

Level of Knowledge and Implementation of Lean Methodology in Small and Medium-sized Croatian Companies

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Abstract - The main objective of this research paper is to examine the level of knowledge and implementation of lean methodology in small and medium-sized (SMEs) Croatian companies. Continual changes in the market require businesses to be flexible, which enables them to react quickly without generating unnecessary costs for the companies.

The methodology of this research paper combines a literature review on lean methodology and lean startup principles with research tool development, data collection and the validation of results. Data analysis were done with cluster analysis. The target sample is 300 companies that operate from incubation centres and technology parks.

The research provides insights into the current situation of Croatian SMEs in regard to applying modern approaches to improving business processes.

Keywords - Lean methodology, lean startup, business strategy, incubation centres, technology parks, cluster analysis

1. Introduction

Changes in conditions under which companies operate are constant and unpredictable and customer demand continuously changes [13].

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The need to reorganize the company has been recognized, and one of the concepts in improving business processes is the adoption of a lean methodology [13]. Lean production has evolved into a management philosophy, which focuses on increasing customer value by reducing non-value-added activities [7]. The structure of the article is as follows: Section 2 defines lean methodology and lean startup principles. Section 3 explains the research methodology and presentation of the analysis and results. Section 4 discusses the most significant results of the research, limitations of the research and potential directions for further research.

2. Lean Methodology and Lean Startup Principles

The concept of lean production became popular when the book *The Machine That Changed the World* was published in 1990 [9].

Prominent academics and practitioners have made efforts to define lean methodology and most of the definitions define lean as a way of focusing on customers and methods to reduce waste and identify value [6]. Lean methodology “provides a way to specify value, line up value-creating action in the best sequence, conduct these activities without interruption whenever someone requests them, and perform them more effectively. In short, lean thinking is ‘lean’ because it provides a way to do more with less—less human effort, less equipment, less time, and less space—while coming closer and closer to providing customers with what they really want” [14].

According to [4], [1] lean thinking or lean production are methodologies for achieving improvements in an economical way and whose special scope is the reduction of muda (waste). Lean thinking implies a focus on the customer and when lean thinking is implemented correctly, it will result in the elimination of “muda” and more efficient processes that provide better value to the customers [3]. According to [9], the main aim of lean production is manufacturing products without waste.

Waste is defined as “*an activity that does not create any value to the final product*”. Lean startup methodology is defined as a methodology which is focused on agile testing and learning cycle to validate hypotheses in the business idea and the term ‘Lean Startup’ was first used in 2008 [10].

The lean startup is a new concept that has roots in lean manufacturing [12]. This concept modifies lean manufacturing ideas in the context of entrepreneurship [12]. The difference between these two concepts is in the unit of progress. Lean manufacturing measures progress by the production of high-quality physical goods, whereas the unit of progress in the lean startup concept is validated learning [12]. Start-up companies are defined as newly founded companies which are usually associated with high-tech projects [8]. Entrepreneurs have to make constant adjustments by build-measure-learn feedback instead of making a complex business plan [12].

The five lean startup principles are defined as follows [12]:

- Entrepreneurs are everywhere. The lean startup approach can be implemented “*in any size company, in any sector or industry*”.
- Entrepreneurship is management. A startup requires a new form of management given the extreme uncertainty.
- Validated learning. Startups “*exist to learn how to build a sustainable business*”. Entrepreneurs can test their vision through experiments.
- Build-measure-learn. Startups have to be geared towards customer feedback on their products to learn if they have to persevere or change their product.
- Innovation accounting. For entrepreneurs to have a successful business they have to focus on things like “*how to measure progress, how to set up milestones, and how to prioritize work*”.

The lean startup methodology is an answer to the problem that sometimes founders spend much time and money on a product that the customer does not want [10]. Unity of the lean startup methodology is defined as the ability to take into account the multiple uncertainties related to the convenience of a given solution to the specific customer problem [11].

Barriers for implementation of lean startup methodology are: no possible media for collecting the customer feedback, the speed of iteration caused by the regulation and administrative stuff required in contacting the customers and confusion about Minimum Viable Product [10]. According to [5] different level of knowledge about lean startup in observed companies are identify, the higher level of knowledge was recognized in startups. The lean startup technique can be applied in any industry and

can be used to test ideas, new products and services [12].

3. Research Methodology

3.1. Sample

The aim of this research was to examine the level of knowledge and implementation of lean methodology in Croatian small and medium-sized companies. The research was conducted on Croatian companies who operate from Croatian incubation centres and technology parks. The target sample was 300 companies and included companies in all categories of economic activity according to the national classification of economic activities. Thus, the analysis covers the following sectors: agriculture, forestry and fishing; manufacturing; construction; wholesale and retail trade; transportation and storage; accommodation and food service activities; information and communication; real estate activities; professional, scientific and technical activities; and arts, entertainment and recreation. The incubation centres and technology parks that are included in the research are the Križevci Entrepreneurial Center, Technology Innovation Centre Medjimurje, Koprivnički poduzetnik, Technology Innovation Center Pleternica, Technology Center Split, Business Incubator for Service Activities Torpedo, Entrepreneurial Incubator Klis, Innovative Zadar, Technology Park Bjelovar, Technology Park Zagreb, Entrepreneurial Incubator Polet, Entrepreneurial Incubator BIOS, Technology Park Varaždin, Technology Park Vinkovci, TERA Tehnopolis, STEP RI, Technology Incubator Virovitica, Entrepreneurial Incubator Izazov, Entrepreneurial Incubator Sisak, and Entrepreneurial Incubator Osvit.

The survey questionnaire was defined according to the reviewed theory and the five lean startup principles: entrepreneurs are everywhere, entrepreneurship is management, validated learning, innovation accounting and build-measure-learn [12]. Based on the defined aims of this research, several research questions were analysed:

RQ 1: What is the level of implementation of the five lean startup principles in Croatian companies?

RQ 2: Is there a lean principle that is the most applicable to Croatian companies?

RQ 3: What is the level of awareness of lean startup principles in Croatian companies?

3.2. Survey Sample

The overall response rate was 12% or 35 responses. The survey questionnaire was sent to

companies via email addresses collected on the web pages of incubation centres and technology parks.

The average number of employees in the companies is four and the range is fifteen. The mode, that is, the most frequent number of employees, is three (Figure 1.). Figure 2. shows the distribution of the companies in the research sample by location.

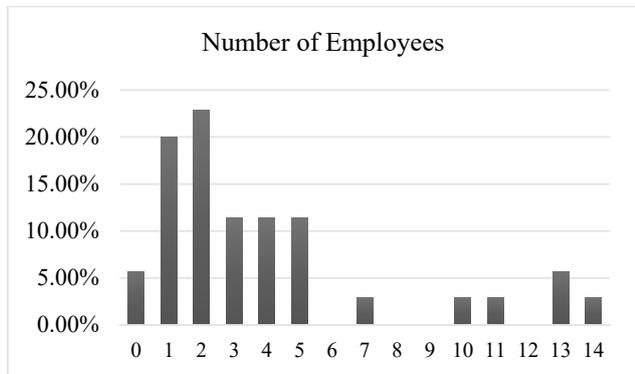


Figure 1. Number of employees in the examined companies

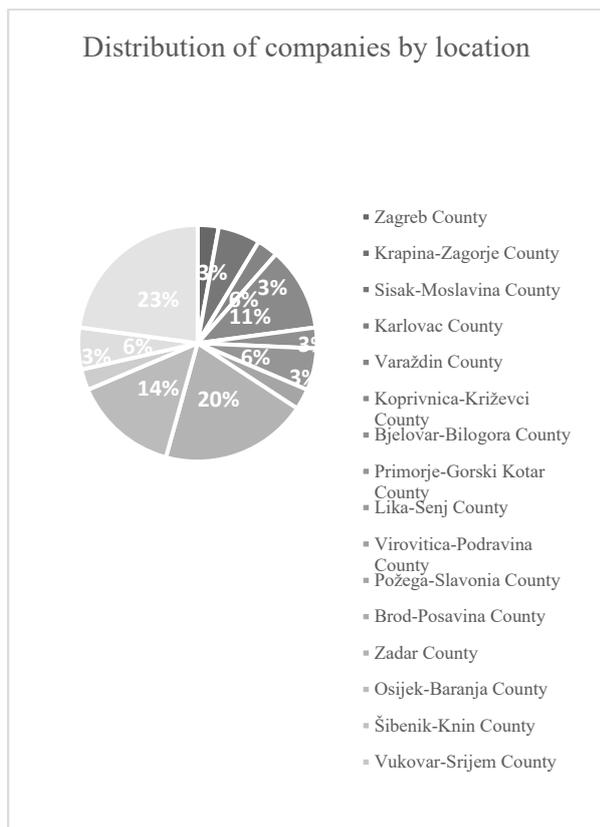


Figure 2. Distribution of companies by location

3.3. Survey and Analysis - Descriptive Analysis

In this section are analysed and presented the results collected through the survey questionnaire.

Statement 1: "In business, the most important thing for me is to fully implement the defined business plan." The scale is "Strongly Disagree – 1", "Disagree – 2", "Neither Agree nor Disagree – 3", "Agree – 4", and "Strongly Agree – 5". Nearly 40%

of respondents selected the response "Neither Agree nor Disagree – 3". 31% of respondents answered "Agree – 4" (Figure 3.). The mean of this statement is 3.14, and the mode as the most common response to statement 1 is three. These answers indicate that a defined business plan is meaningful for entrepreneurs. Large companies write business plans; therefore, venture capitalists require a written business plan from the startup [2]. Over 90 % of successful startups are doing something different from their original plan [2].

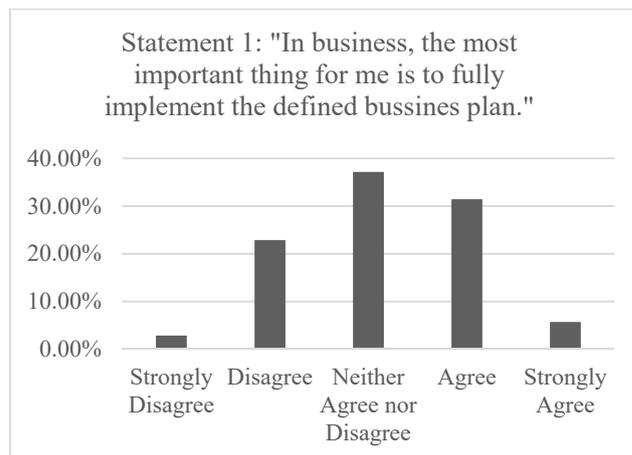


Figure 3. Responses to statement 1: "In business, the most important thing for me is to fully implement the defined business plan. "

Statement 2: "I continuously align business activities with customers' needs." The scale is "Strongly Disagree – 1", "Disagree – 2", "Neither Agree nor Disagree – 3", "Agree – 4", and "Strongly Agree – 5". Nearly 60% of the respondents selected the response "Agree – 4", and nearly 20% of the respondents selected the response "Strongly Agree – 5" in response to this statement. (Figure 4.) The mean of this statement is 3.91, and the mode as the most frequent response to statement 2 is four. These answers indicate that companies focus on customer needs and define business activities according to the feedback. This is one of the lean startup principles [12].



Figure 4. Responses to statement 2: "I continuously align business activities with customers' needs. "

Statement 3: “I always include customers in the product/service development to obtain their feedback.” The scale is “Strongly Disagree – 1”, “Disagree – 2”, “Neither Agree nor Disagree – 3”, “Agree – 4”, “Strongly Agree – 5”. Nearly 47% of the respondents selected “Agree – 4” in response to statement 3. The mean of this statement is 4, as is the mode. The median is 4, so 50% of the respondents selected the responses “Agree – 4” and “Strongly Agree – 5”. (Figure 5.) This result indicates that a significant number of the examined companies implement one of the lean startup principles in their business and they include customers in some phase of product/service development.

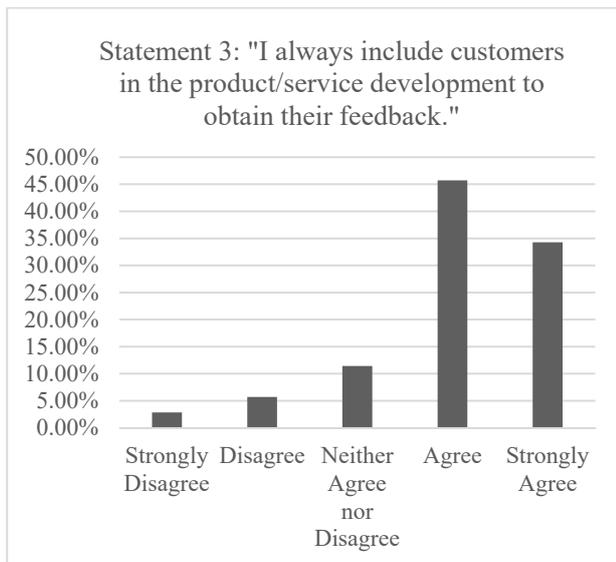


Figure 5. Responses to statement 3: “I always include customers in the product/service development to obtain their feedback.”

Statement 4: “I enter the market only with a final product/service that completely matches the features planned in the design phase.” The scale is “Strongly Disagree – 1”, “Disagree – 2”, “Neither Agree nor Disagree – 3”, “Agree – 4”, “Strongly Agree – 5”. 40% of the respondents selected “Agree – 4” in response to statement 4. This indicates that a significant number of companies do not implement agile methodologies in the development of products or services. Additionally, a significant number of the respondents, nearly 30%, selected “Disagree – 2”, which indicates the implementation of lean startup principles. (Figure 6.) The mean is 3.3, and the most frequent response to this statement was Agree, indicated by a mode of four.

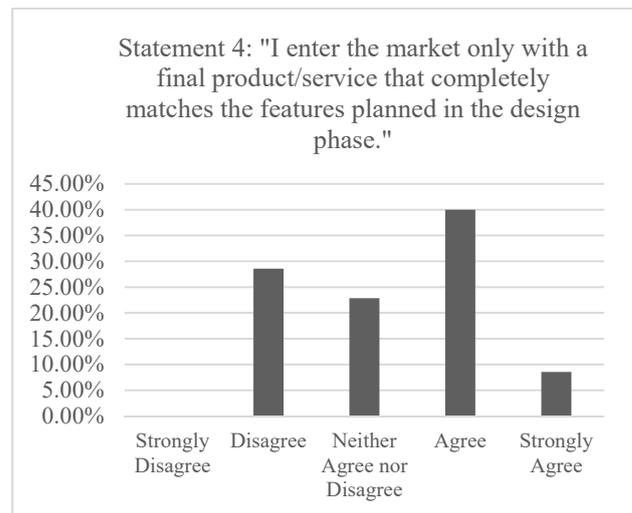


Figure 6. Responses to statement 4: “I enter the market only with a final product/service that completely matches the features planned in the design phase.”

Statement 5: “I often enter the market with incomplete products or services to obtain customer feedback that I apply to the final products or services.” The scale is “Strongly Disagree – 1”, “Disagree – 2”, “Neither Agree nor Disagree – 3”, “Agree – 4”, and “Strongly Agree – 5”. Nearly 23% of the respondents selected “Agree – 4” in response to statement 5. Additionally, 11% of the respondents selected the response “Strongly Agree – 5”. (Figure 7.) These responses suggest that some surveyed companies include customer feedback in the phase of finalizing the product or service and enter the market with a prototype of the product/service. A significant number of companies do not enter the market with incomplete product/service to incorporate customer feedback in the final product. The mean is 2.8, and the mode is 2; thus, the most common response to this statement is “Disagree”.

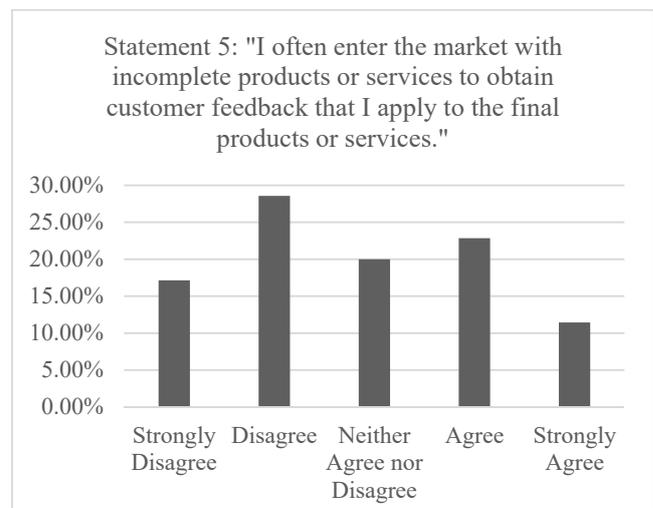


Figure 7. Responses to statement 5: “I often enter the market with incomplete products or services to obtain customer feedback that I apply to the final products or services.”

Statement 6: “I devote a lot of time to non-profit activities (measuring the progress of employees, how to better define deadlines, etc.)” The scale is “Strongly Disagree – 1”, “Disagree – 2”, “Neither Agree nor Disagree – 3”, “Agree – 4”, “Strongly Agree – 5”. 31% of the respondents selected “Agree – 4” in response to statement 6. (Figure 8.) This indicates that some companies are aware of the importance of non-profit activities, which is also one of the lean startup principles. “Innovation accounting” is defined as one of the lean startup principles, which means that companies need to focus on activities that measure progress and define the priority of activities [12]. Nearly 43% of the responders selected the response “Neither Agree nor Disagree – 3”. The mean is 3.14, and the mode is 3. Mode 3 could be interpreted as some respondents not clearly understanding this statement. In addition, the result could be interpreted as non-profit activities having the same importance as profit activities.

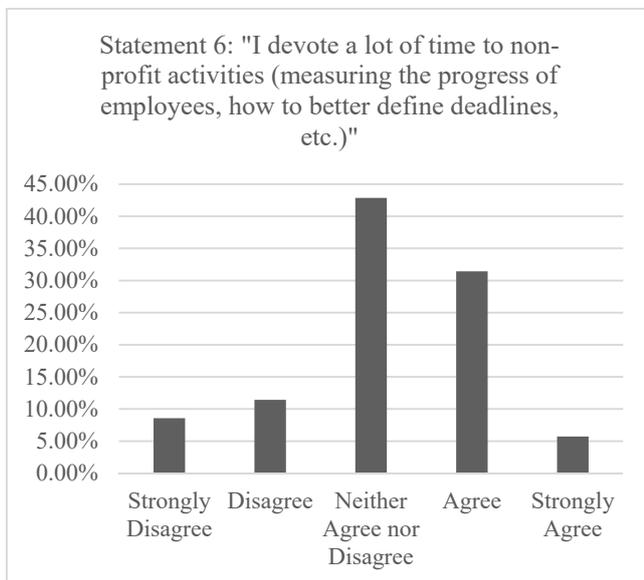


Figure 8. Responses to “I devote a lot of time to non-profit activities (measuring the progress of employees, how to better define deadlines, etc.)”

Statement 7: “I am principally focused on business activities that generate profit.” The scale is “Strongly Disagree – 1”, “Disagree – 2”, “Neither Agree nor Disagree – 3”, “Agree – 4”, “Strongly Agree – 5”. 40% of the respondents selected the response “Agree – 4” in response to statement 7. This statement indicates findings opposite to those of statement 6. Nearly 14% of the respondents selected the response “Disagree – 2”, which indicates that the management in some of the companies is aware of the importance of non-profit activities. (Figure 9.) The mean is 3.3 and the mode is 4. The mode indicates that in the majority of companies, the key focus is just on profit activities.

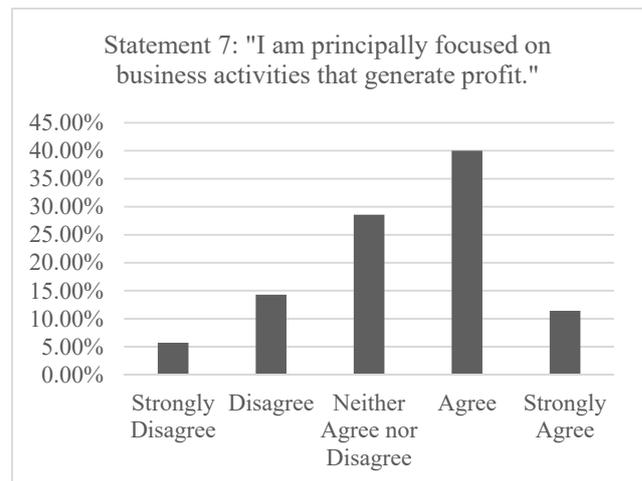


Figure 9. Responses to statement “I am principally focused on business activities that generate profit.”

Statement 8: “Poor customer feedback has an influence on the modification of products/services.” The scale is “Strongly Disagree – 1”, “Disagree – 2”, “Neither Agree nor Disagree – 3”, “Agree – 4”, “Strongly Agree – 5”. Nearly 60% of the respondents selected “Agree – 4” in response to statement 8. (Figure 10.) This indicates that the majority of the surveyed companies implement this lean principle in their business. That is, the companies practice collecting customers’ feedback and apply the received feedback in business activities. The mean is 3.6, and the mode is 4. Agile engineering is one of lean startup principles [2], [12]. Applying this concept in the development of a product includes incrementally, iteratively building the product, and continuously obtaining feedback from the customer [2].

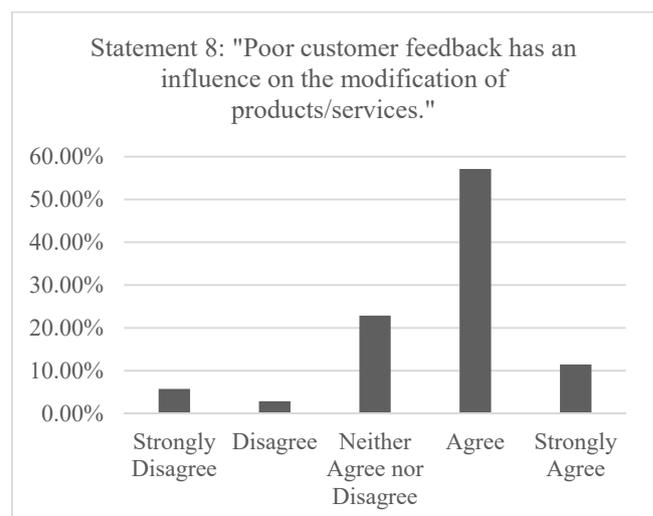


Figure 10. Responses to statement 8: “Poor customer feedback has an influence on the modification of products/services.”

Statement 9: “My own business solution for the product/service is more important than customer feedback.” The scale is “Strongly Disagree – 1”, “Disagree – 2”, “Neither Agree nor Disagree – 3”, “Agree – 4”, “Strongly Agree – 5”. 37% of the respondents selected “Disagree - 2” in response to statement 9. (Figure 11.) These results indicate that some companies focus more on customer feedback than on their own solutions. This suggests the implementation of lean startup principles, because some companies are ready to customize their own solution according to customer feedback. Nearly 43% of the respondents selected the response “Neither Agree nor Disagree – 3”, which could be interpreted as indicating that companies give equal importance to their own solution and customer feedback. The mean is 2.6, and the mode is 3.

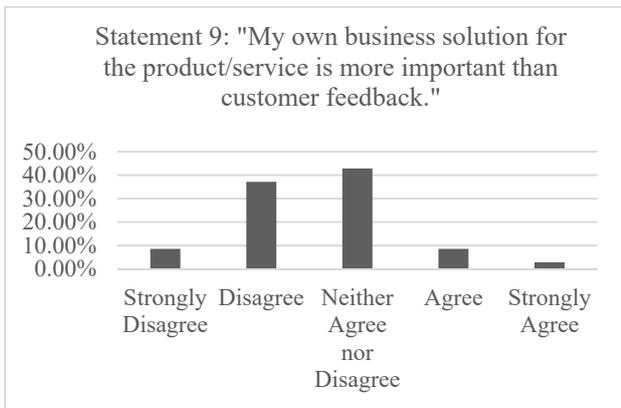


Figure 11. Responses to statement 9: “My own business solution for the product/service is more important than customer feedback. “

Statement 10: “In business, I monitor additional information that is not obligatory within the framework of the Accounting Act.” The scale is “Strongly Disagree – 1”, “Disagree – 2”, “Neither Agree nor Disagree – 3”, “Agree – 4”, “Strongly Agree – 5”. 37% of the respondents selected “Agree – 4” in response to statement 10. (Figure 12.) These results indicate that some of the companies examined are implementing the “build-measure-learn process” and “innovation accounting” as lean principles. The mean is 3.4, and the mode is 3.

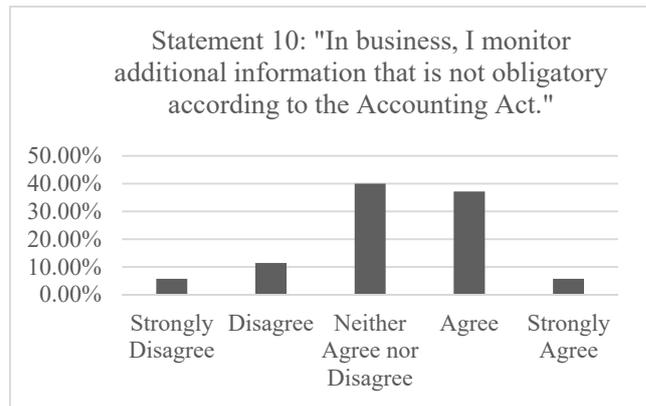


Figure 12. Responses to statement 10: “In business, I monitor additional information that is not obligatory within the framework of the Accounting Act.”

Statement 11: “Monitoring of customer acquisition costs is more important than standard cost analysis, as defined in the Accounting Act.” The scale is “Strongly Disagree – 1”, “Disagree – 2”, “Neither Agree nor Disagree – 3”, “Agree – 4”, “Strongly Agree – 5”. Nearly 30% of the respondents selected “Agree – 4” in response to statement 11. (Figure 13.) This indicates that some companies are focused on financial information other than that which is prescribed within the framework the Accounting Act and that they are implementing “innovation accounting” principles. 45% of the respondents selected the response “Neither Agree nor Disagree – 3”, which could be interpreted as indicating that the majority of the respondents could not decide what is more important. The mean is 3.2, and the mode is 3.

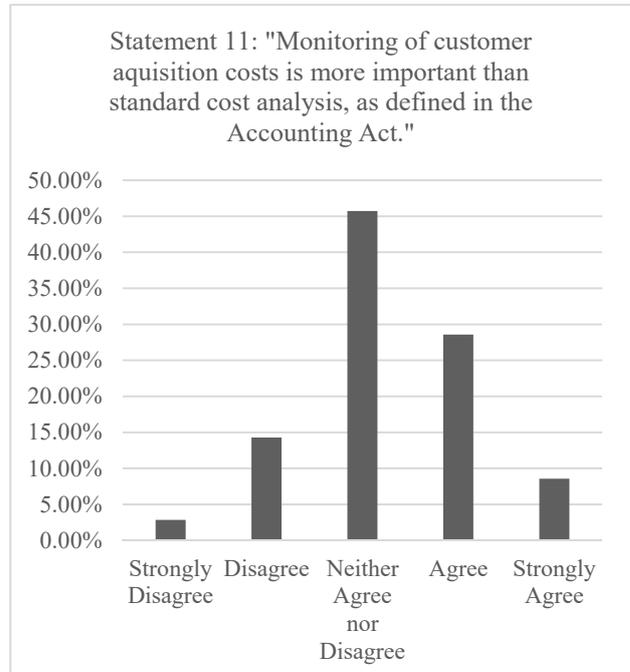


Figure 13. Responses to statement 11: “Monitoring of customer acquisition costs is more important than standard cost analysis, as defined in the Accounting Act.”

Statement 12: “In cooperation with employees, I focus more on fast knowledge acquisition than on the employees’ experience and ability to execute a task.” The scale is “Strongly Disagree – 1”, “Disagree – 2”, “Neither Agree nor Disagree – 3”, “Agree – 4”, “Strongly Agree – 5”. 40 % of the respondents selected “Agree – 4” in response to statement 12, and 23% of the respondents selected the response “Strongly Agree – 5”. (Figure 14.) This result indicates that companies focus on the knowledge acquisition of employees, which is also one of the lean startup principles. The mean is 3.6, and the mode is 4. The median of this statement is 4.



Figure 14. Responses to statement 12: “In cooperation with employees, I focus more on employees’ fast knowledge acquisition than on their experience and ability to execute a task.”

In the last two questions of the survey, the companies had to rate themselves on the level of awareness and implementation of the lean methodology in their business. The aim of these questions was to examine whether there are differences between the results collected through the statements and the self-assessment results on lean approach implementation.

Question 1: “Evaluate your awareness about the implementation of modern approaches to business process improvement: lean methodology.” The scale is “Very poor – 1”, “Poor – 2”, “Average – 3”, “Good – 4”, “Excellent – 5”.

The mean is 2.7, and the mode is 1. Nearly 25% of the respondents selected the responses “Good – 4” or “Excellent – 5”. A significant number (22%) of the respondents selected the response “Very poor – 1” (Figure 15.). These responses indicate that there are many opportunities to increase awareness about the lean methodology.

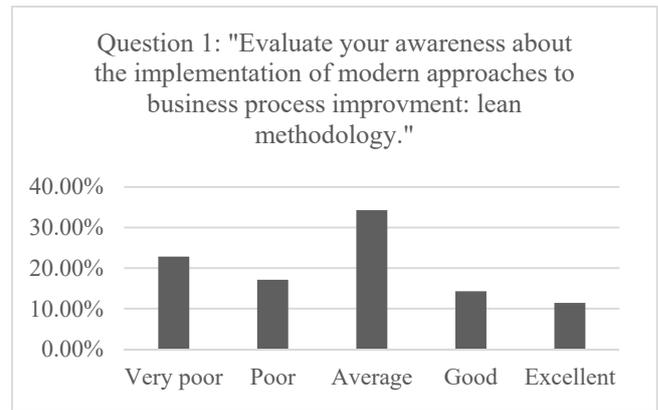


Figure 15. Responses to question 1: “Evaluate your awareness about the implementation of modern approaches to business process improvement: lean methodology.”

Question 2: “In business, I implement a modern approach to business process improvement: lean methodology.” The scale is “Strongly Disagree – 1”, “Disagree – 2”, “Neither Agree nor Disagree – 3”, “Agree – 4”, “Strongly Agree – 5”.

26 % of the respondents selected the response “Strongly Disagree – 1”, and 23% of the respondents selected the response “Disagree – 2”, which means that nearly 50% of the examined companies claim that they do not implement the lean approach in their business. The mean is 2.7, and the mode is 1. The results collected in the statement section suggest that the majority of examined companies implement some of the lean principles in their business.

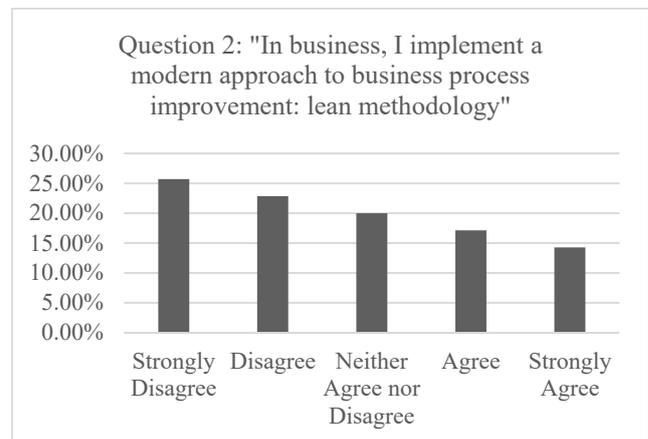


Figure 16. Responses to question 2: “In business, I implement a modern approach to business process improvement: lean methodology”

Table 1. presents the overall research results, according to the statements and questions and their means and modes.

Table 1. Overall research results

Statements from survey	Mean	Mode
Statement 1: “In business, the most important thing for me is to fully implement the defined business plan.”	3.14	3
Statement 2: “I continuously align business activities with customers’ needs.”	3.91	4
Statement 3: “I always include customers in the product/service development to obtain their feedback.”	4.03	4
Statement 4: “I enter the market only with a final product/service that completely matches the features planned in the design phase.”	3.29	4
Statement 5: “I often enter the market with incomplete products or services to obtain customer feedback that I apply to the final products or services.”	2.83	2
Statement 6: “I devote a lot of time to non-profit activities (measuring the progress of employees, how to better define deadlines, etc.)”	3.14	3
Statement 7: “I am principally focused on business activities that generate profit.”	3.37	4
Statement 8: “Poor customer feedback has an influence on the modification of products/services.”	3.66	4
Statement 9: “My own business solution for the product/service is more important than customer feedback.”	2.6	3
Statement 10: “In business, I monitor additional information that is not obligatory within the framework of the Accounting Act.”	3.26	3
Statement 11: “Monitoring of customer acquisition costs is more important than standard cost analysis, as defined in the Accounting Act.”	3.26	3
Statement 12: “In cooperation with employees, I focus more on fast knowledge acquisition than on the employees’ experience and ability to execute a task.”	3.69	4
Question 1: “Evaluate your awareness about the implementation of modern approaches to business process improvement: lean methodology.”	2.74	3
Question 2: “In business, I implement a modern approach to business process improvement: lean methodology.”	2.43	3

3.4. Cluster Analysis

Data analysis were done with cluster analysis based on the K-means algorithm. Authors selected K four in order to analyse if the companies which claim that do not implement lean principles provided different answers through the questionnaire.

The primary objective of the research was to examine the level of implementation of lean methodology in small- and medium-sized (SMEs) Croatian companies and if companies are aware of lean principles implementation in their business. The secondary objective of the research was to examine if companies with the same classifications of economic activities will be in equal cluster. In other words, it was examined if companies with the same classifications of economic activities have a similar level of implementation of the lean methodology. In this section, it will be explained four clusters which are based on 14 variables that have been asked on the questionnaire that measures the level of lean principles implementation in business. Results of cluster analysis are presented in Table 2., Table 3. and Figure 17.

Table 2. Cluster analysis - results (K-mean 4)

Advertising and market research	1
Computer programming consultancy and rel	1
Gambling and betting activities	1
Manufacture of coke and refined petroleu	1
Activities of head offices management co	1
Wholesale trade except of motor vehicles	1
Information service activities	1
Architectural and engineering activities	1
Computer programming consultancy and rel	2
Specialised construction activities	2
Computer programming consultancy and rel	3
Advertising and market research a	3
Manufacture of beverages	3
Activities of head offices management	3
Specialised construction activities	3
Scientific research and development	3
Architectural and engineering activities	4
Manufacture of beverages	4
Computer programming consultancy and rel	4
Printing and reproduction of recorded me	4
Construction of buildings	4
Computer programming consultancy and rel	4
Computer programming consultancy and rel	4
Other professional, scientific and techni	4
Programming and broadcasting activities	4
Construction of buildings	4
Manufacture of computer electronic	4

Activities of head offices management	4
Wholesale and retail trade and repair of	4
Computer programming consultancy and rel	4
Computer programming consultancy and rel	4
Information service activities	4
Computer programming consultancy and rel	4
Computer programming consultancy and rel	4
Architectural and engineering	.

Table 3. Cluster means

Cluster Means				
	Cluster 1 N=8	Cluster 2 N=2	Cluster 3 N=6	Cluster 4 N=18
Statement 1	3.7500	2.0000	2.1667	3.2778
Statement 2	4.1250	1.0000	4.1667	4.0556
Statement 3	4.0000	1.0000	3.8333	4.1667
Statement 4	3.8750	2.0000	2.3333	3.4444
Statement 5	2.5000	1.0000	4.1667	2.8333
Statement 6	2.2500	2.0000	3.5000	3.4444
Statement 7	3.8750	2.0000	3.0000	3.3889
Statement 8	4.0000	1.0000	3.8333	3.6667
Statement 9	2.3750	1.5000	2.5000	2.7222
Statement 10	3.5000	2.0000	3.0000	3.3889
Statement 11	4.0000	2.5000	3.1667	3.0000
Statement 12	4.1250	2.0000	3.5000	3.6667
Question 1	3.8750	3.0000	3.6667	1.8889
Question 2	3.5000	3.0000	4.0000	1.8889

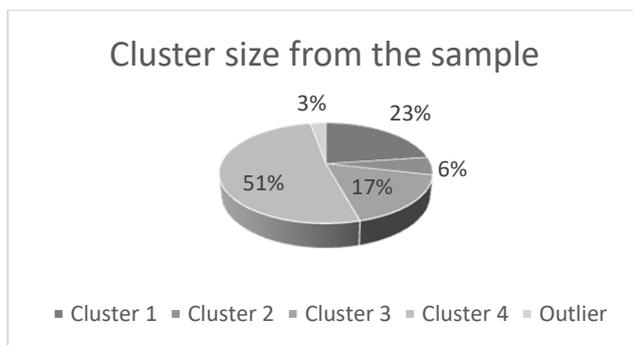


Figure 17. Cluster size from the sample

Of the total 35 SMEs surveyed, cluster 1 has 8 members. Companies in this cluster, according to the answers, implemented some lean principles. Also, they have an average level of knowledge about lean principles and they claim that they implemented lean principles in the business. Cluster two has 2 members. This cluster characterizes the low level of implementation of lean principles in the business. Cluster 3 has 6 members. This cluster characterizes the average level of implementation of lean principles and average level of knowledge about lean methodology. The fourth cluster has 18 members. This cluster is specific because answers of these

companies implicate on the significant implementation of lean principles, but these companies evaluate their awareness about the lean principles and the level of implementation of lean principles significantly below average. This indicates that the highest number of examined companies are implementing lean principles in the business but they are not aware of this.

This could be interpreted that some companies implemented ad hoc lean principles because of the need to adapt to the market rather than through a systematic approach. Results of cluster analysis also imply that it could not extract the one classification of economic activities which have dominated the level of implementation of lean principles in the business. The same classifications of economic activities are assigned to different clusters.

Cluster analysis highlights one examined company as an outlier. Its answers indicate a high level of application of lean principles, and the self-assessment is that the implementation of lean principles is average. For these reasons, it is significantly different from the characteristics of other clusters, and it does not belong to any of the four defined clusters.

4. Conclusion and Limitations

The results of the analysis suggest that a significant number of the examined companies implement some of the lean startup principles. The results regarding the self-assessment of lean methodology implementation suggest that nearly 50% of examined companies do not implement lean startup principles. This conclusion is supported by the mode of one, as the most frequent response to this question and cluster analysis. This could be interpreted as the fact that companies do not have a systematic approach to lean principle implementation and that they state that they do not implement lean principles. However, the survey results imply that some of the companies implement some lean principles in their business. This suggests that companies implement lean principles as they need to adapt to new market conditions but without a systematic approach to the implementation of lean principles in business. On the other hand, a minority of the examined companies are aware of the lean methodology, and they are aware of the importance of implementing the lean methodology in the modern business and the current market conditions. Also, results of cluster analysis indicate that none classification of economic activities is not dominated in the implementation of lean principles in the business.

The most significant limitation of this research is the number of collected responses. The target sample was 300 companies and we received 35 responses.

Despite this limitation, the research results indicate the current situation of lean methodology implementation in Croatian companies. Additionally, the lack of existing research on Croatian companies regarding the implementation of lean methodology is a limiting factor, because the analysed results could not be compared with results from other research.

There are a number of guidance for future research. Future research could be based on an extended research sample. The correlation between the level of implementation of the lean startup methodology and business success could be explored. Business success could be measured with financial data. The relation between the life expectancy of the company and the implementation of lean startup methodology could also be explored. In-depth interviews could provide better insights into how companies implement the lean startup methodology.

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