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Utilisation of ANFIS in analysing impact of cost structure on Croatian maritime companies development

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ABSTRACT

The modern approach to growth analysis and development of enterprises includes the analysis of defined business models progressively. One of the essential factors of any business model is the cost structure, mostly intended to analyse and define better the processes of transferring value to the customer, maintain customer relationship and generate revenue. An analysis of the costs incurred in these processes should facilitate the effective definition of key resources, key activities and key partnerships.

Modern theory distinguishes two types of business models from a cost perspective: a cost-driven model and a value-driven model. The cost-driven model is focused on minimizing costs wherever possible and such an approach has the propensity to create and maintain the lowest possible cost structure using low-cost value propositions. The value-driven model is focused on value creation and superior value propositions.

The aim of this research, by using Adaptive Neuro-Fuzzy Inference System (ANFIS) approach, is to create models for analysing the impact of cost structure on sustainable development and business survival with respect to selected financial indicators. Based on clustering methods, model creation is preceded by a search of the link between the business performance indicators and parameters that increase or decrease a particular cost component. The sample for creation of the model is based on financial data of five maritime Croatian companies obtained through four business years.

Thus, by analysis of the companies' business operations based on such created models it is possible to define the limits, namely the degrees of increase or decrease of a particular type of cost at which companies achieve sound business growth and development. Consequently, the management of a company is enabled to form effective business strategies. Such strategies in modern context imply innovation in business, new technological processes, efficient stock management, and improved relationships with customers and suppliers.

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1 Introduction

Recently, economic theory has been increasingly focused on the importance of creating innovative business models that companies use to gain an advantage over other companies. In these concepts, the approach is increasingly changing and it is oriented towards smart and sustainable solutions that are built into the strategies of most of the world's political and economic models. The very definition of business models, as a platform for creating and preserving value, defines a series of company activities from the procurement of materials to the satisfaction of the end consumer, which ultimately results in the creation of value through various activities. These activities relate mainly to elements such as Value proposition, Target market, Value chain, Revenue mechanism, Value network and Competitive strategy. Innovation refers to the recognition and harmonization of the mentioned factors in the context of increasing organizational efficiency, which can bring an advantage to a company regardless of the technological advantage of another company. In terms of cost savings, customer demand, loyalty and trust, supply chain and commitment to innovation, innovative business models should lead to Business sustainability.

In this paper, the focus is put on the cost component and the link between it and important business indica-

tors through the analysis of selected Croatian maritime companies. By clustering the selected parameters and analysis based on Adaptive Nero-Fuzzy Inference System (ANFIS) approach, it is possible to propose guidelines for introducing the innovative business models in the sector of maritime companies. Such guidelines are particularly important for considering the importance of the development of this sector in the Croatian economy, given the fact that the shipping industry has a widespread impact on the world's economy, as about 90 % of international trade is shipped around the globe by sea. Innovative business models implemented in shipping companies should improve their business and thus influence the evolution of international shipping in the context of economic growth and trade, fleet development, market developments in the sector, trip-level cost structures, technological developments, environmental requirements, security with focus on piracy and armed robbery at sea, and maritime labour.

2 Literature review

The analysis of the cost structure impact on business development can be linked to liquidity, financing, development and sustainability. Liquidity shocks due to deferred payments must be financed by cash or short-term debt. Debt holders provide an irrevocable credit line given the company's expected insolvency risk, and equity owners choose the optimal money retention. Uncertain cash flows lead to cash retention as a precaution if debt holders impose financial constraints. Keeping cash as a precaution reduces the risk of insolvency and improves access to short-term finance (Kling, 2016).

Companies with highly-liquid assets tend to invest more in research and development (R&D) and generate more patents. It is assumed that the positive effect of asset liquidity on innovation is related to the fact that liquidity can help firms to reduce capital costs. Consistent with this hypothesis, it is concluded that the effect is more pronounced for firms with high cash flow uncertainty or less capacity to access external capital. Therefore, it can be said that asset liquidity is an important determinant of innovation (Pham et al., 2017).

The high share of debt volatility most often leads to reduced profitability, and is a consequence of high volatility of operating and investment activities or a tendency to release cash balances and principal payments for absorbing fluctuations (Campbell & Rogers, 2018).

The size of the company and the tangibility of assets have a positive effect on the use of leverage, while profitability and growth opportunities negatively affect the use of debt. Some research showed that the cost of capital is significantly related to their corporate governance practices, and the degree of earnings management is more noticeable in companies with poor business results (Hongbok & Kwangwoo, 2018).

In choosing between bank and bond financing, in the case of financial difficulties, companies prefer to rely on the flexibility of banks in relation to lower marginal costs of issuing bonds. In response to the reduction in the supply of bank loans, aggregate bond issuance is increasing in the corporate sector, but not enough to avoid a decline in total borrowing and investment (Crouzet, 2017).

Analysts can help companies in order to have better access to external financing, which allows them to finance productive projects. They can also act as external supervisors to force managers to invest in the most productive projects. Empirical validation for both channels shows that a positive effect on productivity occurs in less known firms, financially constrained firms, and firms with weaker investor protection. Less coverage with analysts reduces capital expenditures and institutional monitoring, so it can be said that these two channels also have an impact on a company's productivity (To et al., 2018).

When a company's investment spending is below earnings, leverage decreases. Because financial cycles last longer than business cycles, financial cycles should have a long-term leverage effect. Companies are changing their capital structure due to financial and credit cycles, and leverage is mostly stable due to the cyclical nature of the financing decision (Al-Zoubi et al., 2018). In addition, with the existence of developed financial markets, managers can use financial protection as an effective tool to solve the agency problem in debt financing (Ni et al., 2017). The fact is that medium-sized companies in Croatia are usually privately owned. Related to this, the absence of foreign institutional investors and shareholders who can promote long-term investment in fixed capital, innovation and human capital should be noted (Bena et al., 2017). For example, Hsu et al. (2014) in their research highlighted the strong link between capital market development and positive innovation effects, while on the other hand Luong et al. (2017) found a link between foreign institutional investors and fostering innovation, but without implications for long-term investment and employment. Hsu et al. (2014) proved in their research that family private ownership promotes innovation, and Acharya et al. (2013) found a link to the promotion of innovation in employee-friendly laws. Globalization and presence in foreign markets encourages new technologies, products and services and thus the creation of new jobs (Bena et al., 2017).

An operational strategy that seeks to develop a business faces the challenges of investing in flexible or specialized technologies, new technologies and design, by prioritizing investments in a set of new products or services or projects, through networks of different funding sources (Van Mieghem, 2003). Initiating such transformative changes, with the application of structures and platforms for continuous learning and thinking, can be explicitly transformed into practices that are developed and shaped according to values, i.e. developmental norms and logic (Hermelingmeier & von Wirth, 2020). More and more companies are focusing on the application of new

Table 1 The observed variables of five Croatian maritime companies in the period from 2016 to 2019

#	Variable	Variable mean value for all companies in the analysed period
1	Share of material costs in operating income	63.00 %
2	Share of material costs in operating expenses	73.00 %
3	Share of staff costs in operating income	15.00 %
4	Share of staff costs in operating expenses	19.00 %
5	Share of other expenses in operating income	4.90 %
6	Share of other expenses in operating expenses	6.40 %
7	Depreciation share in operating income	6.50 %
8	Depreciation share in operating expenses	9.80 %
9	Share of financial expenses in operating income	6.00 %
10	Share of financial expenses in operating expenses	8.50 %
11	Coverage of total liabilities from EBITDA	1.94
12	Turnover ratio	1.53
13	EBITDA margin	15.50 %
14	ROE	14.70 %
15	ROA	12.70 %
16	Investment ratio	0.083

Source: Author

technologies in the context of development strategies and embracing innovations such as the Internet of Things (IoT) and Artificial Intelligence (AI) and innovating their business models through digitalization and digital transformation (Caputo et al., 2021). The new architecture of business models has led to the adoption of digital infrastructure (Warner, Wager, 2019) leading to dematerialization of the process (Snabe Hagemann & Weinelt, 2016).

In order for a company's business to remain sustainable, significant changes in organizational culture are most often required (Linnenluecke & Griffiths, 2009). The result of such changes are evolutionary processes in organizational attitudes and reactions (Hubbard, 2009) and can actually be called organizational learning (Hermelingmeier & von Wirth, 2020).

More recently, three types of competencies have been identified that contribute to business sustainability: organizational, economic, and environmental (Wong & Ngai, 2021). Economic competencies are viewed in the context of market leadership and innovation, organizational in the context of managerial competencies and social well-being, while environmental ones are considered in reflection, redesign, reuse, recycling and reduced use (Wong & Ngai, 2021). The management structure, i.e. the perception of employees and/or owners, has a positive effect on the dimension of the environmental, social and financial component of business sustainability (Konadu et al., 2021). Strong links with human resource management, information technology departments, quality management, research and development teams and business operations as the core of the organization help to focus intellectual capital management on the process of change management and maturity in the context of better achieving goals and adapting business models (Bornemann et al., 2021). The innovation of business models in organizations requires inclusive leadership as the primary source of motivation in employee engagement for generating and integrating employee knowledge (Fang et al., 2021). Deep and broad knowledge bases are used in creating innovative business models in the context of sustainability. It has been proven that a deep knowledge base is more useful for the growth of a company based on efficiency, while both types of knowledge bases are combined in the growth and development of business based on innovation (Wenwen et al., 2021). Sustainability-oriented business models consist of components: elements and structures, applications, types of business models, transition processes, and circularity as sustainability and technical aspects of innovation (Preghenella & Battistella, 2021).

3 Data and research methodology

The analysis was performed on a financial data sample of five Croatian maritime companies in the period from 2016 to 2019. The observed variables are presented in Table 1, while the associated values are given only as mean values for all companies in afore mentioned period.

The variables 1-16 from Table 1 were first clustered using self-organizing neural networks (SOM), after which the most appropriate input variables are selected for modelling EBITDA margin that served as the ANFIS output variable.

Selected methods have been applied several times in the context of various analyses and are described in more detail in Kohonen (2001), Brlečić Valčić et al. (2016), Jang

(1993), Valčić et al. (2011), Brlečić Valčić et al. (2020). The MATLAB software package was used in the research.

It is important to emphasize that training was performed with all available data, i.e. the model was not validated with new independent validation data set. There are two reasons for this. The first one is related to the lack of data, i.e. only small data set was available. The other one is related to the fact that this model was not developed for prediction purposes, but for modelling of the current state. Thus, the generalization capabilities of the model are not important in this case.

4 Research results and discussion

An insight into the variable mean values in the observed sample (Table 1) indicates the conclusions that Croatian shipping companies pay the most attention to material costs in the cost structure, while other components have significantly lower values. The small share of depreciation costs and the extremely low investment ratio indicate the choice of a cost-driven model instead of a value-driven model.

In addition to this overview, the clustering of all variables (1-16) from Table 1 was performed using the self-organizing neural network (SOM). The SOM was trained with 20 neurons and the clustering results are presented in Figure 1.

The clustering analysis indicates the conclusions that the share of material costs in operating revenues and expenses does not directly affect the selected business indicators (Table 1, variables / SOM inputs 11-16). Therefore, the percentage of cost reduction can be modelled by the means of these shares, if this is necessary in a particular business model of the observed companies.

Business results and performance (Table 1, variables 11-16) mostly depend on the share of staff costs in operating incomes (Table 1, variable 3) and operating expenses (Table 1, variable 4), as well as on the share of other expenses in operating expenses (Table 1, variable 6). Therefore, these categories were selected for modelling in the context of further analysis.

The share of other expenses in operating income can be related to ROE, ROA and investment ratio indicators. Depreciation and financial expenses (Table 1, variables 7-10) are a separate cluster in the observed data and are not related to the selected financial indicators in the selected sample. Thus, they are omitted for further analysis.

Coverage of total liabilities from EBITDA, turnover ratio, ROE, ROA and investment ratio are in the same cluster. Since the observed companies have a good liquidity position, which also means that they do not have a high share of debt volatility, it can be concluded that in this way they maintain a position of relatively good profitability. However, in accordance with the conclusions of the previ-

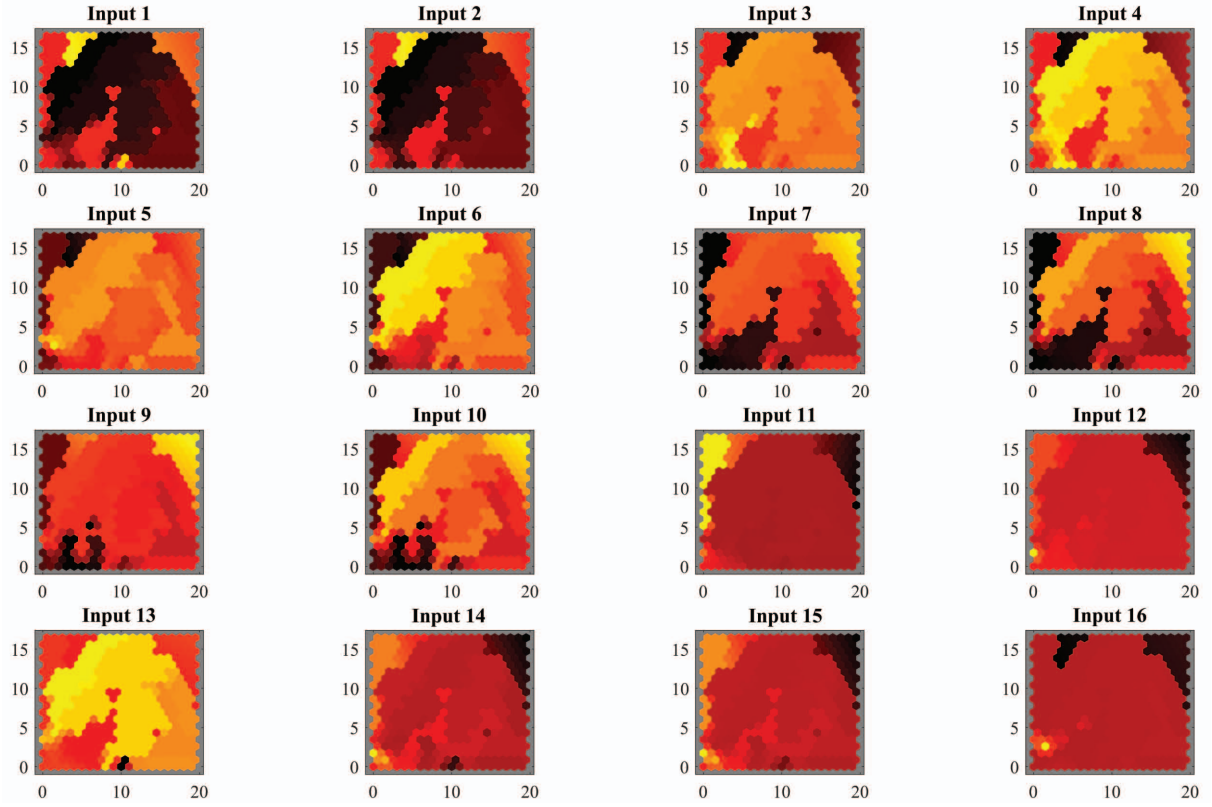

Figure 1 The visualization of SOM clustering results

Source: Author

ous research (Campbell & Rogers, 2018), this also means that there is no volatility of operating and investment activities, i.e. that there is a lack of investment in sustainability and business development.

Since the EBITDA margin (Table 1, variable 13) is usually used as a significant indicator of business performance, and based on the clustering results by which one can easily notice its relationship with variables 3, 4 and 6 (Table 1), the input-output set of variables for the ANFIS modelling was selected as shown in Table 2.

Deployed ANFIS model with RMSE performance index of 0.00084 can be conveniently visualised in terms of top view figures for any combination of two input variables with respect to the output variable values denoted with colour bar, as shown in Figure 2. Considering there are three input variables, there are also three pair-wise combinations.

The obtained results suggest that a better and stable EBITDA margin is caused by higher percentages than the average share of staff costs in operating income and operating expenses shown in Table 1, i.e. these shares should be in the range from 20-30 %. The conducted analysis also suggests that a stable EBITDA margin is conditioned by the share of other expenses in operating expenses in the range of 7-10 %, which is also significantly higher than the average of the observed sample.

Namely, the average share of staff costs in the operating income of the observed companies is 15 %, the average share of staff costs in the operating expenses of the observed companies is 19 %, while the average share of other costs in the operating expenses of the observed companies is 6.4 %. Analyses therefore indicate the need for greater allocation of entrepreneurs in the observed cost categories in the context of enterprise development, i.e. in achieving a value-driven model.

In addition to the above, and in the context of the need for creating development value-driven models of the observed companies, it should be noted that the shares of financial expenditures in the total expenditure structure are on average very low, while the average investment ratio is only 0.083. The averages of the indicators Coverage of total liabilities from EBITDA and ROE indicate the possibility of a stable capital structure and the possibility of greater borrowing in the context of employee development and investment in assets and innovations that would certainly contribute to the development and survivability of such companies.

Table 2 The ANFIS input and output variables

#	ANFIS input variable
1	Share of staff costs in operating income
2	Share of staff costs in operating expenses
3	Share of other expenses in operating expenses

ANFIS output variable
EBITDA margin

Source: Author

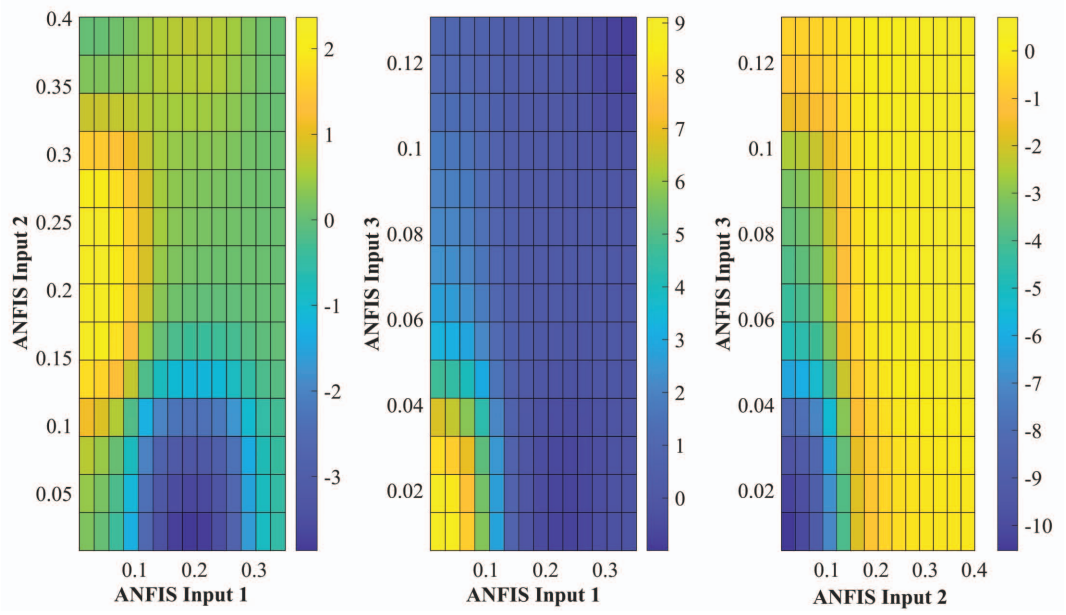

Figure 2 The ANFIS input-output mapping visualization where the colour bar values corresponds with ANFIS output values

Source: Author

5 Conclusion

The approach to the analysis of business models in the context of the cost structure impact on business development and survival is discussed in this paper. In addition, selected Croatian shipping companies were analysed based on their financial data from 2016 - 2019. The analysis showed that the selected companies in terms of cost structure rely mainly on material costs in business models. In the cost structure, given their share in revenues and expenses, they have a low share of staff costs and other costs, which have been proven significant in the context of business development and stability. Therefore, it can be concluded that their business models are more cost-driven than value-driven.

Such conclusions are reached by linking previously conducted research and analysis, mainly because sustainability in a value-driven context is achieved by significant changes in organizational culture. In other words, it can be concluded that in the context of sustainability it is necessary to develop economic and organizational competencies.

Although the concrete conclusions are arising from conducted analyses, a small sample of data can be singled out as a most notable shortcoming. Moreover, only grouped data were used in terms of cost classes, i.e. detailed cost analytics was not performed due to the lack of appropriate data. Regardless of highlighted constraints, these types of analyses could be used for other types of companies with small adaptation in terms of clustering results. Further work should be focused on embracing these issues.

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