Business Game for PMBoK Standard Training of Project Managers

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Abstract. Among the approaches to project management that are widely used in the world, the PMBoK standard should be noted. Training project managers for this standard is widespread. Business games can be applied to consolidate the knowledge gained during the study of the standard, as well as to master the approaches to decision-making when using it. An analysis of the literature showed that there is a fairly large range of business games for training project managers, but there is no game that would be devoted to studying the processes of the PMBoK standard and making decisions regarding the application of these processes, taking into account their costs and the risks that they eliminate. The purpose of the work is to create a business game that will allow to model decision-making by the project management team to create engineering products using the PMBoK standard. Since every year more and more IT products are used in engineering production, such a game will be relevant for mastering the management of IT projects in this area.

The work suggests a business game. The idea of the game is that the members of the project management team make moves on the playing field. At the same time, they fall into one or another management process or the process of creating and putting into production new products. Next, the player must choose a management process from the PMBoK processes that is most appropriate for the situation, taking into account its cost and risks that can be eliminated when applied. The winner is the team that got the best result in a multi-criteria sense, i.e. spent less money and the total remaining risk for all processes is less. The judge sums up the result using a generalized criterion.

Keywords: Business Game, Project Management, Engineering.

1 Business Games in the Field of Project Management

The training of project managers is currently widespread. Such training is conducted both in educational institutions and directly in companies. To consolidate the knowledge gained during the study of existing methodologies and standards in the

field of project management, as well as to master approaches to decision making when using them, business games can be applied.

Business games have many properties, including:

- activation of participants' mental activity;

- giving participants the opportunity to improve their knowledge and skills not only at the expense of the coach's skills set but also at the expense of each other's skills sets;

- involvement of all three components of personality in the training process: intellectual, emotional and strong-willed.

Case study, role play, simulations are often recognized by scientists as training methods with the greatest efficiency, they create situations that mimic the projects that we deliver in our daily work. This encourages the student to actively participate in the game or training process. Motivation, interest and role-playing games deepen the learning process. A good way to improve your motivation to learn is to create an environment in which everyone will play a role related to a real project environment [1,2].

Many researchers made attempts to determine and classify the unique characteristics of various experiential studying techniques. Henry Ellington [3] recorded important observations related to games, simulations, case studies and role-plays. Clark N. Quinn said, "Learning is at its best when it is goal-oriented, contextual, interesting, challenging, and interactive" [4].

Adult learning is studied in numerous works. A learning theory called the Learning cycle was developed by David A. Kolb, who published his model in 1984 [5]. The learning cycle basically involves four stages, namely: concrete learning, reflective observation, abstract conceptualization, and active experimentation. Effective learning can be seen when the learner progresses through the cycle. The learner can also enter the cycle at any stage of the cycle with a logical sequence.

David Veshosky and Johannes H. Egbers [6] describe in their study, how they used a simulation game to teach project management at Lehigh University. They found out that the game was successful when it was used in teaching project management functions and a systematic approach to project management. However, the game did not fully cope with its functions in teaching those concepts that are related to financial and technology management.

In the literature, there are enough classifications of business games by different criteria. For example, according to the methodology of conducting: hole games, role plays, group discussions, simulation games, organizational-activity games, emotional-activity games and ensemble games [7].

Among the existing business board games in the field of project management, there are a number of games that help to improve understanding of project management methodology and improve the skills of managers in different work situations.

It is worth considering the "Sea Wolf Games" developed by Competent.PM [8]. The first version of the game is "PM Game", in which you have to move through the playing field with the help of a cube. The field is made up of small circles and stars, and the participant must pick up the card and solve the situation on it. Accordingly, there is a deck of cards that launch various project management situations and help

consolidate knowledge about management processes, areas of expertise, competencies, terminology, practices, and more. Situations span different spheres of life - from working in the library to developing software. Various roles can be introduced into the project, such as project manager, consultant and others.

The second version of the game is "Sea Wolf" PM Game. This version was developed before the 30th World Congress of IPMA and for the development of ideas of the ICB4 standard on competence. The essence of the game lies in advancing the field and, according to the situation on the card, selecting components of the ICB4 standard. Just like in the first version, there are cards that show problematic situations to solve.

Among the developers of business games for project management is the company Center-Game, one of the business games they have created is "Golden Spike" [9]. It is an interactive training of project teams, which in a game form teaches to manage changes and conflicts, to allocate resources and tasks; to develop skills in practice. The essence of the game lies in the passage of a certain trail - the construction of the railway, the field, which looks like a honeycomb. In the process, you need to purchase the necessary elements for the construction of the road and to solve the emerging situations.

Another example of a Center-Game business game is "Project Cycle", which reproduces the real launch of a project and teaches you how to manage it effectively. Participants join in teams to create a product, limited by customer requests, market requirements, timing, and budget. Players create a prototype and test it in real-world conditions. The more products you create, the better your chances of winning. In just a few hours, the team goes all the way from generating ideas to prototyping, first sales, and mass production. This game is focused on getting started in project activities or Agile project management.

The consulting company BuroAkzent has created an "In Time" business game [10]. This game allows you to get acquainted with the basic principles of time management, to understand the need for planning, to see your weaknesses in planning and organizing activities, to learn how to distribute tasks and more. In the course of the game, the participants take on the role of manager of the trade and industrial holding company "Turbion", where it is necessary to solve tasks, recruit staff and select projects.

Another game of this company is "Project Management. Construction of the Tower Bridge" [11]. The essence of the game, according to the name, is to make a bridge from the Lego building set, during which participants try on various roles, create a project, agree on a budget, respond to risky events and build a quality bridge.

A popular game for the flexible project management methodology training is "Scrum Game" [12]. The essence of the game is for participants to gain experience of working with Scrum, having gone through the stages of Sprint Planning and its Execution, facing the situations closer to reality. Based on their experience, teams draw conclusions and learn over three sprint iterations. The game uses the roles and all the artifacts that are inherent in Scrum Methodology [13] in real work.

Another commonly used tool when working on Scrum methodology is Scrum poker. Planning poker, also called Scrum poker, is a consensus-based, gamified technique

for estimating, mostly used to estimate effort or relative size of development goals in software development. In planning poker, members of the group make estimates by playing numbered cards face-down to the table, instead of speaking them aloud. The cards are revealed, and the estimates are then discussed. By hiding the figures in this way, the group can avoid the cognitive bias of anchoring, where the first number spoken aloud sets a precedent for subsequent estimates.

Planning poker is a variation of the Wideband Delphi method [14]. It is most commonly used in agile software development, in particular in Scrum and Extreme Programming.

The method was first defined and named by James Grenning in 2002 [15] and later popularized by Mike Cohn [16].

Analysis of existing business games showed that there is no board game aimed at studying the most famous standard in the field of project management - PMBoK [17], its processes. Such a game should simulate the decision-making by the project management team regarding the applied management processes, taking into account their cost, as well as the risks that arise when managing the project. The game should be based on the implementation of typical product creation processes in the field of mechanical engineering. Every year more and more IT products are used in engineering production, so this a game will be relevant for mastering the management of IT projects in this area.

Thus, the goal of the work is to create a business board game that will allow to model decision-making by the project management team to create engineering products using the PMBoK standard.

2   Rules of the "Cost-Risk" PM Game © Igor Kononenko, 2018

The "Cost-Risk" PM Game is designed to master the processes of the Project Management Body of Knowledge standard, 6th edition (PMBoK 6th ed.) [17] in the form of team competition. Two or more teams of players can take part in the game. The number of members of each team can vary from one to six. Each team mimics the actions of a project management team. The project is dedicated to the creation of mass production of engineering products. The game considers the following project management processes:

- Develop Project Charter
- Develop Project Management Plan
- Collect Requirements
- Define Scope
- Create WBS
- Develop Schedule
- Estimate Costs
- Determine Budget
- Plan Quality Management
- Estimate Activity Resources
- Plan Communications Management

- Identify Risks
- Perform Qualitative and Quantitative Risk Analysis
- Plan Risk Management
- Plan Procurement Management

It also discusses the processes of creation and launching the production of new products. These include:

1) Preparatory works:
- Determining the need for new products
- Product design development forecast
- Production technology development forecast
- Assessment of the current level of technology and organization of production
- Comprehensive standardization and unification

2) Product design development:
- Terms of reference
- Technical Proposal
- Preliminary design
- Technical project
- Development of the working documentation:
For the prototype
For the installation series
For the established serial or mass production

3) Production technology development:
- Documentation for the technological processes
- Documentation for the special technological equipment and accessories
- Documentation for the mechanization and automation means
- Production of the special technological equipment and accessories
- Production of the mechanization and automation means

4) Organization and planning preparation of the production:
- Development of the project for the organization of production processes
- Development of the system of labor organization and its payment
- Creation of the normative framework for technical and economic, operational and production planning
- Organization of logistics
- Organization of the system for servicing the new products at the consumer

5) The product launches:
- Redevelopment of the workshops and areas
- Installation and commissioning works
- Mastering of the new technological processes
- Delivery the acceptance committee of the installation series
- Product Quality Certification
Close Project.

Each team has at its disposal:
- a playing field (see Fig. 1),
- cards on which the names of the management processes from the PMBoK 6th ed standard are written and the costs of these processes are indicated,

- a field indicating the risks that arise at all stages of the project life cycle in the absence of appropriate project management processes, let's call it "Project risks",

- a table indicating the results of the cube,

- a cube for the roll,

- player chips,

- cards indicating the money allocated to each team.

The essence of the game is as follows. Players of one team are seated at a table on which all the components of the game are laid out. Team players form a project management team.

At the beginning of the game, the chips of all players are at the start of the playing field. The names of the managing and creating the project product processes are written on the playing field. The money allocated to the team is located in the Wallet rectangle (on the playing field). This money belongs to the whole team. In the Bank rectangle are the money of the bank. The player whose turn is next performs the functions of a project manager. He discusses his actions with the whole team and makes decisions on this basis.

The first player rolls a cube. Then he moves his chip along the managing and creating a project product processes on the playing field by as many positions as there are points on the top of the cube. Each process on the "playing field" corresponds to a situation on the field indicating risks. The player must close a square with a description of the risk event with a card with the name of the corresponding process and its cost. For this, the player must pay the bank with team money. The task is to cover risk events with process cards so that less money is spent and the total remaining risk for all processes is minimal.

If at the same time the player fell into a rectangle with a "?" sign, then he rolls the cube again. Depending on the number of points on the top face of the cube, the player selects the event indicated in the Table 1.

If the team won extra money, the player takes it from the Bank rectangle and moves it to the Wallet rectangle. If the team must pay, then it pays with the money to the bank.

Then the next player makes a move. It is advisable that the players make moves in a certain order, for example, as they sit at the table, clockwise. All actions are repeated. If a player enters a process that another player has already been in or is currently in, he must cover a risk event not yet closed by the process. If there are no such events not yet covered by process cards, then the player moves to the next process of managing or creating the project product. If the team runs out of money before the end of the project, it is considered a loser.
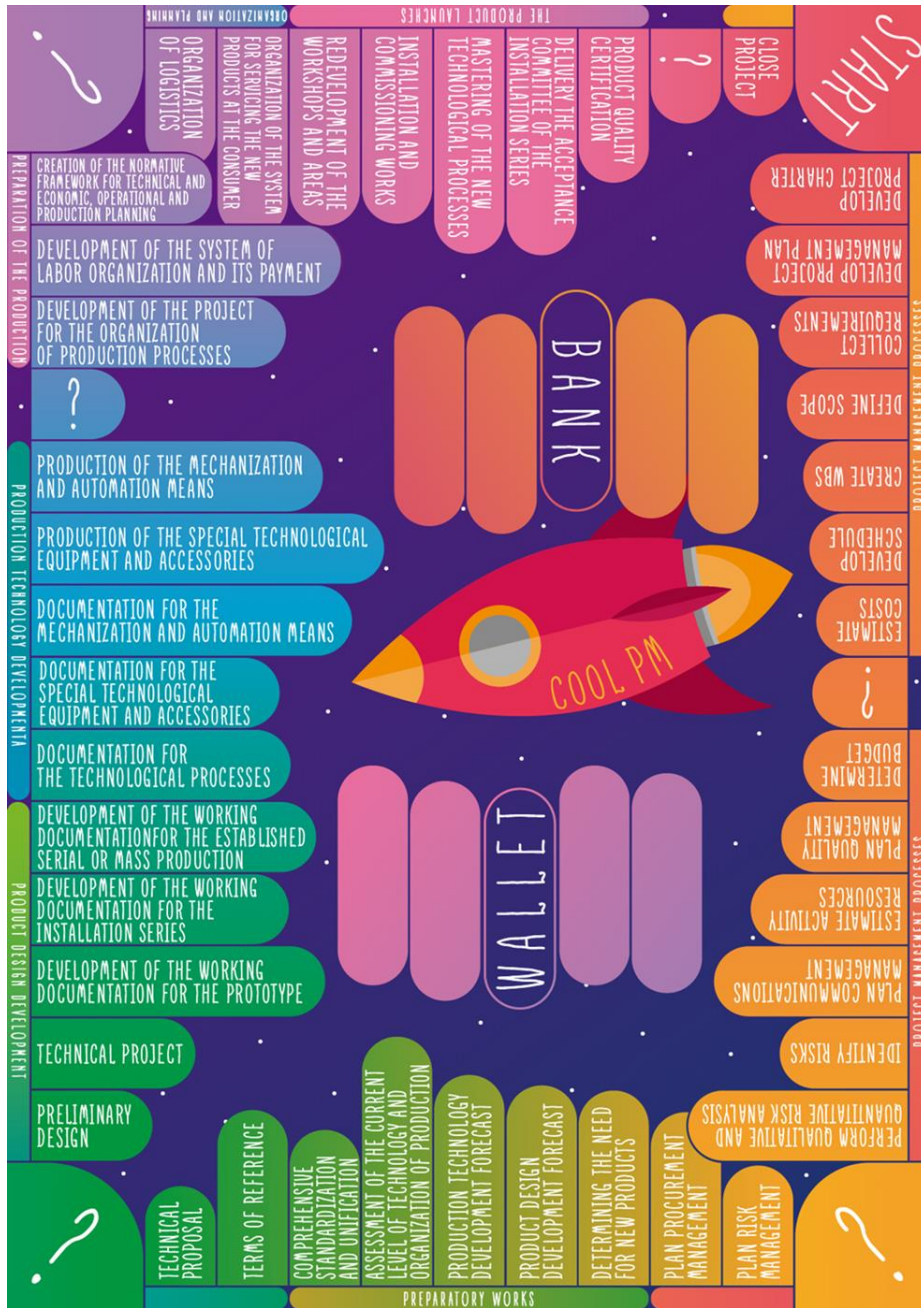
Fig. 1. The playing field.

Table 1. Cube roll results.

Cube roll results	Event
1	The cost of Cube roll results purchased equipment has increased. You lost $10,000.
2	Serious flaws were found in the project product. You lost $7000.
3	Leading project management specialist resigned. You lost $5000.
4	You have been awarded an honorary diploma.
5	The cost of components has decreased. You saved $3000.
6	The project budget was increased by $10,000.

The game ends when the chips of all players are in the "Close project" rectangle. After that, there is a calculation of the money spent by the teams that have reached the finish line. All the risks that have not been covered by management processes are summarized. The winner is the team that got the best result according to two criteria in a multi-criteria sense, i.e. spent less money and the total remaining risk for all processes is less. The judge sums up the result using a generalized criterion.

3 Summing up Results of the Game

For each team, it is necessary to calculate the sum of all money spent and the sum of all risks that have remained uncovered by the management processes. The minimum value of money spent among participating teams, let's call it C_{min}, and the maximum value of money spent among participating teams, let's call it C_{max}, is chosen. Similarly, the minimum value of uncovered risks among the participating teams, let's call it R_{min}, and the maximum value of uncovered risks among the participating teams, let's call it R_{max}, is chosen. The result of the team (in points) is calculated by the following formula

$$Outcome = 0,6(C - C_{min})/(C_{max} - C_{min}) + 0,4(R - R_{min})/(R_{max} - R_{min}), \quad (1)$$

where C and R are the costs and remaining risks of a particular team.
The winner is the team whose Outcome is less.

To make calculations during the game an application was developed. C# was used as the programming language. The developed application is intended for automation of calculations during the business board game, for use by the master (referee) of the game.

The application allows you to enter the number of teams, budget, current moves (processes for creating and launching new products, management processes, risk events, and risk values), calculate the results (money spent, residual risk points), and choose the winner of the game. After starting the application, an initial window will appear in front of the user. In order to create a new game, you must click on the appropriate button "New Game" in the upper left corner of the window.

In the "Team Name" field, you must enter, accordingly, the name of the first team and click the "Add Team" button. These actions must be performed until all teams have been entered. In the field "Budget" you must enter the starting amount of money. It is the same for each team. After entering the teams and budget, you need to click on the "Confirm" button and the user will go to the next window. The screen will display the progress of the game for each team (see Fig. 2).
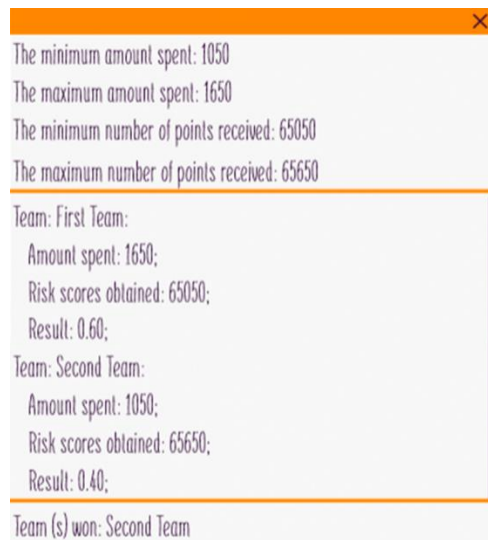

Fig. 2. Progress of the game

In the tables that appear, you need to select the group to which the current process belongs, select the current process, and select the risk and the management process.

After selecting all the parameters, click on the "Add" button. In case of an error, the move can be deleted by clicking on the corresponding "Delete" button. The same steps are repeated to enter the moves of other teams.

The game ends after all the teams get into the cell with the Close Project process. After that, click on the "Get Results" button in the upper left corner of the window. The results window will appear in front of the user (see Fig. 3).

The minimum amount spent: 1050
The maximum amount spent: 1650
The minimum number of points received: 65050
The maximum number of points received: 65650

Team: First Team:
    Amount spent: 1650;
    Risk scores obtained: 65050;
    Result: 0.60;
Team: Second Team:
    Amount spent: 1050;
    Risk scores obtained: 65650;
    Result: 0.40;
Team (s) won: Second Team

Fig. 3. Results window

It shows the amounts spent by each team, the maximum and minimum of them, the obtained risk points, the maximum and minimum of them, the coefficient for each team and the winner selected.

To get help on the application, click on the "Help" button on the top panel of the application.

4   Conclusion

As a result of the work, the desktop business game the "Cost-Risk" PM Game was created. The game is designed for project managers to master PMBoK standard processes. Both project management processes and the processes of creating and launching the production of new products in the field of mechanical engineering are considered. During the game, participants are trained in decision making regarding the application of various project management processes. At the same time, they solve a two-criterion problem - it is necessary to minimize management costs and the remaining risks.

The following should be noted as the advantages of the game. All members of the project team communicate all the time in the decision-making process, each of them in his turn acts as a project manager and organizes a discussion on decision-making. The game contains random events. With the help of such events, the occurrence of financing problems or their successful resolution is simulated. Teams compete with each other so that players have excitement and a desire to be better than competitors. The processes of the PMBoK standard are constantly used by players to solve emerging problems, which contributes to the active understanding of the standard. The real stages of creating and putting into production new products that are consistent with best practices in this area are considered. The game can be used to train project managers in the field of IT for mastering management skills in the context of predictive project life cycles. It also can be used to train project managers in new education systems [18,19].

The developed game was successfully applied in the process of training project managers at the National Technical University "Kharkiv Polytechnic Institute", as well as participants in the 10th International Scientific and Practical Conference "Integrated Management", February 19 - February 21, 2019, Slavsko, Lviv region, Ukraine.

References

1. Drappa, A., Ludewig, J.: Simulation in Software Engineering Training. In: Proceedings of the International Conference on Software Engineering, pp. 199-208, Limerick, Ireland. (2000).
2. Dantas, R., Barros, M. Werner, C.: A Simulation Based Game for Project Management Experiential Learning. SEKE 19, p. 24 (2004).
3. Ellington, H., Fowlie, J., Gordon, M.: Using Games and Simulations in the Classroom: A Practical Guide for Teachers. 1st edn. Routledge (1998).
4. Quinn, C.: Engaging learning: Designing e-learning simulation games, John Wiley Publications, San Francisco (2005).
5. Kolb, D.: Experiential Learning: experience as the source of learning and development. Prentice Hall, Englewood Cliffs, NJ (1984).
6. Veshosky, D., Egbers, J.: Civil Engineering project management game: teaching with simulation. Journal of Professional Issues in Engineering Education and Practice 117(3), 203-213 (1991).
7. Lean, J., Moizer J., Towler, M., Abbey, C.: Simulations and games. Active Learning in Higher Education, SAGE Publications 7(3), 227-242 (2006).
8. Sea Wolf Games, https://www. competent.pm, last accessed 2019/12/14.
9. Golden Spike Game Homepage, https://center-game.com›goldenspike, last accessed 2019/12/14.
10. In Time Game Homepage, https://buro-akzent.ru/services/biznes-simulyacii-i-delovye-igry/in-time.html, last accessed 2019/12/14.
11. Tower Bridge Game Homepage, https://buro-akzent.ru/services/biznes-simulyacii-i-delovye-igry/stroitelstvo-tauerskogo-mosta.html, last accessed 2019/12/14.
12. Scrum Card Game Homepage, https://scrumcardgame.com/, last accessed 2019/12/14.
13. A Guide to the Scrum Body of Knowledge (SBOK™ Guide) –3rd edition, SCRUMstudy™, a brand of VMEdu, Inc, Arisona, USA, (2016).

14. Wiegers, K.: Practical Project Initiation: A Handbook with Tools. Microsoft Press (2007).
15. Grenning, J.: Planning Poker or How to avoid analysis paralysis while release planning. https://wingman-sw.com/articles/planning-poker, last accessed 2016/11/21.
16. Cohn, M.: Agile Estimating and Planning. Prentice Hall, NJ (2007).
17. A Guide to the Project Management Body of Knowledge (PMBOK® Guide) Sixth Edition. Project Management Institute (2017).
18. Bomba, A., Kunanets, N., Nazaruk, M., Pasichnyk, V., Veretennikova, N.: Information technologies of modeling processes for preparation of professionals in smart cities. Advances in Intelligent Systems and Computing 754, 702-712 (2019).
19. Veretennikova, N., Pasichnyk, V., Kunanets, N.,Gats, B.: E-Science: New paradigms, system integration and scientific research organization. In proceedings of the International Conference on Computer Sciences and Information Technologies, CSIT 2015, Lviv, Ukraine, pp. 76-81 (2015).