Development of an Innovative Methodology Supporting Project Risk Management in the Manufacturing Company of the Automotive Industry

Anna Gembalska-Kwiecień
Faculty of Organization and Management, Institute of Production Engineering, Silesian University of Technology, Roosevelta 26 str., Zabrze, Poland

Keywords: Innovations, Project Risk Management, Methodology, Optimization of the Decisions, Management Science.

Abstract: The presented article attempts to develop an innovative methodology for supporting risk management of the implementation of projects. The methodology applies to manufacturing companies of the automotive industry, because it is one of the industries where the projects are comparable to each other. On this basis, it is possible to identify the risks that occurred in the past during the various stages of projects, which can contribute to more effective risk management during the current and future projects. The paper presents selected methods of data analysis: statistical method and method of graphical data visualization. There are also shown recommendations for data collection and processing which will enable the development of the innovation called authorial methodology. This developed methodology describes how to collect data on ongoing projects, as well as how to make their analysis to allow their subsequent use. The presented methodology is to aimed at optimizing decision making for project implementation in management sciences.

1 INTRODUCTION

The basis of production companies of the automotive industry is the completion of projects. Extensive engineering centers, cooperating closely with production facilities, are responsible for the development of existing, and entirely new product concepts. Starting with the implementation of the developed solutions and ending in production. In situation where the project involves cooperation with crucial contractor for the company, or is intended to implement a very important strategic objectives of the company. The success depends on whether the company is competitive on the market.

Regardless of market segment of the company, the completion of projects involves many challenges, which are diverse and complex. However, the common feature for all difficulties is that they carry a risk. It could threaten the planned completion of the project, or lead to a total failure. To avoid failure, people such as project managers, operational managers, or leaders of the various units use methods supporting the management of risks. The aim of these methods is to prepare for the risk (negative risk – called threat »Korczowski, 2010; PMBOK Guide, 2012«) to respond in the incidents of danger, and to eliminate or at least to reduce their undesirable effects. Concept of the risk is also associated with the possibility of incidents which can lead to positive consequences: this risk is called opportunity (Jaafari, 2001). The role of the person responsible for this phase of the project is to make the opportunity happen.

In the case of companies whose functioning is based on the successful completion of projects, it is very important to pay attention to various aspects of the tasks. The aim is to improve efficiency, reduce the amount of unplanned costs and to achieve the intentions according to the plan. In such situations, it is important to draw the appropriate conclusions after, and during the completion of each project.

It should concern issues such as execution management tasks, cooperation with subcontractors, or the quality of the work performed by the individual functional groups. Information about these issues can be useful for risk management in the future, because the knowledge of the past risks or opportunities, combined with the knowledge on how

Gembalska-KwiecieÅĎ A.
Development of an Innovative Methodology Supporting Project Risk Management in the Manufacturing Company of the Automotive Industry.
DOI: 10.5220/0006121102650271
In *Proceedings of the 6th International Conference on Operations Research and Enterprise Systems (ICORES 2017)*, pages 265-271
ISBN: 978-989-758-218-9

to deal with such situations, can contribute to the fast, and appropriate risk response (Larose, 2006; Pickett and Elliot, 2007).

Sometimes after the completion of the project, there is not enough time to analyze it and draw conclusions, because next project is started very quickly.

In that case it is not possible to share the knowledge gained during the completion of the project with other employees of the company or to catalogue it properly. That is why it would be useful to have a tool to support fast archiving of information and knowledge, and to be able to draw conclusions on the basis of available data.

An obstacle to the practical use of such tool is the fact that each of project is innovative and unique, so their comparative analysis will not always make sense. However if similar projects would be studied, their comparison can provide useful information and lead to conclusions which will be helpful in managing the risk of other similar projects realized by the company in the future.

This situation takes place in companies in automotive industry, which realize many similar projects. This means that the projects are comparable to each other, and on this basis it is possible to formulate a thesis that the identify the risks that have occurred in the past at different stages of projects, it can contribute to more effective risk management during the current and future projects.

To be able to use this approach in practice, it is necessary to know the methodology of data analysis on completed projects in order to identify the risks related with them.

The aim of this paper is to develop the methodology for collecting and analyzing data on completed projects that allow their subsequent analysis, in order to identify key risks of projects, and provide valuable information.

2 METHODS OF DATA ANALYSIS

The development of the methodology of analysis of projects and to implement it as a tool based on a spreadsheet, it is helpful to have knowledge of exploration topics (Dvir, Raz and Shenhar, 2003). The following are methods for the analysis and presentation of data:

- The statistical method, which will be used in creating the spreadsheet, supporting project risk management. This method is based on the analysis of the probability of risks. The possibility of using this method is based on the information gathered from past projects;
- Method of graphical data visualization, which enables to analyze the data through the visual, and thus it gives the chance the data will be noticed in a way that would be difficult to determine through analysis of algorithm by a computer. The method should be used in the process of developing a spreadsheet, because it can provide additional opportunities to draw conclusions by the user through the observation of graphical presentation of the data (Hand, Mannila and Smyth, 2006).

Note, however, that before you can use the selected method, it is necessary to determine the appropriate method of collecting data on developing on developing projects.

3 METHODOLOGY OF DATA COLLECTION AND ANALYSIS

To make valuable data analysis it is necessary to determine the appropriate method of data collection. It was determined that the collection of data may occur as follows:

1) At the beginning of the project and at each of its stages, the following information should be provided:
   a) what budget has been allocated for the completion of the project (planned cost of completion);
   b) time planned for completion;
   c) the identified sources of uncertainty;
   d) the identified risks.
   e) the success factors of the project, which should be provided.
2) After completion of the project and at each of its stages, the following data should be collected:
   a) the amount of money that has been spent on the completion (actual cost);
   b) the duration of completion;
   c) the person responsible for the result of the work performed;
   d) persons/functional group that carried out the work;
   e) other stakeholders involved in the completion and their impact on the project;
   f) sources of uncertainty identified during the implementation;

g) sources of uncertainty, that resulted in materialized risks;
h) risks identified during the completion;
i) materialized risks;
j) financial and timing impact of materialized risks on project/stage;
k) success factors of the project, which should be provided.

In a situation where the above mentioned data was collected, it is possible to analyze it. Based on the literature, its solutions (Atkinson, 1999; Gardiner and Stewart, 2012; Pritchard 2002), and experience, it has been attempted to create a methodology supporting risk management of the completion of projects in the manufacturing company of the automotive industry.

The following is a developed methodology:

1) To conduct a separate analysis of each of the projects/stages:
   a) comparison of the project's budget with actual costs that had to be allocated for its completion;
   b) comparison of the budget of the project's stages with actual costs that had to be allocated for their completion;
   c) comparison of the planned completion time of the project with the actual time that was needed to complete it;
   d) comparison of the planned execution time of subsequent stages with the actual time that was needed to complete them;
   e) comparison of the list of sources of uncertainty identified before the start of project with those that have been identified during the subsequent stages;
   f) specification of the received summary list of uncertainties, which resulted with materialized risk during project's completion;
   g) comparison of the list of risks identified before the start of the project and at each of the stages, with those that have been identified during the completion of the project;
   h) specification of the received summary list of risks that have materialized and note their impact on the project in terms of cost and completion time;
   i) comparing the list of success factors of the project, which should be provided during its completion (and at each of the individual stages) with a list of success factors, which are guaranteed in the completion of tasks;
   j) to determinate which of other stakeholders involved in the project had positive, and which ones had negative impact on its completion;
   k) to determinate which person was responsible for the result of work performed on particular stage, along with details which stage was completed before planned time, which was completed on time and which was delayed;
   l) to determine which person was responsible for the result of work performed on the particular stage, along with details which stage exceeded the budget, which took the assumed costs and which was carried out cheaper than it was expected;
   m) to determine which person/functional group performed work at each stages, along with details which stage was completed before time, which was completed on time and which was delayed;
   n) which person/functional groups performed work at each stage, with details which stage exceeded the budget, which took the assumed costs and which was carried out cheaper than expected.
2) Determination of completion indicators, separately for each of the projects/stages:
   a) The index of the financial viability of the project's completion/stage:

$$W_F = \frac{K_R}{K_P} \cdot 100\% \quad (1)$$

where:
K_R – the actual cost of the phase/project;
K_P – the planned cost of the phase/project.

   b) The index of the time efficiency of the project's completion/stage:

$$W_T = \frac{T_R}{T_P} \cdot 100\% \quad (2)$$

where:
T_R – the actual duration of the project/phase;
T_P – planned duration of the project/phase.

   c) The efficiency indicator of identification sources of uncertainty of the project/stage:

$$W_{N_I} = \frac{N_{P_Z}}{N_{P_Z} + N_{P_{NZ}} + N_{R_{NZ}}} \cdot 100\% \quad (3)$$

where:
N_{P_Z} – the number of types of sources of uncertainty identified before the project/stage started, which have also been identified during its completion;

$N_{P_{NZ}}$ – the number of types of sources of uncertainty identified before the project/stage started, which were not identified during its completion;
$N_{R_{NZ}}$ – the number of types of sources of uncertainty not identified before the project/stage started, which were identified during its completion.

d) The efficiency indicator of identification of sources of uncertainty leading to the materialization of risks:

$$W_{N_M} = \frac{N_{P_{ZM}}}{N_{P_Z} + N_{P_{NZ}} + N_{R_{NZ}}} \cdot 100\% \quad (4)$$

where:
$N_{P_{ZM}}$ – the number of types of sources of uncertainty identified before the project/stage started, which have also been identified during its completion and led to the materialization of risks;
N_{P_Z} – the number of types of sources of uncertainty identified before the project/stage started, which have also been identified during its completion;
$N_{P_{NZ}}$ – the number of types of sources of uncertainty identified before the project/stage started, which were not identified during its completion;
$N_{R_{NZ}}$ – the number of types of sources of uncertainty not identified before the project/stage started, which were identified during its completion.

e) The efficiency indicator of ensuring of the factors' success of the project/stage:

$$W_{CS} = \frac{CS_R}{CS_P} \cdot 100\% \quad (5)$$

where:
CS_R – the number of success' factors of the project/stage provided during its completion;
CS_P – the number of success' factors of the project/stage, which should have been provided during completion.

f) The indicator of financial efficiency of the person responsible for the result of the work carried out within the project/stage:

$$O_{O_F} = \frac{K_P - K_R}{K_P} \cdot 100\% \quad (6)$$

where:
K_P – the planned cost of the project/stage;
K_R – the actual cost of the project/stage.

g) The indicator of time efficiency of the person responsible for the result of the work carried out within the project/stage:

$$O_{O_T} = \frac{T_P - T_R}{T_P} \cdot 100\% \quad (7)$$

where:
T_P – the planned duration of the project/stage;
T_R – the actual duration of the project/stage.

h) The indicator of financial efficiency of the person/functional group responsible for the work carried out within the project/stage:

$$O_{W_F} = \frac{K_P - K_R}{K_P} \cdot 100\% \quad (8)$$

where:
K_P – the planned cost of the project/stage;
K_R – the actual cost of the project/stage.

i) The indicator of time efficiency of the person/functional group responsible for the work carried out within the project/stage:

$$O_{W_T} = \frac{T_P - T_R}{T_P} \cdot 100\% \quad (9)$$

where:
T_P – the planned duration of the project/stage;
T_R – the actual duration of the project/stage.

j) The indicator of efficiency of risk identification of the project/stage:

$$W_{R_I} = \frac{R_{P_Z}}{R_{P_Z} + R_{P_{NZ}} + R_{R_{NZ}}} \cdot 100\% \quad (10)$$

where:
R_{P_Z} – the number of the types of risks identified before the project /stage started, which have also been identified during its completion;
$R_{P_{NZ}}$ – the number of the types of risks identified before the project/stage started, which were not identified during its completion;
$R_{R_{NZ}}$ – the number of types of risks not identified before the project/stage started, that were identified during its completion.

k) The indicator of efficiency of identification of materialized risks in the project/stage:

$$W_{R_M} = \frac{R_{P_{ZM}}}{R_{P_Z} + R_{P_{NZ}} + R_{R_{NZ}}} \cdot 100\% \quad (11)$$

where:
$R_{P_{ZM}}$ – the number of types of risks identified before the project/stage started, which were also identified during its completion, and which were materialized;

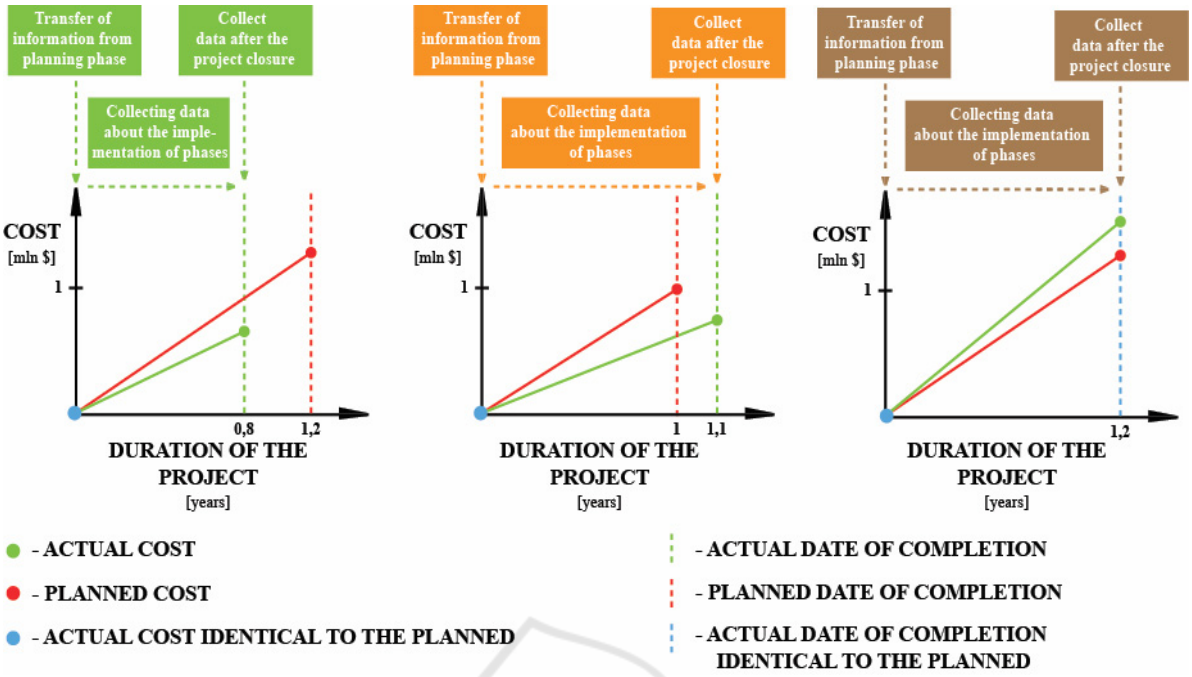

Figure 1: Main stages of the developed methodology (phase of data collection).

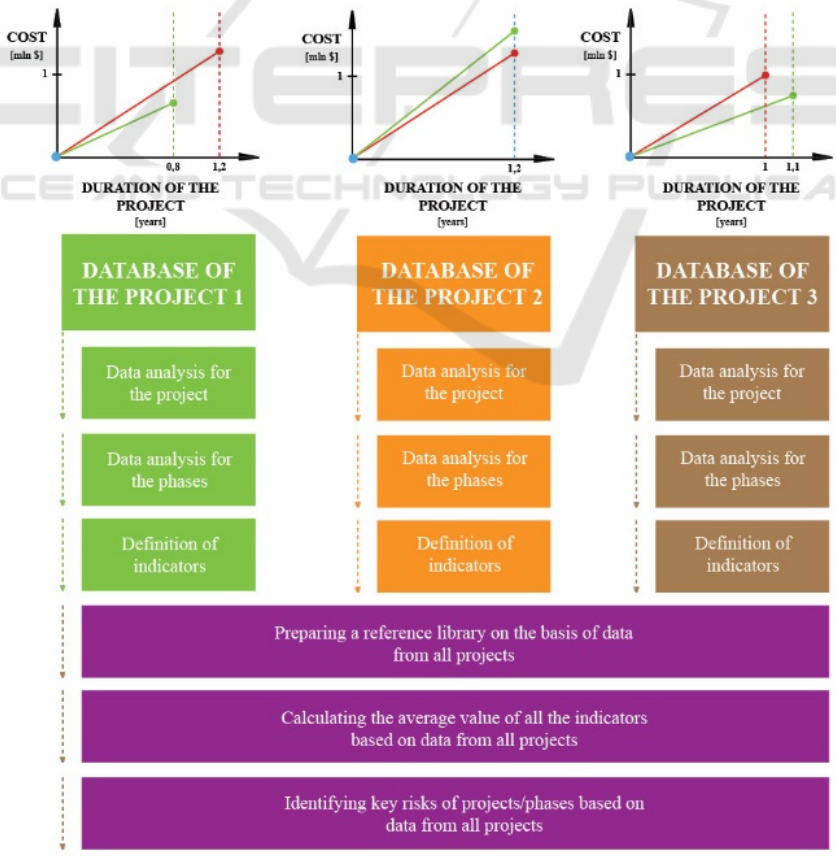

Figure 2: Main stages of the developed methodology (phase of data analysis).

R_{P_Z} – the number of the types of risks identified before the project/stage started, which have also been identified during its completion;
$R_{P_{NZ}}$ – the number of the types of risks identified before the project/stage started, which were not identified during its completion;
$R_{R_{NZ}}$ – the number of types of risks not identified before the project/stage started, which were identified during its completion.

3) Preparation of the reference library by comparing of the corresponding data from all projects, so that in the future it would be possible to further analyze the available data and to have a direct insight into its features.
4) The calculation of the average value of the each of indicators of project/stages of completion based on the values determined through the completion in point 2.
5) Identifying key risks of projects/stages:
   a) calculating the probability of occurrence of each of the risks, based on the data;
   b) determination of the level of severity for each of the risks, keeping the differentiation on the degree of financial risk and the degree of time of the risk, in sequence according to the following formulas:

$$S_{R_F} = |P_R \cdot WR_F| \tag{12}$$

where:
P_R – the probability of risk;
WR_F – the average financial impact (loss/gain caused by the risk);

$$S_{R_T} = |P_R \cdot WR_T| \tag{13}$$

where:
P_R – the probability of risk;
WR_T – medium time impact (shortening the time/delay caused by the risk).

   c) the risk categorization of particular phases – selection of appropriate limit values should be made on the basis of information, experience of the project manager and the nature of the implemented project. For the purposes of this paper categories were determined

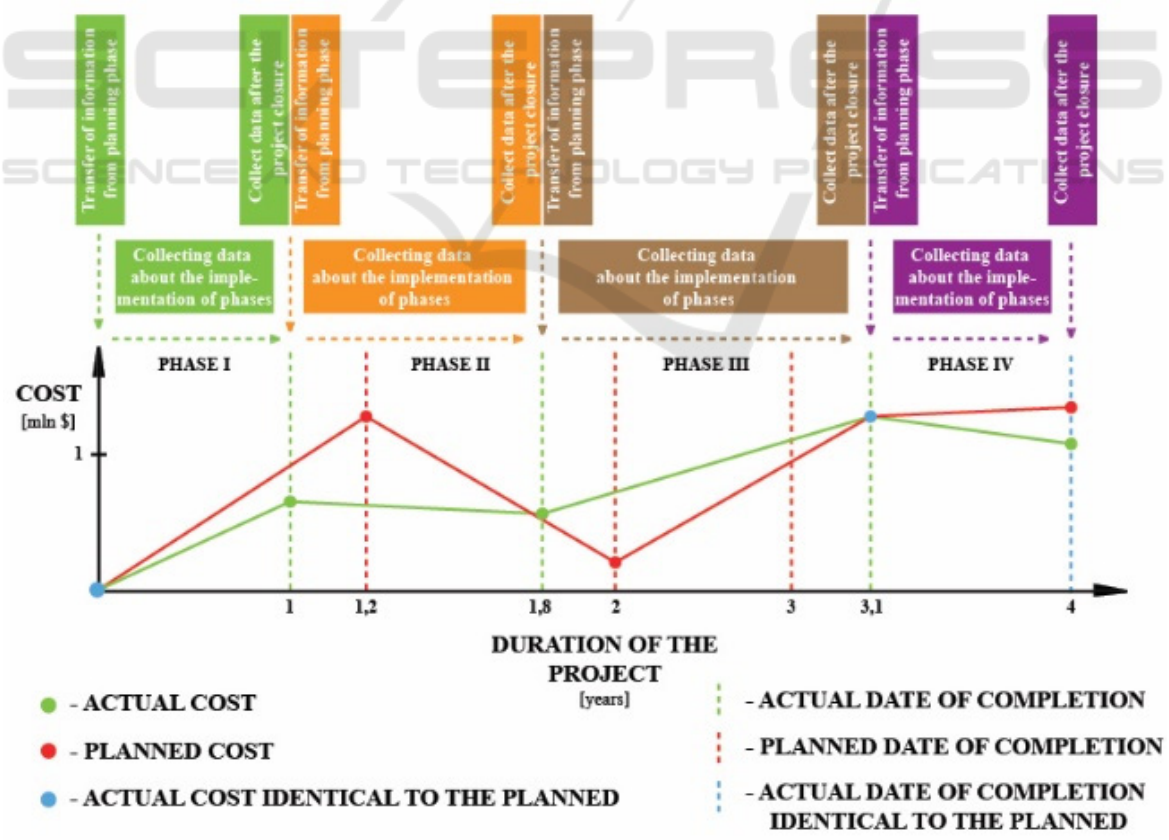

Figure 3: Phase of collect data on the implementation phases of the project.

according to the following criteria:

- low risk – the value of the degree of risk from 0 to 0.15;
- moderate risk – the value of 0.16 to 0.37;
- high risk – the value of 0.38 to 0.75;
- critical risk – the value of 0.76 and above.

Implementation of the described methodology is shown in the example below: Figure 1 (own elaboration based on: Żmuda, 2016). shows the steps of data collection in a situation where the company has completed three projects.

In situation where data were collected for the three projects, the analysis phase can occur, as it is schematically presented below in Figure 2 (own elaboration based on: Żmuda, 2016).

Both the collection and analysis of data for each of particular phases is carried out similarly to carrying out these activities for the project, the idea is presented Figure 3 (own elaboration based on: Żmuda, 2016).

4 CONCLUSIONS

In the presented paper it has been developed a methodology for collecting data on completed projects to allow their subsequent analysis, and also a methodology of data analysis to identify the key risks of projects and to provide a valuable information. Using the developed methodology, in the future it is planned to create a tool to support the completion of projects in the form of a spreadsheet. While continuing work on the field tackled in this paper, it is recommended to implement the developed methodology for the data collection and analysis into a computer application.

While using the developed methodology it should be borne in mind that phenomena such as risk and uncertainty are often very dynamic and they have interdisciplinary nature, thus the degree of repeatability can vary depending on the nature and level of innovation and uniqueness of the delivered project (Gembalska-Kwiecień, 2016). Therefore, using solutions developed from this paper it should be taken into account that it is intended to only assist the decision making process of project manager. It means that in terms of risk management the project manager should in the first place follow the logic, experience gained in the industry and his own assessment of the situation.

ACKNOWLEDGEMENTS

The article is the result of the registered work with symbol 13/030/BK_16/0024 entitled "Production engineering methods and tools for development of smart specializations" carried out in the Institute of the Production Engineering, Department of Organization and Management at Silesian University of Technology.

REFERENCES

Project Management Institute, 2012. *A Guide to the Project Management Body of Knowledge (PMBOK Guide)*. USA, 5th edition.

Atkinson, R., 1999. *Project management: cost, time and quality, two best guesses and a phenomenon, it's time to accept other success criteria*. "International Journal of Project Management", vol. 17, no. 6, pp. 337-342.

Gembalska-Kwiecień, A., 2016. *Innovative forms supporting safe methods of work in safety engineering for the development of intelligent specializations.* "Management Systems in Production Engineering", vol. 24 no. 4, pp. 268-273.

Gardiner, P.D., Stewart, K., 2000. *Revisiting the golden triangle of cost, time and quality: the role of NPV in project control, success and failure*. "International Journal of Project Management", vol. 18, pp. 251-256.

Dvir, D., Raz, T., Shenhar, A., 2003. *An empirical analysis of the relationship between project planning and project success*. "International Journal of Project Management", vol. 21, pp. 89-95.

Hand, D., Mannila, H., Smyth, P., 2006. *Eksploracja danych*, Wydawnictwo Naukowo-Techniczne. Warszawa.

Jaafari, A., 2001. *Management of risks, uncertainties and opportunities on projects: time for a fundamental shift.* "International Journal of Project Management", vol. 19, pp. 89-101.

Korczowski, A., 2010. *Zarządzanie ryzykiem w projektach informatycznych. Teoria i praktyka*, Wydawnictwo Helion. Gliwice.

Office of Government Commerce, 2010. *PRINCE2™ – Skuteczne zarządzanie projektami*, The Stationery Office. London.

Larose, D., 2006. *Odkrywanie wiedzy z danych*, Wydawnictwo Naukowe PWN. Warszawa.

Pickett, T., Elliot, B., 2007. *Transforming Historical Project Data into Useful Information*, AACE International Transactions. Morgantown.

Pritchard, C., 2002. *Zarządzanie ryzykiem w projektach. Teoria i praktyka*, WIG PRESS. Warszawa.

Żmuda, K., 2016. *Opracowanie narzędzia wspomagającego zarządzanie ryzykiem podczas realizacji projektów w przedsiębiorstwie produkcyjnym branży motoryzacyjnej* (unpublished MA thesis), Wydział Organizacji i Zarządzania, Politechnika Śląska. Zabrze.