										
20	CAPEX (Subsidiaries 2-8), discounted, Year 5	2202586207										
21	CAPEX (Subsidiaries 2-8), discounted, Year 1	1048679961										
22												
23	Strike price (K)	2202586207										
24	Price of underlying asset (S)	641622317,5										
25	Standard deviation	30,85%										
26	Risk-free rate	5,50%										
27												
28	d(1)	-1,044445195										
29	d(2)	-1,734255195										
30	N(d1)	0,148139731										
31	N(d2)	0,041436407										
32	Call price	25725692,82										

The discounting rate of 16% was fixed by the company for all IT projects (that is why WACC was not calculated).

Figure 19. *The probability N(d2) calculation*

Source: compiled by the author



B32 =B24*B30-B23*EXP(-B26*5)*B31

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
TOTAL REVENUE	**39913086,82**	**373614942**	**360215394**	**410158970,6**	**393420906,5**	**392823996,3**	**120120233,6**	**2351435437**	**2462964408**	**2365194375**	**2552527733**
TOTAL COSTS	**681535404,3**	**254330000**	**184330000**	**145330000**	**136330000**	**136330000**	**4272310000**	**1227310000**	**954310000**	**891310000**	**891310000**
Fixed costs	**681535404,3**	**27330000**	**27330000**	**27330000**	**27330000**	**27330000**	**2683310000**	**128310000**	**128310000**	**128310000**	**128310000**
CAPEX	588000000	0	0	0	0	0	2555000000	0	0	0	0
OPEX	93535404,33	27330000	27330000	27330000	27330000	27330000	128310000	128310000	128310000	128310000	128310000
Variable costs	**0**	**227000000**	**157000000**	**118000000**	**109000000**	**109000000**	**1589000000**	**1099000000**	**826000000**	**763000000**	**763000000**
FCF	**-641622317,5**	**119284942**	**175885394**	**264828970,6**	**257090906,5**	**256493996,3**	**-4152189766**	**1124125437**	**1508654408**	**1473884375**	**1661217733**
DCF	-641622317,5	102831847	130711499,7	169664712,2	141989019	122120130	-1704234130	397748775	460177999,9	387562288,5	376570821,8
CDCF	-641622317,5	-538790471	-408078971,1	-238414258,9	-96425239,88	25694890,14	-1678539239	-1280790464	-820612464,5	-433050176	-56479354,16
Period	0	1	2	3	4	5	6	7	8	9	10

DISCOUNTING RATE	16%
NPV (Subsidiary 1)	**25694890,14**
NPV (Subsidiary 2-8), Year 5	-82174244,3
NPV (Subsidiary 2-8), Year 0	**-39124227,24**
CAPEX (Subsidiaries 2-8)	2555000000
CAPEX (Subsidiaries 2-8), discounted, Year 5	2202586207
CAPEX (Subsidiaries 2-8), discounted, Year 1	1048679961
Strike price (K)	**2202586207**
Price of underlying asset (S)	641622317,5
Standard deviation	30,85%
Risk-free rate	5,50%
d(1)	-1,044445195
d(2)	-1,734255195
N(d1)	0,148139731
N(d2)	0,041436407
Call price	**25725692,82**

The discounting rate of 16% was fixed by the company for all IT projects (that is why WACC was not calculated).

Figure 20. *The call price calculation*

Source: compiled by the author

APPENDIX 2. PROJECT 2 CALCULATIONS

The project: solution for accompanying the process of equipment repair at the stages of planning, implementation, and completion.

FIXED COSTS	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Improvement of the calendar repair time due to the implementation of the solution	**101592055**	**500000**	**500000**	**500000**	**500000**	**500000**	**280500000**	**500000**	**500000**	**500000**	**500000**
Capex	***96000000***	***0***	***0***	***0***	***0***	***0***	***280000000***	***0***	***0***	***0***	***0***
External consulting	56000000	-	-	-	-	-	-	-	-	-	-
Equipment	40000000	-	-	-	-	-	280000000	-	-	-	-
Opex	***5592054,967***	***500000***	***500000***	***500000***	***500000***	***500000***	***500000***	***500000***	***500000***	***500000***	***500000***
External consulting	3050000	500000	500000	500000	500000	500000	500000	500000	500000	500000	500000
Internal consulting (PM)	658354,9674	-	-	-	-	-	-	-	-	-	-
Internal consulting (Architects)	1657243	-	-	-	-	-	-	-	-	-	-
Internal consulting (Business Analysis)	226457	-	-	-	-	-	-	-	-	-	-
Improvement productive repair time by implementing a solution	**91289539,98**	**600000**	**600000**	**600000**	**600000**	**600000**	**424200000**	**4200000**	**4200000**	**4200000**	**4200000**
Capex	***83000000***	***0***	***0***	***0***	***0***	***0***	***420000000***	***0***	***0***	***0***	***0***
External consulting	23000000	-	-	-	-	-	-	-	-	-	-
Equipment	30000000	-	-	-	-	-	210000000	-	-	-	-
Licenses	30000000	-	-	-	-	-	210000000	-	-	-	-
Opex	***8289539,981***	***600000***	***600000***	***600000***	***600000***	***600000***	***4200000***	***4200000***	***4200000***	***4200000***	***4200000***
External consulting	4760000	600000	600000	600000	600000	600000	4200000	4200000	4200000	4200000	4200000
Internal consulting (PM)	1645839,981	-	-	-	-	-	-	-	-	-	-
Internal consulting (Architects)	1657243	-	-	-	-	-	-	-	-	-	-
Internal consulting (Business Analysis)	226457	-	-	-	-	-	-	-	-	-	-
Licenses (support)	0	-	-	-	-	-	-	-	-	-	-
TOTAL	**192881594,9**	**1100000**	**1100000**	**1100000**	**1100000**	**1100000**	**704700000**	**4700000**	**4700000**	**4700000**	**4700000**

Figure 21. *Fixed costs calculation*

Source: compiled by the author

VARIABLE COSTS	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Expenditures on overhaul and optimization of the well working mode	0	16000000	34000000	34000000	34000000	34000000	112000000	238000000	238000000	238000000	238000000
Reengineering activities	0	200000000	100000000	80000000	80000000	80000000	1400000000	700000000	560000000	560000000	560000000
TOTAL VARIABLE COSTS	**0**	**216000000**	**134000000**	**114000000**	**114000000**	**114000000**	**1512000000**	**938000000**	**798000000**	**798000000**	**798000000**
			-38%	-15%	0%	0%	1226%	-38%	-15%	0%	0%

The flows of variable costs were not simulated but were calculated in this particular case, as the simulation is impossible to complete: the flow is inconsistent and changes with different growth ratio.

Figure 22. *Variable costs calculation*

Source: compiled by the author

REVENUE	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Income due to improvement of the calendar repair time due to the implementation of the solution	0	0	0	897997535,7	927906913,3	944412381,4	744411563,4	753219584,9	745096108,8	856745017,9	945071699,8
Income due to the improvement productive repair time by implementing a solution	0	0	0	96792,04754	107932,8805	1209176,511	49176,51147	50533,11252	52014,32563	70565,11252	72783,32563
TOTAL REVENUE	**0**	**0**	**0**	**898094327,7**	**928014846,1**	**945621558**	**744460740**	**753270118,1**	**745148123,1**	**856815583,1**	**945144483,1**
		#DIV/0!	#DIV/0!	#DIV/0!	3,33%	1,90%	-21,27%	1,18%	-1,08%	14,99%	10,31%

The flows of revenue were not simulated but were calculated in this particular case, as the simulation is impossible to complete: the flow is inconsistent and changes with different growth ratio.

Figure 23. *Revenue calculation*

Source: compiled by the author

B23 *fx* =B20

	A	B	C	D	E	F	G	H	I	J	K	L
1		**Year 0**	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**Year 8**	**Year 9**	**Year 10**
2	**TOTAL REVENUE**	**0**	**0**	**0**	**898094327,7**	**928014846,1**	**945621558**	**744460740**	**753270118,1**	**745148123,1**	**856815583,1**	**945144483,1**
3	**TOTAL COSTS**	**192881594,9**	**217100000**	**135100000**	**115100000**	**115100000**	**115100000**	**2216700000**	**942700000**	**802700000**	**802700000**	**802700000**
4	**Fixed costs**	**192881594,9**	**1100000**	**1100000**	**1100000**	**1100000**	**1100000**	**704700000**	**4700000**	**4700000**	**4700000**	**4700000**
5	CAPEX	179000000	0	0	0	0	0	700000000	0	0	0	0
6	OPEX	13881594,95	1100000	1100000	1100000	1100000	1100000	4700000	4700000	4700000	4700000	4700000
7	**Variable costs**	**0**	**216000000**	**134000000**	**114000000**	**114000000**	**114000000**	**1512000000**	**938000000**	**798000000**	**798000000**	**798000000**
8	**FCF**	**-192881594,9**	**-2,17E+08**	**-135100000**	**782994327,7**	**812914846,1**	**830521558**	**-1472239260**	**-189429881,9**	**-57551876,89**	**54115583,06**	**142444483,1**
9	DCF	-192881594,9	-187155172	-100401308	501631324,4	448965632,9	395422123,3	-604269201,3	-67025886,07	-17554787,54	14229853,83	32289828,72
10	CDCF	-192881594,9	-380036767	-480438075,3	21193249,08	470158881,9	865581005,3	261311804	194285917,9	176731130,4	190960984,2	223250812,9
11	Period	0	1	2	3	4	5	6	7	8	9	10
12												
13												
14	DISCOUNTING RATE	16%										
15	**NPV (Subsidiary 1)**	**865581005,3**										
16	NPV (Subsidiary 2-8), Year 5	-642330192,4										
17	**NPV (Subsidiary 2-8), Year 0**	**-305821764,8**										
18												
19	CAPEX (Subsidiaries 2-8)	700000000										
20	CAPEX (Subsidiaries 2-8), discounted, Year 5	603448275,9										
21	CAPEX (Subsidiaries 2-8), discounted, Year 1	287309578,3										
22												
23	**Strike price (K)**	**603448275,9**										
24	Price of underlying asset (S)	192881594,9										
25	Standard deviation	30,85%										
26	Risk-free rate	5,50%										
27												
28	d(1)	-0,909909844										
29	d(2)	-1,599719844										
30	N(d1)	0,181435029										
31	N(d2)	0,054830374										
32	**Call price**	**9863291,174**										

The discounting rate of 16% was fixed by the company for all IT projects (that is why WACC was not calculated).

Figure 24. *Strike price calculation*

Source: compiled by the author

B24 | fx =-B9

	A	B	C	D	E	F	G	H	I	J	K	L
1		**Year 0**	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**Year 8**	**Year 9**	**Year 10**
2	**TOTAL REVENUE**	**0**	**0**	**0**	**898094327,7**	**928014846,1**	**945621558**	**744460740**	**753270118,1**	**745148123,1**	**856815583,1**	**945144483,1**
3	**TOTAL COSTS**	**192881594,9**	**217100000**	**135100000**	**115100000**	**115100000**	**115100000**	**2216700000**	**942700000**	**802700000**	**802700000**	**802700000**
4	**Fixed costs**	**192881594,9**	**1100000**	**1100000**	**1100000**	**1100000**	**1100000**	**704700000**	**4700000**	**4700000**	**4700000**	**4700000**
5	CAPEX	179000000	0	0	0	0	0	700000000	0	0	0	0
6	OPEX	13881594,95	1100000	1100000	1100000	1100000	1100000	4700000	4700000	4700000	4700000	4700000
7	**Variable costs**	**0**	**216000000**	**134000000**	**114000000**	**114000000**	**114000000**	**1512000000**	**938000000**	**798000000**	**798000000**	**798000000**
8	**FCF**	**-192881594,9**	**-2,17E+08**	**-135100000**	**782994327,7**	**812914846,1**	**830521558**	**-1472239260**	**-189429881,9**	**-57551876,89**	**54115583,06**	**142444483,1**
9	DCF	-192881594,9	-187155172	-100401308	501631324,4	448965632,9	395422123,3	-604269201,3	-67025886,07	-17554787,54	14229853,83	32289828,72
10	CDCF	-192881594,9	-380036767	-480438075,3	21193249,08	470158881,9	865581005,3	261311804	194285917,9	176731130,4	190960984,2	223250812,9
11	Period	0	1	2	3	4	5	6	7	8	9	10
12												
13												
14	DISCOUNTING RATE	16%										
15	**NPV (Subsidiary 1)**	**865581005,3**										
16	NPV (Subsidiary 2-8), Year 5	-642330192,4										
17	**NPV (Subsidiary 2-8), Year 0**	**-305821764,8**										
18												
19	CAPEX (Subsidiaries 2-8)	700000000										
20	CAPEX (Subsidiaries 2-8), discounted, Year 5	603448275,9										
21	CAPEX (Subsidiaries 2-8), discounted, Year 1	287309578,3										
22												
23	**Strike price (K)**	**603448275,9**										
24	Price of underlying asset (S)	192881594,9										
25	Standard deviation	30,85%										
26	Risk-free rate	5,50%										
27												
28	d(1)	-0,909909844										
29	d(2)	-1,599719844										
30	N(d1)	0,181435029										
31	N(d2)	0,054830374										
32	**Call price**	**9863291,174**										

The discounting rate of 16% was fixed by the company for all IT projects (that is why WACC was not calculated).

Figure 25. *Price of underlying asset calculation*

Source: compiled by the author

A	B	C	D	E	F	G	H	I	J	K	L
	Year 0	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**Year 8**	**Year 9**	**Year 10**
TOTAL REVENUE	**0**	**0**	**0**	**898094327,7**	**928014846,1**	**945621558**	**744460740**	**753270118,1**	**745148123,1**	**856815583,1**	**945144483,1**
TOTAL COSTS	**192881594,9**	**217100000**	**135100000**	**115100000**	**115100000**	**115100000**	**2216700000**	**942700000**	**802700000**	**802700000**	**802700000**
Fixed costs	**192881594,9**	**1100000**	**1100000**	**1100000**	**1100000**	**1100000**	**704700000**	**4700000**	**4700000**	**4700000**	**4700000**
CAPEX	179000000	0	0	0	0	0	700000000	0	0	0	0
OPEX	13881594,95	1100000	1100000	1100000	1100000	1100000	4700000	4700000	4700000	4700000	4700000
Variable costs	**0**	**216000000**	**134000000**	**114000000**	**114000000**	**114000000**	**1512000000**	**938000000**	**798000000**	**798000000**	**798000000**
FCF	**-192881594,9**	**-2,17E+08**	**-135100000**	**782994327,7**	**812914846,1**	**830521558**	**-1472239260**	**-189429881,9**	**-57551876,89**	**54115583,06**	**142444483,1**
DCF	-192881594,9	-187155172	-100401308	501631324,4	448965632,9	395422123,3	-604269201,3	-67025886,07	-17554787,54	14229853,83	32289828,72
CDCF	-192881594,9	-380036767	-480438075,3	21193249,08	470158881,9	865581005,3	261311804	194285917,9	176731130,4	190960984,2	223250812,9
Period	0	1	2	3	4	5	6	7	8	9	10
DISCOUNTING RATE	16%										
NPV (Subsidiary 1)	**865581005,3**										
NPV (Subsidiary 2-8), Year 5	-642330192,4										
NPV (Subsidiary 2-8), Year 0	**-305821764,8**										
CAPEX (Subsidiaries 2-8)	700000000										
CAPEX (Subsidiaries 2-8), discounted, Year 5	603448275,9										
CAPEX (Subsidiaries 2-8), discounted, Year 1	287309578,3										
Strike price (K)	**603448275,9**										
Price of underlying asset (S)	192881594,9										
Standard deviation	30,85%										
Risk-free rate	5,50%										
d(1)	-0,909909844										
d(2)	-1,599719844										
N(d1)	0,181435029										
N(d2)	0,054830374										
Call price	**9863291,174**										

The discounting rate of 16% was fixed by the company for all IT projects (that is why WACC was not calculated).

Figure 26. *d1 calculation*

Source: compiled by the author

B29 | fx =B28-B25*5^(1/2)

	A	B	C	D	E	F	G	H	I	J	K	L
1		Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
2	TOTAL REVENUE	0	0	0	898094327,7	928014846,1	945621558	744460740	753270118,1	745148123,1	856815583,1	945144483,1
3	TOTAL COSTS	192881594,9	217100000	135100000	115100000	115100000	115100000	2216700000	942700000	802700000	802700000	802700000
4	Fixed costs	192881594,9	1100000	1100000	1100000	1100000	1100000	704700000	4700000	4700000	4700000	4700000
5	CAPEX	179000000	0	0	0	0	0	700000000	0	0	0	0
6	OPEX	13881594,95	1100000	1100000	1100000	1100000	1100000	4700000	4700000	4700000	4700000	4700000
7	Variable costs	0	216000000	134000000	114000000	114000000	114000000	1512000000	938000000	798000000	798000000	798000000
8	FCF	-192881594,9	-2,17E+08	-135100000	782994327,7	812914846,1	830521558	-1472239260	-189429881,9	-57551876,89	54115583,06	142444483,1
9	DCF	-192881594,9	-187155172	-100401308	501631324,4	448965632,9	395422123,3	-604269201,3	-67025886,07	-17554787,54	14229853,83	32289828,72
10	CDCF	-192881594,9	-380036767	-480438075,3	21193249,08	470158881,9	865581005,3	261311804	194285917,9	176731130,4	190960984,2	223250812,9
11	Period	0	1	2	3	4	5	6	7	8	9	10
12												
13												
14	DISCOUNTING RATE	16%										
15	NPV (Subsidiary 1)	865581005,3										
16	NPV (Subsidiary 2-8), Year 5	-642330192,4										
17	NPV (Subsidiary 2-8), Year 0	-305821764,8										
18												
19	CAPEX (Subsidiaries 2-8)	700000000										
20	CAPEX (Subsidiaries 2-8), discounted, Year 5	603448275,9										
21	CAPEX (Subsidiaries 2-8), discounted, Year 1	287309578,3										
22												
23	Strike price (K)	603448275,9										
24	Price of underlying asset (S)	192881594,9										
25	Standard deviation	30,85%										
26	Risk-free rate	5,50%										
27												
28	d(1)	-0,909909844										
29	d(2)	-1,599719844										
30	N(d1)	0,181435029										
31	N(d2)	0,054830374										
32	Call price	9863291,174										

Comment: **The discounting rate of 16%** was fixed by the company for all IT projects (that is why WACC was not calculated).

Figure 27. *d2 calculation*

Source: compiled by the author

B30 | fx =NORMSDIST(B28)

	A	B	C	D	E	F	G	H	I	J	K	L
1		Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
2	TOTAL REVENUE	0	0	0	898094327,7	928014846,1	945621558	744460740	753270118,1	745148123,1	856815583,1	945144483,1
3	TOTAL COSTS	192881594,9	217100000	135100000	115100000	115100000	115100000	2216700000	942700000	802700000	802700000	802700000
4	Fixed costs	192881594,9	1100000	1100000	1100000	1100000	1100000	704700000	4700000	4700000	4700000	4700000
5	CAPEX	179000000	0	0	0	0	0	700000000	0	0	0	0
6	OPEX	13881594,95	1100000	1100000	1100000	1100000	1100000	4700000	4700000	4700000	4700000	4700000
7	Variable costs	0	216000000	134000000	114000000	114000000	114000000	1512000000	938000000	798000000	798000000	798000000
8	FCF	-192881594,9	-2,17E+08	-135100000	782994327,7	812914846,1	830521558	-1472239260	-189429881,9	-57551876,89	54115583,06	142444483,1
9	DCF	-192881594,9	-187155172	-100401308	501631324,4	448965632,9	395422123,3	-604269201,3	-67025886,07	-17554787,54	14229853,83	32289828,72
10	CDCF	-192881594,9	-380036767	-480438075,3	21193249,08	470158881,9	865581005,3	261311804	194285917,9	176731130,4	190960984,2	223250812,9
11	Period	0	1	2	3	4	5	6	7	8	9	10
12												
13												
14	DISCOUNTING RATE	16%										
15	NPV (Subsidiary 1)	865581005,3										
16	NPV (Subsidiary 2-8), Year 5	-642330192,4										
17	NPV (Subsidiary 2-8), Year 0	-305821764,8										
18												
19	CAPEX (Subsidiaries 2-8)	700000000										
20	CAPEX (Subsidiaries 2-8), discounted, Year 5	603448275,9										
21	CAPEX (Subsidiaries 2-8), discounted, Year 1	287309578,3										
22												
23	Strike price (K)	603448275,9										
24	Price of underlying asset (S)	192881594,9										
25	Standard deviation	30,85%										
26	Risk-free rate	5,50%										
27												
28	d(1)	-0,909909844										
29	d(2)	-1,599719844										
30	N(d1)	0,181435029										
31	N(d2)	0,054830374										
32	Call price	9863291,174										

Comment: **The discounting rate of 16%** was fixed by the company for all IT projects (that is why WACC was not calculated).

Figure 27. *Probability N(d1) calculation*

Source: compiled by the author

B31 =NORMSDIST(B29)

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
TOTAL REVENUE	0	0	0	898094327,7	928014846,1	945621558	744460740	753270118,1	745148123,1	856815583,1	945144483,1
TOTAL COSTS	192881594,9	217100000	135100000	115100000	115100000	115100000	2216700000	942700000	802700000	802700000	802700000
Fixed costs	192881594,9	1100000	1100000	1100000	1100000	1100000	704700000	4700000	4700000	4700000	4700000
CAPEX	179000000	0	0	0	0	0	700000000	0	0	0	0
OPEX	13881594,95	1100000	1100000	1100000	1100000	1100000	4700000	4700000	4700000	4700000	4700000
Variable costs	0	216000000	134000000	114000000	114000000	114000000	1512000000	938000000	798000000	798000000	798000000
FCF	-192881594,9	-2,17E+08	-135100000	782994327,7	812914846,1	830521558	-1472239260	-189429881,9	-57551876,89	54115583,06	142444483,1
DCF	-192881594,9	-187155172	-100401308	501631324,4	448965632,9	395422123,3	-604269201,3	-67025886,07	-17554787,54	14229853,83	32289828,72
CDCF	-192881594,9	-380036767	-480438075,3	21193249,08	470158881,9	865581005,3	261311804	194285917,9	176731130,4	190960984,2	223250812,9
Period	0	1	2	3	4	5	6	7	8	9	10

DISCOUNTING RATE	16%
NPV (Subsidiary 1)	865581005,3
NPV (Subsidiary 2-8), Year 5	-642330192,4
NPV (Subsidiary 2-8), Year 0	-305821764,8
CAPEX (Subsidiaries 2-8)	700000000
CAPEX (Subsidiaries 2-8), discounted, Year 5	603448275,9
CAPEX (Subsidiaries 2-8), discounted, Year 1	287309578,3
Strike price (K)	603448275,9
Price of underlying asset (S)	192881594,9
Standard deviation	30,85%
Risk-free rate	5,50%
d(1)	-0,909909844
d(2)	-1,599719844
N(d1)	0,181435029
N(d2)	0,054830374
Call price	9863291,174

The discounting rate of 16% was fixed by the company for all IT projects (that is why WACC was not calculated).

Figure 28. *Probability N(d2) calculation*

Source: compiled by the author

B32 =B24*B30-B23*EXP(-B26*5)*B31

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
TOTAL REVENUE	0	0	0	898094327,7	928014846,1	945621558	744460740	753270118,1	745148123,1	856815583,1	945144483,1
TOTAL COSTS	192881594,9	217100000	135100000	115100000	115100000	115100000	2216700000	942700000	802700000	802700000	802700000
Fixed costs	192881594,9	1100000	1100000	1100000	1100000	1100000	704700000	4700000	4700000	4700000	4700000
CAPEX	179000000	0	0	0	0	0	700000000	0	0	0	0
OPEX	13881594,95	1100000	1100000	1100000	1100000	1100000	4700000	4700000	4700000	4700000	4700000
Variable costs	0	216000000	134000000	114000000	114000000	114000000	1512000000	938000000	798000000	798000000	798000000
FCF	-192881594,9	-2,17E+08	-135100000	782994327,7	812914846,1	830521558	-1472239260	-189429881,9	-57551876,89	54115583,06	142444483,1
DCF	-192881594,9	-187155172	-100401308	501631324,4	448965632,9	395422123,3	-604269201,3	-67025886,07	-17554787,54	14229853,83	32289828,72
CDCF	-192881594,9	-380036767	-480438075,3	21193249,08	470158881,9	865581005,3	261311804	194285917,9	176731130,4	190960984,2	223250812,9
Period	0	1	2	3	4	5	6	7	8	9	10

DISCOUNTING RATE	16%
NPV (Subsidiary 1)	865581005,3
NPV (Subsidiary 2-8), Year 5	-642330192,4
NPV (Subsidiary 2-8), Year 0	-305821764,8
CAPEX (Subsidiaries 2-8)	700000000
CAPEX (Subsidiaries 2-8), discounted, Year 5	603448275,9
CAPEX (Subsidiaries 2-8), discounted, Year 1	287309578,3
Strike price (K)	603448275,9
Price of underlying asset (S)	192881594,9
Standard deviation	30,85%
Risk-free rate	5,50%
d(1)	-0,909909844
d(2)	-1,599719844
N(d1)	0,181435029
N(d2)	0,054830374
Call price	9863291,174

The discounting rate of 16% was fixed by the company for all IT projects (that is why WACC was not calculated).

Figure 29. *Call price calculation*

Source: compiled by the author

As the call price is positive, the option to expand should be exercised as well. Though NPV of the MVP was positive, the NPV of the expansion and the total NPV occurred to be negative. The company made a decision not to expand that project. But on the basis of the ROV model, the decision should have been made that the project should have been continued. So, there is a high probability that the company made another unfortunate investment decision.