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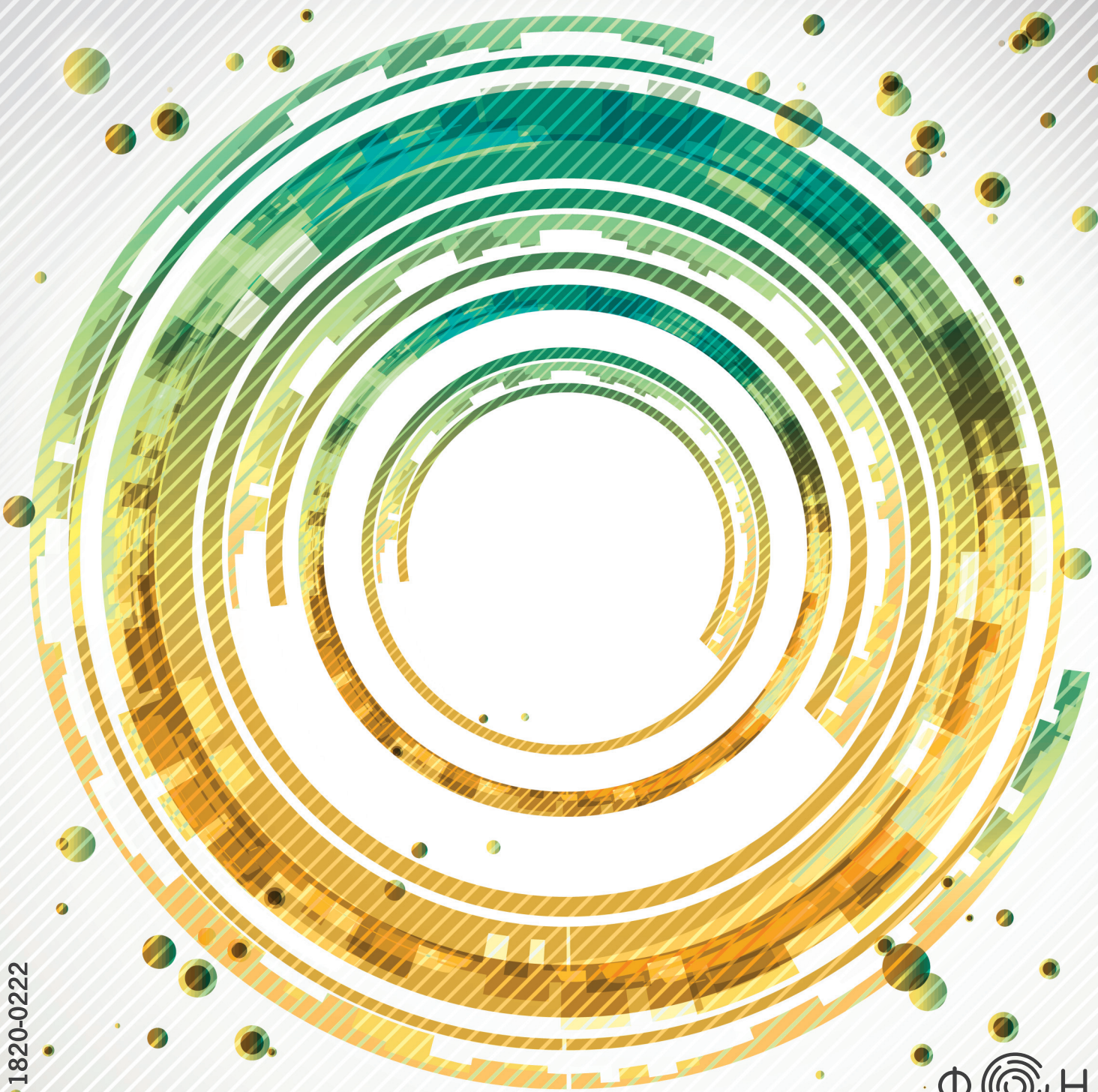

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УНИВЕРЗИТЕТ У БЕОГРАДУ
ФАКУЛТЕТ ОРГАНИЗАЦИОНИХ НАУКА

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Exploring the Mechanisms for Implementing a Risk Management Process: Overall Approach and Practical Example

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The aim of this paper is to explore the mechanisms for implementing a risk management process into an organisation. A way of exploring the mechanisms for implementing a risk management process is to break it down into its component parts and examine what each part should contribute to the overall risk management process. The main aim of the empirical part of the paper is on the other hand to present empirical research of risk management focusing on forecasting sales using a neural network method. A neural network is a powerful data modeling tool that is able to capture and represent complex input/output relationships. Integrating an overall risk management process into an organisation can significantly improve the response of the organisation to unplanned events (good or bad) and enhances its ability to compete, not to mention that the objectives of an organisation are easier to achieve and that resources areeffectively allocated. Applying neural network method produces consistently accurate sales forecast. However, effort should be put in proper preparation of dataset. This paper has a tremendous added value for all risk management officers, CFOs and all others involved in risk management process. The added value is shown in the description of theoretical risk management model which is upgraded with a practical approach example.

Keywords: enterprise risk management, strategical risk management, operational risk management, risk management process, organisation, neural network, forecasting

1. Introduction

Risk is inescapable in business activity. Economic activity by definition commits present resources to an uncertain future. The one thing that is certain about the future is its uncertainty, its risks. Hence, to take the risks is the essence of economic activity. Nearly all operational tasks and processes are now viewed through the prism of risk (Chapman, 2011). Risk has become shorthand for any corporate activity. It is believed that it not possible to create a business that does not take risks. The end result of successful strategic direction setting must be capacity to take a greater risk, because this is the only way to improve entrepreneurial performance. Organisations that are more risk conscious have for a long time known that actively managing risk and opportunity provides them with a decisive competitive advantage. Taking and managing risk is the essence of business survival and growth.

Enterprise risk management is a response to the sense of inadequacy in using a silo-based approach to manage increasingly interdependent risks. Enterprise risk management is about understanding the interdependencies between the risks, how the materialisation of a risk in one business area may increase the impact of risks in another business area (see for example Duckert, 2011; Moeller, 2011; Monahan, 2008). Under enterprise risk management all risk areas should function as parts of an integrated, strategic and enterprise-wide system. While risk management is coordinated with senior-level oversight, employees at all levels of the organisation using enterprise risk management are encouraged to view risk management as an integral and ongoing part of their jobs (Fraser and Simkins, 2010).

Early empirical work on enterprise risk management investigated why companies adopted enterprise risk management and most studies utilized survey data. The first study by Colquitt, Hoyt and Lee (1999) investigated the characteristics and extent of integrated risk management. They found that political risk, exchange rate risk and interest rate risk were the three most common nonoperational risks handled by the risk management department. Other early work on enterprise risk management included a focus on the determinants of enterprise risk management. Liebenberg and Hoyt (2003) compared firms that appointed a chief risk officer to a matched sample. They found that firms that appoint a chief risk officer are more likely to be financially leveraged. Similar study can be found in Pagach and Warr (2008). More recent work on enterprise risk management has examined additional determinants of enterprise risk management adoption (see for example Desender, 2007; Beasley, Pagach and Warr, 2008). The earlier studies moved beyond the enterprise risk management adoption question and examined the aspects of whether enterprise risk management adds value. Gates, Nicolas and Walker (2009) extend the early work by examining the value seen inside the company as measured by better decision making and increased profitability.

Without a shadow of doubt, businesses nowadays operate in an entirely different environment compared with just a few years ago. The adoption of expansion strategies, such as investment in emerging markets, developing significant new products, acquisition, organisational restructuring can all increase an organisation's risk exposure. The main aim of risk management process, as seen as one part of the structure of enterprise risk management, is to ensure that organisation is able to respond to unplanned events (good or bad) and rises its ability to compete. The process is successful when enough scenarios are prepared to capture as many different risks as possible and the way how to handle it. In the first stage, the goal of risk management process and people included in such a process is to incorporate risks and different scenarios in business and strategic planning of organisation and at the same time to provide the top management with information on current business environment.

The aim of this paper is to explore the mechanisms for implementing a risk management process into an organisation. A way of exploring the mechanisms for implementing a risk management process is to break it down into its component parts and examine what each part should contribute to the overall risk management process. The main aim of the empirical part of the paper is on the other hand to present empirical research of risk management focusing on forecasting sales using a neural network method.

The paper is structured as follows. The introduction is followed by an overview of the risk management process where the proposed stages of the process are described in detail. It is followed by an empirical example of risk management applying neural network method. The paper concludes with a short summary of the main findings.

2. the risk management process

A way of exploring the mechanisms for implementing a risk management process is to break it down into its component parts and examine what each part should contribute to the overall risk management process. It is proposed here that the risk management process is broken down into the following stages: organisation, methodology, setting the sources of risk, keeping the process up to date. While activities follow a largely sequential pattern, it may be an iterative process over time. For example, as new risks are identified the earlier processes of identification and analysis are revisited and the subsequent processes are repeated through to the implementation of risk response action. The proposed stages are described in detail below.

2.1 Organisation

The risk management process represents strategically important process which can in certain situations act as a framework for changes in business decisions. That is why the process functioning is connected with the top management directly (usually it operates under the chief financial officer) and what is more, the flow of information is provided to the highest levels of organisation.

On the other hand it is important that identification of operational risks is suitably managed and that adequate controls are available to regulate the risk management process. In such a manner a completely newly identified or changed risks should be managed as soon as possible. To be able to ensure that, the roles and responsibilities in the risk management process have to be clearly defined. The board of directors (top management) at the top level is empowered with the authority to confirm and directly track the risk management process, whereas the subordinate body consisting of key process representatives is given the authority to ensure the efficiency and effectiveness of the process functioning. At the operational level there is an ongoing risk management process as a composite part of current processes and represents a mindset of each and every employee. Operational identification, assessment and management is implemented by system trail, which is fundamental for trend analysis of constant risk management process improvements over the time period.

2.2 Methodology

The methodology which is usually implemented in risk evaluation is based on interaction between the likelihood of risk and consequences that might the risk impose to the business process or to organisation as a whole. When we try to define the probability, it is important to take into consideration the history of a certain event as well as the estimated frequency of such an event (for example the event occurs on each x's repeated process).

According to the mutual influence of both risk parameters, it is presented as a product of numerically estimated levels. Risk management strategy is defined according to the obtained results and represents a framework for setting certain actions and the deadline by which the actions have to be taken. A set of actions is implemented periodically (determining the activities, deadlines and decision makers) and is known as risk treatment plan. On the level of a business group unified risk management is especially a great challenge in the area of providing the compatibility of methodologies. For certain areas, more sophisticated methodologies are used, whereas the results of such methodologies have to be adjusted in accordance, logically complementary of an overall risk assessment.

2.3 Setting the sources of risk

A way of setting the sources of risk is to consider that risk emanates from two primary areas (see figure 1): from within the organisation itself (labelled as internal risk) and from the environment or context within which the organisation operates and over which it has no control (labelled as external risk). Such classification shows the relationship with the international risk standard ISO 31000 respectively.

What is more, setting the sources of risk in the overall process is as much important as the proper use and suitably chosen optimisation method for risk evaluation. The value of a risk management process is reduced without a clear understanding of the sources of risk and how they should be responded to. It is expected that the sources of risk should be carefully examined not to forget any and included into a catalog of risk. The catalog of risk consists of a set of predetermined risks where each is described with additional parameters needed to properly estimate the risk.

Financial risk		
Internal risk		**External risk**
• Internal financial control / Internal audit • Fraud exposure • Historical liabilities • Investment • Capex decisions • Liquidity and cashflow		• Risk of accounting standards • Interest rate risk • Currency risk • Credit risk
Infrastructure risk		
Internal risk		**External risk**
• Personnel risk (new employees) • Risk of proper qualifications and competencies • Health risk and safety at work • Working environment risk • Computer /IT systems risk		• Communication risk • Distribution risk • Suppliers/contractors risk • Terrorism • Natural catastrophe • Epidemics
Reputation and goodwill risk		
Internal risk		**External risk**
• Brand and name expansion • Structure of a board • Control of environment		• Product recalls risk • Social responsibility risk • Public image risk • Legal risk • Competition risk (unfair)
Market risk		
Internal risk		**External risk**
• Mergers and acquisitions risk • Research and development risk • Intellectual property risk • Contractual risk		• Economic risk • Technological development risk • Competition risk on the market • Demand risk and users needs risk on the market • Legal and market needs risk

Figure 1: Setting the sources of risk

Risks that are monitored during the risk management process represent the set of risk. It is written and evaluated in the catalog of risk which has to be kept up to date by the whole team which is devoted to risk management process in the organisation. It should not be forgotten to harmonize the set of risk with business needs as well as with operational functioning of business processes.

2.4 Keeping the process up to date

Keeping the risk management process up to date is the most important factor especially in the area of risk management, which has the impact on efficiency, effectiveness and quality of the overall risk management process. At the highest level it is reflected in the appropriateness of the risk management process to the business objectives. Within such process the period of checking the up to date process depends on the objectives considered. Business objectives are connected with the strategy and vision of an organisation (organisation's risk) and they do change regarding the branch of industry and long-term objectives of an organisation. For the set of risk and method to evaluate risk we can take an assumption that they are rarely changed, whereas in the case of major changes on the level of organisation's performance they change. These changes are mostly faced when expanding to new business activities or branches of industry, which can be related with acquisitions of new companies, business expansion onto different political-economic zones or when changing critical business partners.

Keeping the risk management process up to date is on one hand dynamic, on the other hand simplified taking into consideration project management or project oriented work where goals and risk are defined by establishing the project or in the stage of preparing project elaborate. Risk here is short to medium-term as in most cases risk is terminated by the project duration (when objective goals of a project are accomplished), partly it is transferred to the subject of a project - usually this is a process (when we want to accomplish earmarked goals of a project).

Process risks are the most operational connected risks as they are connected with the process goals as well as with the resources needed for process functioning. The set of risks can be mapped from earmarked project goals in the case of process that is a consequence of previously implemented project, on the other hand the process set of risk partly indicates the transfer of risks that are connected with the strategy and vision, as requests of vision as well as of strategy are delegated to the process level.

Keeping the risk management process up to date is inevitably directly connected with setting the goals no matter the level where they are determined and tracked. When goals change, it is always necessary to conduct an audit of risk management process, above all it is necessary to check the catalog of risk and set of controls and measures which are established to manage the risk.

Besides ensuring the suitability of risk management process it is also necessary to take into consideration the influences of external world when conducting risk management. Mostly we deal with process controls performed by external auditors and process consistency with valid standards and recommendations which are valid for the branch of industry and in general in the area of risk management.

If the risk management process is to be up to date we need to regularly supervise the controls and measures whose role is to manage the risk. This is done by checking whether the planned risk response actions have been implemented or whether the potential opportunities have been examined and results obtained and to what extent the intensity of controls is used.

3. Empirical example of risk management

Our empirical example of risk management focuses on forecasting sales using a rich database provided by a company which is a leading manufacturer of home appliances. The motivation for choosing the sales forecasting area is that this area is becoming more important in everyday business, not to mention risks involved here (for example economic downturns, changing trends and fashions, increased competition, manufacturer recalls). Sales forecasting is a crucial part of the financial planning of a business. Good forecasting models can increase efficiency of businesses, they are saving money on excess inventory, increase profit and serve its customers better.

There are several methods that can produce consistently accurate sales forecasts. One of them is neural network which we apply in empirical research. A neural network is a powerful data modeling tool that is able to capture and represent complex input/output relationships. The motivation for the development of neural network technology stemmed from the desire to develop an artificial system that could perform “intelligent” tasks similar to those performed by the human brain. Neural networks resemble the human brain in the following two ways:

1. A neural network acquires knowledge through learning.
2. A neural network’s knowledge is stored within inter-neuron connection strengths known as synaptic weights.

The true power and advantage of neural networks lies in their ability to represent both linear and non-linear relationships and in their ability to learn these relationships directly from the data being modeled. Traditional linear models are simply inadequate when it comes to modeling data that contains non-linear characteristics.

The most common neural network model is the multilayer perceptron (MLP). This type of neural network is known as a supervised network because it requires a desired output in order to learn. The goal of this type of network is to create a model that correctly maps the input to the output using historical data so that the model can then be used to produce the output when the desired output is unknown (cited from NeuroSolutions.com).

3.1 Data and variables

Proper preparation of dataset is the most important and with no doubt the most time-consuming step in working with neural networks. It is very important to have the right amount of data. Too much data may increase training time of a neural network and even deteriorate network performance. If we have a dataset with

a small number of cases, then the neural network will not have enough information about the problem to train correctly. Our dataset, which is based on historical data on sales, contains 1995 cases. From our primary dataset we also removed data with missing values and detected outliers. We have also carefully chosen the variables that should best represent the problem that we want to analyze. In order to include such variables we firstly performed multiple regression analysis to see which variables statistically significantly influence our dependent variable (that is sales). From table 1 we can see that such variables are brand name and type of product. Other variables (such as month of sales) did not perform statistical significant influence on our dependent variable and were therefore excluded from analysis. Since both independent variables are categorical, we also pay attention that categories for both variables are well presented in different combination to ensure that neural network will be able to find the differences and that the results will be valid and reliable.

Table 1: Statistically significant coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	32.202	1.281		25.142	.000
	brand	2.480	.099	.221	25.169	.000
	type	-.048	.014	-.029	-3.348	.001

3.2 Empirical application

3.2.1 Analysis

In this step the data is partitioned onto training, test and validation set. The training set is a part of input dataset used for neural network training, i.e. for adjustment of network weights. The validation set is a part of dataset used to tune network topology or network parameters other than weights. The statistical program itself retain the best network (the network with the lowest error on validation set). Whereas the test set is a part of input dataset used only to test how well the neural network will perform on new data. The test set is used after the network is ready (trained), to test what errors will occur during future network application. This set is not used during training and thus can be considered as consisting of new data entered by the user for the neural network application. The partition of data can be done manually or automatically by statistical program. Our dataset is partitioned as follows: 68% for training set; 16% for validation set and 16% for test set.

3.2.2 Preprocessing

Preprocessing transforms the data to make it suitable for neural network. For example, scaling numeric values and transforming text values into numeric ones. It has to be mentioned that neural networks work only with numeric data. Numeric columns are automatically scaled during data preprocessing. For input columns (in our case brand name and type of product) scaling range is [-1...1]. For the target column (in our case sales) scaling range depends on activation function of the output layer: linear output layer activation function (scaling range -1...1); logistic (sigmoid) output layer activation function (scaling range 0...1); hyperbolic tangent output layer activation function (scaling range -1...1); softmax output layer activation function (scaling range 0...1). In table 2 there are some details of the preprocessing stage.

Table 2: Variable details of the preprocessing stage

Variable	Column type	Format	Scaling range	Scaling factor
Type of product	Input	Numerical	[-1..1]	0.068966
Brand name	Input	Numerical	[-1..1]	0.083333
Sales	Output	Numerical	[0..1]	0.003226

3.2.3 Design

This step helps us to design the most efficient neural network architecture. If we want to design a network. we have to specify the network architecture (number of hidden layers and units in each layer) and network properties (error and activation function). A network with too few hidden units only roughly discovers hidden dependencies in the data whereby the network produces a significant number of errors. A network with too many hidden units will tend to memorize all the data instead of finding relations that also lead to bigger network errors. We have chosen a topology with one hidden layer and with one hidden unit. The neural network architecture most efficient for our case was 2-2-1. Whereas activation functions for hidden layers are (see for example Haykin. 1998; McNeil. Frey and Embrechts. 2011):

- Linear: this function produces its input as its output or in other words. just passes the activation level directly as the output. Its output range is [-inf..inf].
- Logistic: this function has a sigmoid curve and is calculated using the following formula: $F(x) = 1/ (1+e^{-x})$. Its output range is [0..1]. This function is used most often and was selected also in our case.
- Hyperbolic tangent: this function also has a sigmoid curve and is calculated using the following formula: $F(x) = (e^{x} - e^{-x})/ (e^{x} + e^{-x})$. Its output range is [-1..1]. Empirically. it is often found that this function performs better than the logistic function.

3.2.4 Training

To train the network we selected back propagation training algorithm which is the most popular algorithm for training of multilayer perceptron. However there are some drawbacks such as slow convergence. we need to tune up the learning rate and momentum parameters.

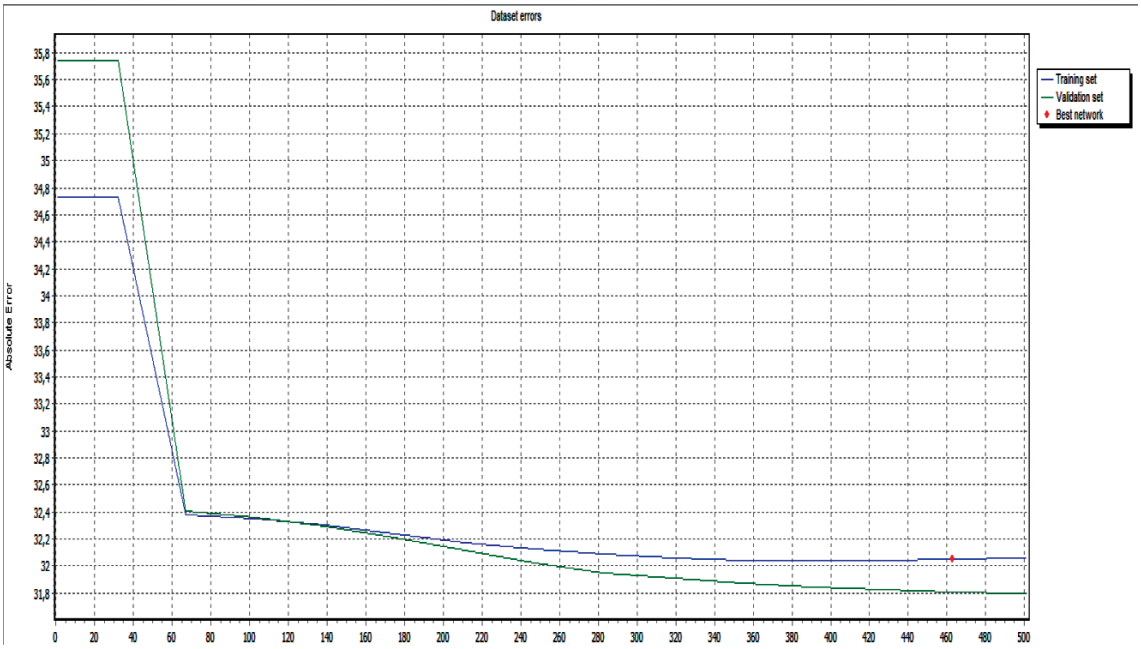

Figure 2: The dataset errors graph

In figure 2 the dataset errors graph plots the average absolute dataset error vs. iteration on training and/or validation sets. Because we deal with regression problem. we can see from the graph how the absolute error is reduced from iteration to iteration.

3.2.5 Testing

Network testing is performed after training completion. Testing can help us to analyze performance of the trained network. In accordance with the regression situation in our case we have two indications of quality of trained network: absolute error (AE) and absolute relative error (ARE). the difference between the actual value of the target column and the corresponding network output. The difference is displayed in absolute values and in percentage terms. In our case the AE is 32.052541. whereas the ARE is 6.135216.

3.2.6 Query

In this step we can query the trained network either by enterinf the query manually. loading the file or by selecting records from the loaded dataset. From the figure 3 we can see that our trained network performs well as the output lies not far away from the confidence limits (which are calculated using the average absolute error on the test set).

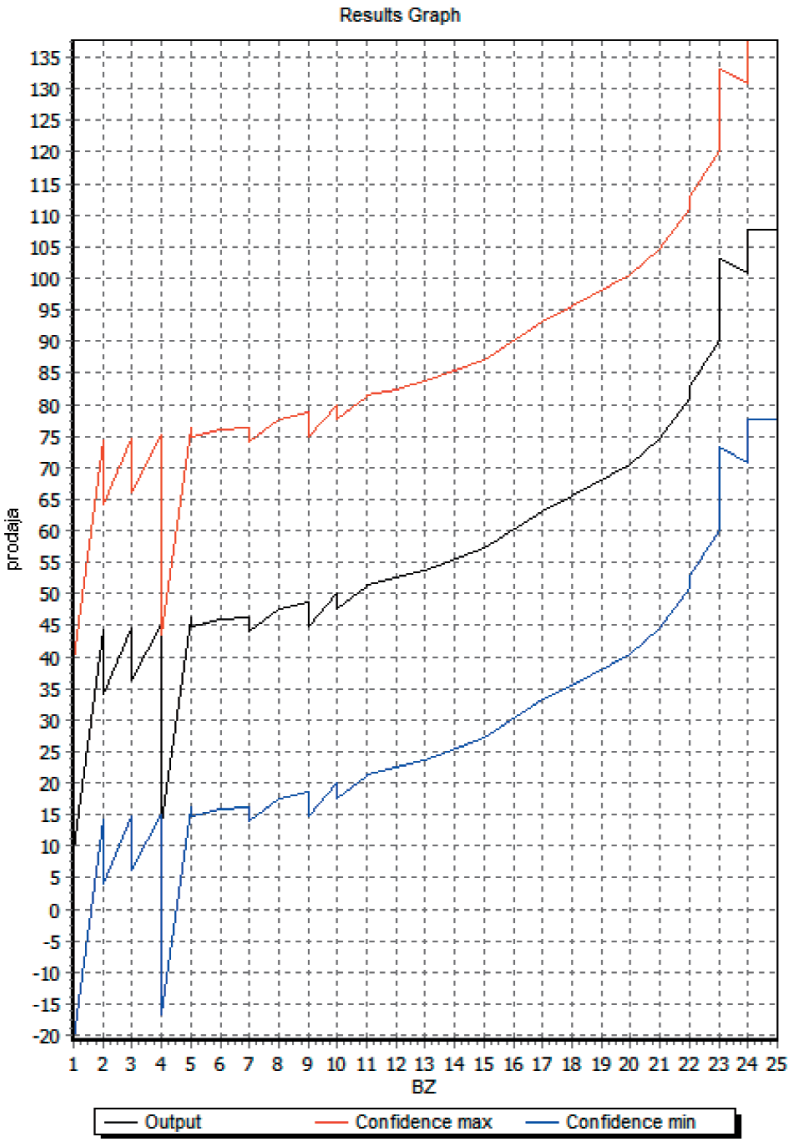

Figure 3: Confidence limits for the output

Conclusion

The risk management process represents strategically important process which can in certain situations act as a framework for changes in business decisions. That is why the process functioning is connected with the top management directly (usually it operates under the chief financial officer) and what is more. the flow of information is provided to the highest levels of organisation.

The main aim of this paper is to explore the mechanisms for implementing a risk management process into an organisation. It is proposed that the risk management process is broken down into the following stages: organisation. methodology. setting the sources of risk. keeping the process up to date. Whereas in the empirical part of the paper the proposed theoretical model is upgraded with a practical approach example focusing on forecasting sales using a neural network method.

The paper contributes to the better understanding of the risk management process as well as to the implementing different quantitative methods at different stages of risk management process. It also contributes to the relatively thin literature in the field of risk management process and empirical application of different quantitative methods into the process.

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