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Modeling-based Risk Analysis of a Small Enterprise

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Abstract **– The paper discusses risk management and analysis of a small enterprise. A particular enterprise-oriented analysis approach is developed and performed using such research methods as descriptive modeling, business process modeling, ABC analysis, risk identification and classification, qualitative and quantitative risk analysis. The customer service level is used as a performance indicator of quality. The paper introduces the statistical approach to the analysis of the dependence of quality from an inventory management strategy under uncertainty of demand in different scenarios. The analysis of simulation results shows how a certain approach can be applied to reveal sensitive spots and gaps in the business process.**

Keywords **– Business process modeling, risk analysis, risk management, small business.**

I. Introduction

The pressure of globalization and rapid technological advancement of the recent years have made risk management and analysis a focus for most companies. Despite the wide variety of issue-related information sources, there is no unified approach to risk analysis; furthermore, most of the sources tend to consider only large enterprises. The aim of the study is to demonstrate a particular enterprise-oriented modeling-based risk analysis approach of a small enterprise.

Research on the significance of small enterprises revealed that small business has relevant benefits for both the entrepreneur and the country, having a significant impact on the development of Latvian entrepreneurship and its successful recovery from the 2008/2009 economic crisis, being accountable for over 90 % of all economically active enterprises in Latvia in the year 2013, encouraging regional business and employing over 50 % of all residents throughout the last 5 years, also being accountable for over 40 % of the overall gross value added in the country and, therefore, playing an important role in the gross domestic product generation and development of the Latvian economy [1].

In order to choose the most applicable methods, tools and techniques of risk analysis for a particular small enterprise, a local map shop, an in-depth study of risk analysis, is carried out based on [2]–[24], starting with the very basics of risk definitions, classification, risk management frameworks and other important subject related issues.

This is followed by the development of the business process model for the particular business, using modeling language ArchiMate [25]. The developed model is used as the foundation for understanding company's business in a clear illustrative way and underlying the course of the following risk analysis.

This approach reflects the novelty of the study through combining business process modeling with a risk analysis, as well as combining different risk analysis methods and techniques to develop an individual risk analysis approach.

The practical risk analysis of the enterprise is carried out in three major steps. Step one is described as the preliminary analysis, devoted to inventory arrangement and ABC analysis, defining the most important inventory group in terms of use by value. Step two performs the method of qualitative risk analysis combining such risk analysis techniques as the semi-structured interview and cause-and-effect analysis for risk identification and classification, and combination of risk assessment table and risk matrix for risk evaluation and record of prevention and mitigation measures. Step three executes the quantitative risk analysis for the time period of 34 weeks, by developing a mathematical simulation model using Microsoft Office Excel, combining such techniques as the Monte Carlo simulation and scenario analysis.

II. Preliminary Analysis

The study of the particular enterprise business process showed that the main process was the sales management and the main object in this process was the inventory [26]. In order to carry out further inventory analysis, a certain arrangement of the shop's inventory was performed, distinguishing seven groups of items based on their type. Each item type was given a code name consisting of a Latin alphabet letter. This arrangement was further used for the ABC analysis to define the most important item groups in terms of use by value which would require most attention of management and analysis [27]. The use in terms of value was calculated for each of the previously defined product groups, as in (1). Equations (1) and (2) were adapted from [27].

$$U = Q \cdot P, \tag{1}$$

where U is the use in terms of value of a certain item, €; Q is a number of item units sold in a particular time period; P is a unit cost, €.

Percent of total use in terms of value was calculated, as in (2):

$$U_{T\%} = \frac{U}{U_T} \cdot 100\%, \tag{2}$$

where $U_{T\%}$ is a percent of total use in terms of value for an item group, %; U is the use in terms of value of an item group, €; U_T is a total use in terms of value of all item groups together, €.

A typical percentage distribution of use by value for categories was as follows: A category items – 80 %, B – 15 %, C – 5 %. This is also referred to as a standard Pareto analysis or "rule of 80/20", which suggests that 20 % of inventory items need 80 % of the attention, while the remaining 80 % of items need only 20 % of the attention [28]. It is important to note that this percentage can also vary, depending on the actual items [29], as illustrated in Fig. 1.

Items of *A* category were further analyzed in a quantitative risk analysis as they contributed most in terms of use by value.

III. Qualitative Analysis

Major risks of the retailer under the study are mainly associated with the inventory or will have an impact on inventory management if they occur.

Qualitative analysis starts with risk identification through a semi-structured interview, which involves certain aspects of a scenario analysis. A list of risks is provided in [26] considering most realistic potential risks and risk sources to the particular business. The list was constructed on the basis of the study on the subject related literature sources [2]–[24] and an insight in the company's business process. Results of the semi-structured interview were comprehensively illustrated through a cause-and-effect analysis or the so-called Ishikawa diagram, which can be found in [26]. Fragment of the diagram is given in Fig. 2.

The negative effect resulting in occurrence of certain risks is defined as the failure to meet predefined business objectives and satisfy customers. Example of a risk cause is customer associated risks such as inaccurate demand forecast, return of a purchase and other risks.

The obtained information is then summarized in a risk assessment table, using risk matrix to rank the risks and see which risks acquire most attention, according to their likelihood of occurrence and the impact on the main business objective should they occur.

Assigned likelihood and impact criteria have to be stipulated a prior assignment.

In the table suggestions are made on how the identified risks could be prevented or mitigated should they occur or what measures have already been taken by the management. Both the adapted risk matrix and table can be found in [26].

This analysis brought management's attention to the extreme risks in the business that had not been identified and considered prior a qualitative analysis; an example of such risk factor is suspension of globe supply.

It is important to understand that each business has both common and very specific risks that have to be considered during the analysis, as well as classification and division of

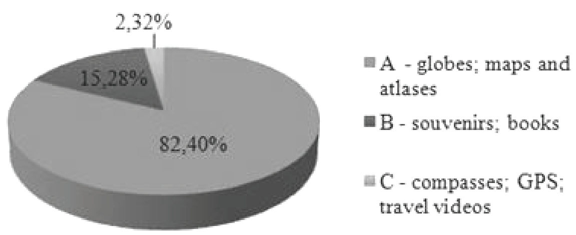

Fig. 1. Map shop's inventory categories and percentage of their total use in terms of value.

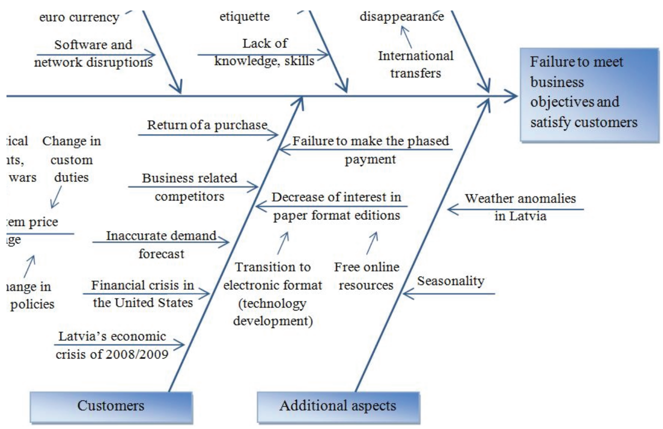

Fig. 2. Fragment of Ishikawa diagram.

Risks and the design of the risk assessment table are highly subjective as there is no unified approach.

IV. Quantitative Analysis

This analysis provides a more numerical data-based approach to the risk previously described by a qualitative analysis, as concisely presented in Table I.

Inventory data obtained from the company presents certain quantitative information gaps that put restrictions on the further options of the quantitative analysis. For instance, there is no information concerning the dynamics of the demand, which excludes the use of discrete-event simulation software tools [30]. This aspect determines the criteria for choosing the indicator under the study of the analysis having it not to be directly connected with costs. Such an indicator is a service level.

As the available data are quite limited, generalized and insufficient to perform an accurate and in-depth quantitative analysis, the purpose of this study is to demonstrate a practical use of such quantitative risk analysis techniques as the Monte Carlo simulation and scenario analysis and see what general trends can be observed in the change of service level under different demand variation scenarios using Microsoft Office Excel 2007 (MS Excel), thus analyzing the risk of failing to satisfy the customer.

The analysis was performed for the time period of 34 weeks, considering only the items of *A* category as they had been previously categorized as the most important in terms of use by value [26].

TABLE I

Analogy Between the Analyzed Aspects of Qualitative and Quantitative Analysis

Risk analysis method	Analyzed risk	Effect on the main goal
Qualitative analysis	Difficult to predict demand accurately	Increasing number of unsatisfied customers
Quantitative analysis	Demand variation	Service level fluctuations

The first step of the quantitative risk analysis is to determine the type of theoretical distribution that best fits the character of the demand. An assumption is made that the demand is best described by truncated normal distribution, that is known to represent the properties of a service process and allows analyzing a system with several random variables, and also excludes negative values [30].

The next assumption is the choice of a supply tactic, when all that is known regarding the supply is the total value of the 34-week period. As there is no information on whether, if any, actual tactic is used by the company; it is assumed that a weekly supply is equal to the mathematical average, as in (3):

$$\overline{S} = \frac{S_T}{n}, \tag{3}$$

where $\overline{S}$ is an average weekly supply, €; S_T is a total supply per time period of 34 weeks, €; n is a number of weeks.

When the basic assumptions are made, it can be continued with Monte Carlo simulation for random number generation to model demand – the continuous random variable of our system. To start this simulation using MS Excel, we must define the initial parameters, which are as follows: average weekly demand; standard deviation of the demand according to the chosen scenario; *a* and *b* (see Fig. 3) as additional constraints for random number generation.

The average weekly demand is calculated in the same manner, as in (3), except the values in the equation are for demand.

Equation (4) is adapted from [31] and used to assign standard deviation for demand.

$$\sigma_D = x \cdot \overline{D}, \tag{4}$$

where σ_D is a standard deviation for demand, €; $\overline{D}$ is an average weekly demand, €; x is a decimal fraction of the demand variation percent according to a chosen variation (a chosen scenario).

MS Excel does not operate with truncated normal or distribution, only the normal distribution [32], which allows negative values, not valid in the case of demand. As illustrated in Fig. 3, adapted from [33], continuous random variables (demand, in our case) are described using a cumulative distribution function and the generation of random variables uses the inverse-transform technique Y: $FY(y)$.

In simple terms, we start with the value on the vertical axis x_i, representing the random numbers generated by MS Excel (greater than or equal to 0 and less than 1) to find the value on the horizontal axis y_i, representing the demand value for each week (Di), as opposed to the traditional approach. However, this technique also allows for negative values, not valid for demand. Additional constraints *a* and *b* are required to respectively define the lower and upper limits on the horizontal axis. *a* is defined as 0 and *b* is defined as 3 standard deviations ($3\sigma_D$), thus eliminating the area on the left-hand side of the vertical axis, to provide solely positive random variable generation.

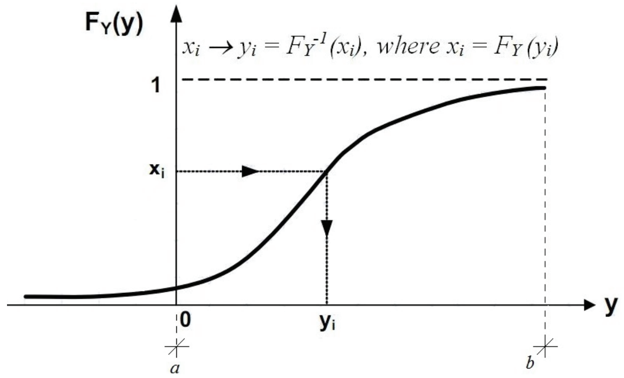

Fig. 3. Graphical representation of the inverse-transform technique.

When the previously mentioned steps are performed, the Monte Carlo simulation or, in other words, random demand value generation, can take place using a combination of such MS Excel functions as *NORMINV* and *RAND* [32].

After the demand is generated for each week of the 34-week period, we continue with the weekly residue calculation, taking into account that no negative values must appear. Equation (5), adapted from [34], describes the calculation of residue. The same equation is used to calculate loss, except in the case of loss MS Excel function allows for negative values.

$$R_i = I_i + S_i - D_i, \tag{5}$$

where R_i is a residue at the end of the week, €; I_i are items in stock at the beginning of the week, €; S_i is the average weekly supply, €; D_i is a demand of the week, €; i is a serial number of a particular week, ($i = \overline{1{,}34}$).

Table II presents one section (1 experiment) of the MS Excel simulation table. In total, 10 scenarios were carried out with demand variations of 20 %, 25 %, 30 %, 40 %, 45 % – 50%. Fewer values of variation simply proved to have no effect on the service level when performing the MS Excel simulation.

For each scenario, 100 replications (100 experiments) were conducted, each time generating a different demand value for each week, accordingly also changing in terms of stock,

TABLE II

Section of a Demand Variation Simulation Table Representing One Experiment under the Scenario of 50% Demand Variation

Weeks	Stock (EUR)	Supply (EUR)	Demand (EUR)	Residue (EUR)	Loss (EUR)
1	10305.55	1085.18	2963.97	8426.76	0.00
2	8426.76	1085.18	1475.53	8036.41	0.00
...	...	...	...	...	...
19	222.34	1085.18	1916.62	0.00	-609.10
20	0.00	1085.18	1169.59	0.00	-84.41
...	...	...	...	...	...
34	917.02	1085.18	1639.61	362.59	0.00
Total demand (EUR)					49010.56
Total loss (EUR)					-2171.50
Service level SL_i					0.96

residue and loss values. The following approach was used – first, 20 experiments were conducted and then each of the 20 experiments was replicated 5 times.

A total loss and demand were calculated as a sum of each week indicators (accordingly, $\sum_{i=1}^{n} L_i$ and $\sum_{i=1}^{n} D_i$) for each experiment, allowing for further calculation of service level of each 34-week period, described by (6), adapted from [34].

$$SL_i = \frac{L_T + D_T}{D_T}, \tag{6}$$

where SL_i is a service level of a particular experiment expressed as a decimal number, 1 being 100 % service level; L_T is a total loss of the 34-week period of a particular experiment, €; D_T is a total demand of the 34-week period of a particular experiment, €.

After obtaining values of service levels of each experiment, the average service level for each scenario is calculated and used for the final analysis.

Standard deviation for a service level is a measure of the variability of service levels of each scenario and is calculated using MS Excel function, based on (7), adapted from [32].

$$\sigma_{SL} = \sqrt{\frac{\sum_{i=1}^{n}\left(SL_i - \overline{SL}\right)^2}{(n-1)}}\ , \tag{7}$$

where σ_{SL} is a standard deviation for service level of a particular scenario; SL_i is a service level of a particular experiment; $\overline{SL}$ is an average service level of the particular scenario; n is a number of experiments.

Before continuing with further calculations regarding a service level, it is assumed that the obtained service level will fall into the defined confidence interval with a probability of 95%, which is a standard assumption [31].

For terminating systems, when the initial conditions are known, interval estimation of the average service level of each scenario is described in (8), adapted from [31].

The estimation of (8) starts with obtaining the probability coefficient t from the 't-distribution table' found in various issue associated books, such as [30: 303] or using MS Excel function *TINV* [32]. In order to use such a table, two values have to be known: $\alpha/2$, which is half of the probability to make a mistake and design an interval that does not include the defined average service level and $(n - 1)$, which are the degrees of freedom. According to $(n - 1) = 19$ and $\alpha/2 = 0.025$ the probability coefficient t equals 2.093 [30].

$$\mu_{SL} \in \overline{SL} \pm \frac{\sigma_{SL} \cdot t_{n-1}^{\alpha/2}}{\sqrt{n}}, \tag{8}$$

where μ_{SL} is a mean value of service level; $\in$ describes boundaries of the interval, where '+' is used for the upper limit calculation of the confidence interval and '−' for the lower limit; t is a probability coefficient; n is a number of experiments; α is a probability to make a mistake.

Results of all 100 experiments for each demand variation scenario are then summarized. A short summary of the data obtained from the MS Excel simulation is also presented in Table III.

Because of the limited data, the obtained numerical values are not considered to be accurate and are only analyzed in terms of the pattern they produce.

However, the large initial stock of 10305.55 € at the beginning of the 1st week of the analyzed period did not allow drawing precise numerical conclusions. All the more, analysis of the data showed that the average demand of the period was almost eight times less than the initial stock and the total residue of the period approximately three times less than the initial stock, indicating that the management was currently trying to minimize the initial stock rather than adapt a particular order quantity tactic. This could be a consequence of the 2008/2009 financial crisis, during which, the company suffered significant financial loss, so the following years, including the analyzed period, could have been dedicated to minimize the inventory pile-up of the crisis years. This is also the reason behind the minor service level fluctuations beginning only at the demand variation of 40 %, which is not genuine in the real life. Moreover, the service levels of 100 % in case of 20 % and 30 % demand variation are deceptive, the data of an item group are used, not exact data on each particular item and its demand or dissatisfied demand.

Comparison of scenarios of supply once per week and once per two weeks presented almost no difference in service level fluctuations, for the previously described reason.

Nevertheless, a general pattern is observed and illustrated in Fig. 4, displaying that, as the demand variation increases, service level starts to decrease. In the case of this particular analysis, values of the service level have little significance as they are predicted to be unrealistic, what is important, is the trend line, illustrating the previously described interrelation of demand variation and service level.

TABLE III

SUMMARY OF THE OBTAINED SERVICE LEVELS AND DEMAND VARIATIONS

Demand variation	Average service level	Lower limit for service level	Upper limit for service level
50 %	0.957	0.946	0.968
49 %	0.977	0.971	0.983
48 %	0.973	0.966	0.980
47 %	0.973	0.964	0.982
46 %	0.975	0.968	0.983
45 %	0.991	0.987	0.995
40 %	0.996	0.994	0.997
30 %	1.000	1.000	1.000
25 %	1.000	1.000	1.000
20 %	1.000	1.000	1.000

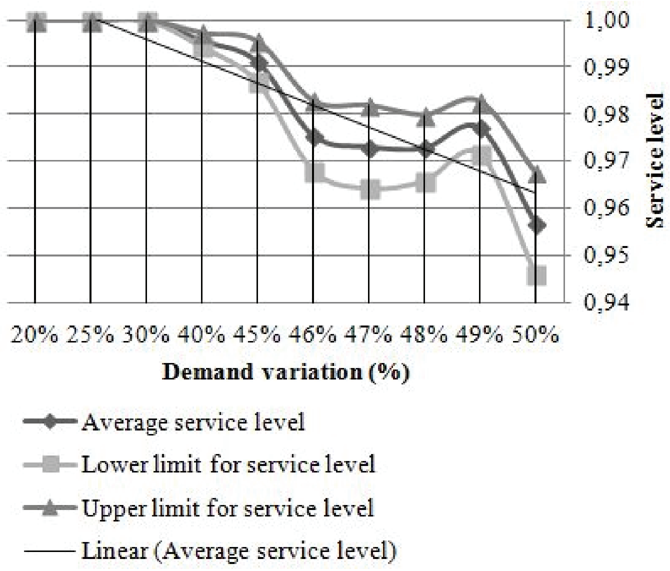

Fig. 4. General pattern of demand variation effect on a service level.

The trend line pattern agrees with the logic that as the demand variation increases (the accuracy of predicting such demand decreases), the service level decreases (more unsatisfied customers emerge). This in turn allows concluding that the developed simulation model within the Ms Excel is correct and can serve to produce more precise conclusions in terms of value when more precise data, such as satisfied and unsatisfied demand for each item, are available.

V. Conclusion

Small enterprises in Latvia are accountable for the majority of all economically active enterprises in the year 2013, thus encouraging development of Latvian entrepreneurship and employing over half of all residents of the country, also playing an important role in the gross domestic product generation and development of the Latvian economy. These facts substantiate the significance of risk analysis of a small enterprise in particular.

There is no unified definition of risk, nor a unified risk management and analysis framework or classification approach, making risk analysis highly subjective in terms of design and the specific business.

Development of a business process model, using any modeling language that best fits the need of the business under analysis, is a significant milestone for the risk analysis, facilitating not only the comprehension of the particular business but also giving an insight to elements and processes presenting potential sources for risk occurrence.

ABC analysis serves as a useful preliminary analysis tool to identify the most important item groups in terms of use by value that will require most attention.

Qualitative analysis demonstrates the practical development and use of a combination of such techniques as the semi-structured interview and cause-and-effect analysis to identify and classify risks as well as divide them into groups. Risk assessment table in combination with the risk matrix evaluates the previously identified risks and makes suggestions on how these risks could be prevented or mitigated, should they occur.

Quantitative analysis demonstrates the practical use and development of a combination of such risk analysis techniques as the Monte Carlo simulation and scenario analysis using the software tool Microsoft Office Excel, and reveals that as the demand variation increases, service level starts to decrease. This in turn allows concluding that the developed simulation model is correct and can serve to produce more precise conclusions in terms of value when more precise data are available. In the case of this particular analysis, values of the service level have little significance as they are predicted to be unrealistic, because of the limited and generalized data.

The developed and performed modeling-based risk analysis of a particular small enterprise allows identifying gaps for business improvement.

For more precise mathematical simulation, a research on both satisfied and unsatisfied demand of the best-selling items is suggested to reveal critical demand variation in terms of non-tolerable service level.

References

[1] European Commission for Enterprise and Industry, “SME Performance Review: Database for the Annual Report,” 2014. [Online]. Available: http://ec.europa.eu/enterprise/policies/sme/facts-figures-analysis/performance-review/index_en.htm. [Accessed: March, 2014].

[2] A. M. Marchetti, *Enterprise Risk management Best Practices: From assessment to Ongoing Compliance*. Hoboken, New Jersey, USA: John Wiley & Sons, 2011, pp. 7–43. http://dx.doi.org/10.1002/9781118386699

[3] C. Verbano and K. Venturini, “Managing Risks in SMEs: A Literature Review and Research Agenda,” *Journal of Technology Management and Innovation,* vol. 8, no. 3, 2013, pp. 187–189. http://dx.doi.org/10.4067/S0718-27242013000400017

[4] M. Abkowitz, D. Shimko and F. Fabozzi, *Approaches to Enterprise Risk Managemen*, Huntingdon, United Kingdom: Bloomsbury Information Ltd., 2010, pp. 3–66.

[5] B.M Ayyub, *Risk Analysis in Engineering and Economics*. USA: Chapman & Hall/CRC Press, 2003, 570 p. http://dx.doi.org/10.1201/9780203497692

[6] C.A. Wilhelmsen and L.T. Ostrom, *Risk Assessment: Tools, Techniques and Their Applications*. Somerset, NJ, USA: John Wiley & Sons, 2012, 392 p.

[7] J. J. Hampton, *Fundamentals of Enterprise Risk Management: How Top Companies Assess Risk, Manage Exposure and Seize Opportunity*. Saranac Lake, New York, USA: AMACOM Books, 2009, pp. 4–18.

[8] T. Aven, *Foundations of Risk Analysis*. Hoboken, New Jersey, USA: John Wiley & Sons, 2012, 211 p. http://dx.doi.org/10.1002/9781119945482

[9] P. Hopkin, *Fundamentals of Risk Management: Understanding, evaluating and implementing effective risk management*. United Kingdom: Kogan Page Ltd., 2010, pp. 11–61.

[10] J.P. Chavas, *Risk Analysis in Theory and Practice*. Saint Louis, Missouri, USA: Elsevier Academic Press, 2004, pp. 5–11. http://dx.doi.org/10.1016/B978-012170621-0.50001-8

[11] S. Segal, *Corporate Value of Enterprise Risk Management: The Next Step in Business Management. Hoboken*, New Jersey, USA: John Wiley & Sons, 2011, 404 p.

[12] J. Mun, *Modeling risk: Applying Monte Carlo Simulation, Strategic Real Options, Stochastic Forecasting and Portfolio Optimization*, Hoboken, New Jersey, USA: John Wiley & Sons, 2010, 986 p.

[13] *Risk management – Vocabulary*, International Standard ISO Guide 73:2009, 2009, 15 p.

[14] *A Practical Guide to Risk Assessment*. Price water house Coopers, 2008, pp. 5–32. [Online]. Available: http://www.pwc.com/en_US/us/issues/enterprise-risk-management/assets/risk_assessment_guide.pdf. [Accessed: May, 2014].

[15] "3rd Annual Survey on Supply Chain Resilience," *Business Continuity Institute*, 2011, pp. 6–11.
[16] B. Bemeleit, J. Schumacher and C. Hans, "Methods of Risk Assessment and their Sustainability in Logistic Environment," *Symposium on Risk Management and Cyber-Informatics: RMCI \'05 in the Context of the 9th Multi-conference on Systemics*, Cybernetics and Informatics, SCI 2005, 2005, pp. 425–431.
[17] W.G., Shenkir and P.L. Walker, *Enterprise Risk Management: Tools and Techniques for Effective Implementation*. Montvale, New Jersey, USA: Institute of Management Accountants, 2007, pp. 4–14.
[18] A. Szabo, "Risk Management: An Integrated Approach to Risk Management and Assessment," *Annals of the University of Oradea: Economic Science Series*, vol. 21, no. 2, 2012, pp. 776–781.
[19] *Understanding Supply Chain Risk: A Self – Assessment Workbook*. Bedford, United Kingdom: Cranfield University, Cranfield School of Management, Centre for Logistics and Supply Chain Management, 2003, pp. 16–21.
[20] *Risk management – Principles and guidelines*, International Standard ISO 31000:2009, 2009, 24 p.
[21] *Risk management – Risk assessment techniques*, International Standard ISO/IEC 31010:2009, 2009, 176 p.
[22] Y. Yacov, *Risk Modeling, Assessment and Management*. Hoboken, New Jersey, USA: John Wiley & Sons, 2005, 837 p.
[23] A.J. Anderson, Business *Risk Management: Models and Analysis*. Oxford, United Kingdom: John Wiley & Sons, 2013, 367 p. http://dx.doi.org/10.1002/9781118749388
[24] D. Ritter, "Home page – certified project management professional D. Ritter," Oct. 2008. [Online]. Available: http://certifedpmp.wordpress.com/2008/09/17/risk-analysis-techniques/ [Accessed: Apr., 2014].
[25] Website of the independent modeling language for enterprise architecture 'ArchiMate', Dec. 2012. [Online]. Available: http://archi.cetis.ac.uk. [Accessed: Apr., 2014].
[26] K. Bendza, "Modeling-based risk analysis of a small enterprise," M.S. thesis, Riga Technical University, BALTECH Study Centre, Riga, Latvia, 2014.
[27] D. Walters, Logistics: *An Introduction to Supply Chain Management*. United Kingdom: Palgrave Macmillan, 2003, pp. 274–275.
[28] R. Koch, *The 80/20 Principle: The Secret of Achieving More with Less*. New York, USA: The Doubleday Publishing Group, 2008, pp. 3–6.
[29] G. Ghiani, G. Laporte and R. Musmanno, *Introduction to Logistics Systems Planning and Control*. United Kingdom: John Wiley & Sons, 2004, pp. 148–149.
[30] S. Robinson, *Simulation: The Practice of Model Development and Use*. Chichester, United Kingdom: John Wiley & Sons, 2004, 316 p.
[31] J. Shao, *Mathematical Statistics, 2nd Edition*. New York, USA: Springer, 2003, 591 p. http://dx.doi.org/10.1007/b97553
[32] L. W. Winston, Microsoft Office Excel 2007: Data Analysis and Business Modeling. Washington, USA: Microsoft Press, 2007, 601 p.
[33] J. Banks, J. S. Carson and B. L. Nelson, *Discrete-Event System Simulation*, 4th ed., USA: Prentice-Hall, 2004, 608 p.
[34] T. M. Choit, *Handbook of EOQ Inventory Problems: Stochastic and Deterministic Models and Applications*, New York, USA: Springer, 2014, 281 p.

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Kristīne Bendža, Jeļena Pečerska. Modelēšanā bāzēta mazā uzņēmuma risku analīze
Globalizācijas un straujās tehnoloģiju attīstības pieaugošā spiediena ietekmē pēdējo gadu laikā risku pārvaldība un analīze ir nonākusi daudzu uzņēmumu uzmanības centrā, strauji ieņemot svarīgu vietu vadītāju skatījumā. Neskatoties uz informācijas avotu daudzveidību, vienota pieeja risku analīzei nepastāv, pamatojoties uz dažādajiem uzņēmējdarbības veidiem, ekonomiskajiem, politiskajiem un citiem aspektiem, turklāt lielākā daļa literatūras šajā kontekstā apskata tikai lielos uzņēmumus. Šis raksts ir veltīts maza uzņēmuma risku analīzei. Šī raksta mērķis ir prezentēt īpaši pētāmajam uzņēmumam pielāgotu analīzes pieeju. Rakstā ir aplūkotas analīzes metodes konkrētam uzņēmumam. Praktiskā uzņēmuma risku analīze ietver trīs galvenos posmus. Pirmajā analīzes posmā tiek paveikta uzņēmuma krājumu ABC analīze, un krājumi tiek sagrupēti pēc to svarīguma. Uz šīs analīzes pamata ir piedāvāta kvalitatīva un kvantitatīva pieeja pētāmā uzņēmuma risku analīzei. Otrajā posmā veikta riska faktoru kvalitatīvā analīze, izmantojot metožu kombināciju − daļēji strukturēto interviju un cēloņu un seku analīzi. Rezultātā riska faktori tiek identificēti un klasificēti. Tāpat šajā posmā risku novērtēšanai un pasākumu izstrādei, risku seku novēršanai un mazināšanai tiek izmantota riska novērtējuma tabula kombinācijā ar riska matricu. Trešajā posmā paveikta uzņēmuma risku kvantitatīvā analīze. Kvantitatīvā analīze apstiprina apkalpošanas kvalitātes līmeņa atkarību no pieprasījuma mainīguma pakāpes, un rezultātā uzņēmuma riska faktoru pētījumu veikšanai tiek piedāvāts matemātiskais modelis. Analīze balstās uz Montekarlo modelēšanas rezultātiem, modelis tika izstrādāts, izmantojot *Microsoft Office Excel* programmrīku. Statistiskajā modelēšanā bāzētā mazā uzņēmuma risku analīze sniedz ieskatu par izstrādāto un pielietoto analīzes pieeju uzņēmējdarbības jutīgo punktu un nepilnību identificēšanai.

Кристине Бенджа, Елена Печерская. Анализ рисков малого предприятия на основе моделирования
Повышенное давление глобализации и быстрого технического прогресса в последние годы выдвинули управление и анализ рисков, играющих всё более важную роль в повестке дня руководителей, в центр внимания большинства предприятий. Несмотря на разнообразие источников информации, единого подхода к анализу рисков не существует, поскольку подход зависит от конкретного бизнеса, экономических, политических и других аспектов. Кроме того, в большей части публикаций рассматриваются только крупные предприятия. Данная статья рассматривает анализ рисков малого предприятия. Целью статьи является рассмотрение подхода к анализу рисков малого предприятия. В статье рассмотрены методы анализа рисков для конкретного предприятия. Практический анализ рисков предприятия включает в себя три основных этапа: на начальном – предварительном – этапе выполнен ABC анализ складских запасов предприятия, и запасы сгруппированы по степени их важности. На базе предварительного анализа предложен качественный и количественный подход к анализу рисков изучаемого предприятия. На втором этапе выполнен качественный анализ факторов риска с использованием комбинации методов полуструктурированного интервью и причинно-следственного анализа. В результате факторы риска идентифицированы и классифицированы. На этом же этапе использована таблица оценки рисков в сочетании с матрицей рисков для оценки рисков и формулирования мероприятий по предотвращению рисков и смягчению их последствий. На третьем этапе выполнен количественный анализ рисков предприятия. Количественный анализ позволил подтвердить зависимость уровня качества обслуживания от степени изменчивости спроса и предложить математическую модель для проведения исследований факторов риска предприятия. Анализ основан на результатах моделирования с применением метода Монте Карло в программе Microsoft Office Excel. Анализ рисков малого предприятия на основе статистического моделирования даёт представление о разработанном и реализованном подходе к идентификации чувствительных точек и недостатков бизнес-процесса.