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From analysis to action: a cluster approach to assessing the digital transformation of Ukrainian business

Abstract. Digital transformation of business became a key aspect of the modern corporate environment, driving large-scale shifts in business processes. This article is devoted to assessing the effectiveness of digital transformation in Ukrainian enterprises, applying cluster analysis as a key tool. The study purpose is to thoroughly review and systematically assess the processes of digital transformation of Ukrainian companies using the cluster analysis methodology. The main task is to identify effective strategies for integrating digital technologies into business processes and identify the key drivers of the success of digital transformation of domestic enterprises. The key research methods included cluster analysis, just like analyzing and summarizing information from leading researchers in this area. Analysis results show that the effectiveness of digital transformation is still low at most enterprises, and concrete actions for further improvement are recommended. The article is aimed at business owners, executives, and researchers who want to develop digital transformation strategies for the Ukrainian business environment.

Keywords: digitalization, digital economy, digital transformation, business process, cluster analysis.

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Від аналізу до дії: кластерний підхід до оцінки цифрової трансформації українського бізнесу

Анотація. Цифрова трансформація бізнесу визначає сучасне корпоративне середовище, викликаючи значущі зміни у бізнес-процесах. Представлена стаття присвячена оцінці ефективності цифрової трансформації українських підприємств, використовуючи кластерний аналіз як ключовий інструмент. Дослідження акцентоване на розподілі підприємств за кластерами, оптимізації ресурсів та розумінні успішних сценаріїв цифрової трансформації. Мета статті полягає в ретельному аналізі та системній оцінці процесів цифрової трансформації підприємств в Україні з використанням методології кластерного аналізу. Основним завданням є визначення ефективних стратегій інтеграції цифрових технологій у бізнес-процеси та ідентифікації ключових факторів, що впливають на успішність цифрових перетворень українських підприємств. У рамках дослідження використовуються методи кластерного аналізу, а також аналізу, сиентезу узагальнення інформації сучасних провідних досліджень у даній сфері. Результати аналізу вказують на невисокий рівень

ефективності цифрової трансформації на більшості підприємств, що слугує розробці пропозицій конкретних заходів для подальшого вдосконалення. Робота адресована власникам підприємств, керівникам і дослідникам, сфера діяльності яких спрямована на покращення стратегій цифрової трансформації в українському бізнес-середовищі.

Ключові слова: діджиталізація, цифрова економіка, цифрова трансформація, бізнес-процес, кластерний аналіз.

Introduction

Progressive development of digital technologies, steady dynamics of changes in consumption patterns and intensive introduction of information and communication technologies in business and various areas of society and economy, commonly known as "digital transformation", triggered profound metamorphoses in the business structure, including business processes.

Fundamental transformations in the landscape of enterprise activity, in turn, require fundamental transformations in the ways of doing business. For a successful digital economy and a new industrial revolution to take place, the government and business will increasingly have to shift their priorities toward digitization and business transformation. Digital technologies (Internet of Things, big data, artificial intelligence, cloud solutions, etc.) are the catalyst for transformation processes, used to develop new ways of creating and delivering value propositions. The ability to successfully adapt business processes to modern digital conditions has actually become one of the key characteristics of the successful development of the digital economy in the state (*Barr, 2019*).

At the same time, despite the significant potential of digital development and business readiness towards digital transformation, the level and efficiency of business process transformation in Ukrainian enterprises is still extremely low, and the intensity of digital technologies, automation, robotization, etc. is extremely inefficient in most industries, primarily due to a significant lag in labor productivity and innovation activity of enterprises.

The study purpose is to analyze and systematically assess the processes of digital transformation of Ukrainian enterprises based on the cluster analysis methodology. The main task is to identify effective strategies for integrating digital technologies into business processes and to define the key drivers of the success of digital transformation in Ukrainian enterprises.

The theoretical and practical problems of digital business transformation and the processes of digital economy development have been studied comprehensively in the works of R. Alt, P. Weil, R. Coase, A. Osterwalder, A. Slywotzky, D. Tapscott, P. Timmers, D. Schalm, K. Schwab, etc. Ukrainian scientists V. Bazylevych, V. Hurochkina, I. Zrybneva, G. Fyliuk, O. Marchenko, A. Melnyk, O. Pizhuk, V. Reshetylo, V. Tarasevych, and others made a significant contribution to researching the problems of digital transformation of the economy and society.

Actually, in the last few years, the issue of digitalization of the economy has been coming to the forefront of discussion in Ukraine and becoming one of the key aspects of the discussion. The focus has been on carrying out research aimed at studying the current state and benefits that digital transformations introduce into the country's economic systems. However, regardless of the relevance and importance, as well as growing focus on this issue, there is still a vast field for research on the effectiveness and quality of systemic changes in business processes. The article aims to

identify the typical attributes of businesses that have successfully implemented digital strategies and develop recommendations for those faced with the task of effective digital transformation. Research findings presented in the article are intended for a wide range of audiences, including business leaders, researchers, consultants, government agencies, investors, and financial institutions. The main task is to provide the target audience with strategic recommendations and insights on the effective implementation of digital strategies in Ukrainian enterprises, based on a systematic analysis and application of the cluster approach.

The impact of digital transformation on business processes

The digitization of business processes stands as a pivotal evolutionary development within the corporate domain. This entails the shift from conventional methodologies in managing routine tasks towards the incorporation of digital tools and technologies. Such digital transformation augments operational efficiency and flexibility within an organization, presenting the prospect of noteworthy cost reductions through the automation of processes. A central challenge confronting enterprises throughout this trajectory lies in the optimization of the customer experience. The profound influence of digital transformation on business operations and strategy necessitates an adaptive approach as enterprises progressively depend on digital technologies for operational functionality and customer value delivery (*Couper, 2023*).

Conducting an analysis of current processes constitutes a fundamental initiative in the digital transformation of businesses. This imperative practice is instrumental in methodically delineating extant procedures, yielding a lucid understanding of ongoing operations. Process mapping serves to furnish all stakeholders with a comprehensive panorama of the organization's activities, thereby promoting enhanced coordination and coherence (*Schallmo & Williams, 2018*). Various tools are available to facilitate process mapping within corporate frameworks. These tools encompass process diagrams and project management software, offering visual depictions of workflows. Additionally, enterprises can leverage Business Process Management (BPM) software tailored for the modeling and administration of business processes. Furthermore, the incorporation of dematerialization and electronic document management software can prove advantageous for companies. In certain instances, optimal outcomes may entail soliciting the expertise of specialized process management consultants to meticulously map and optimize existing procedures.

One of the foremost effects of digital transformation on business operations is the notable enhancement of operational efficiency. Digital technologies empower businesses to automate tasks, streamline processes, and diminish reliance on manual labor. This, in turn, translates into substantial cost savings and heightened productivity. Illustratively, businesses can harness automation tools to curtail the time and resources expended on routine tasks, such as data entry or order processing. Executing a digital transformation strategy entails a sequential series of steps. Commencing the process involves garnering support from all stakeholders within the company, fostering a shared vision, and ensuring alignment among all parties. Identification of specific departments poised to experience the direct impact of the transformation is imperative (*Bodrov et al., 2019*).

Subsequently, the formulation of a comprehensive strategy is essential, delineating priorities, objectives, and performance metrics. A thorough evaluation of the financial requisites for this digital revolution is crucial. Recognizing potential gaps in employee experience with digital

transformation, the establishment of an in-house team to spearhead the project is advisable. During the implementation phase, a prudent approach involves initiating low-risk projects that entail minimal organizational disruption (*Pimenowa et al., 2023*). This strategy not only generates positive momentum but also facilitates the gradual introduction of digital tools. Feedback from employees becomes instrumental in refining newly introduced technologies to align with the unique needs of the company. Digital transformation champions, such as Chief Digital Officers, play a pivotal role in guiding the integration of technologies in harmony with strategic objectives. These feedback mechanisms and champions serve to mitigate the risks associated with digitalization by identifying issues at an early stage.

Thus, the principal advantages of digitization encompass heightened operational efficiency, expanded sales growth, and enhanced employee productivity. Moreover, digitization yields cost reductions linked to physical document management, manual processes, and travel expenses. In the realm of intangible benefits, the digitization of business processes optimizes both customer satisfaction and information management. Enterprises fortified with an agile digital infrastructure exhibit a capacity for rapid adaptation to market fluctuations, resulting in enhanced performance, heightened profitability, and increased competitiveness within the marketplace.

Cluster analysis in assessing the effectiveness of digital transformation of business

Digital transformation is a continuous and comprehensive process of transforming a company at all levels. It takes place in products and services, organization structure, management approaches, changes in the format of work with clients and even corporate culture. In other words, it is a revolutionary transformation of the business model of a business entity. The special feature of this process is that, beginning at "point A", it has no end destination. Today, we do not choose whether to implement digital transformation or not – it is already happening and affects any organization, be it a small, medium or large business (*Schwertner, 2017*). And while digital transformation is always associated with innovation and disruptive technologies, this is only part of the success. The use of digital and data is a transformation tool, not an end in itself. Business and operational models of digital transformation are also based on customer needs and expectations.

Today's situation with business process transformation in domestic enterprises is characterized by certain trends and features that determine the growing awareness of the need for digital transformation in the context of global change. First, there is an increase in the companies' interest in implementing digital technologies. More businesses see digital transformation as a strategic step to increase competitiveness and adapt to the new realities of the market environment. Second, there is an increase in the use of information technology to optimize business processes. Businesses are implementing automation systems, electronic platforms, and other digital tools to improve operational efficiency and reduce costs (*Ionan, 2023*).

On the other hand, many businesses face challenges in integrating new technologies into existing business processes. Insufficient staff qualifications, difficulties in managing change, and limited budgets can slow down the pace and completeness of digital transformation. Overall, the current state of business process transformation in Ukraine reflects the shift from traditional management methods to digital strategies, but also highlights the need for further efforts to fully integrate and optimize this process.

Using a cluster analysis to evaluate the benefits of digital transformation is an effective tool for understanding and improving the efficiency of this strategic process. There are several key aspects to highlight in this context:

1) Cluster analysis allows grouping enterprises by similar characteristics of digital transformation efficiency. This helps to identify the types of enterprises that can more successfully perceive and realize the benefits of digital transformation.
2) Identification of successful clusters allows us to consider them as models for other enterprises. This helps to increase the likelihood of successful digital transformation through the use of proven innovations.
3) Cluster analysis creates a convenient tool for managing digital transformation, allowing you to identify weaknesses and strengths in different groups and adapt strategies accordingly.

In general, applying cluster analysis allows businesses not only to identify specific aspects of their performance in digital transformation, but also to implement targeted and optimized strategies to succeed in this important area (*Pinto, 2023*).

The basis for the cluster analysis was a survey conducted using the online tool Google Forms in August-October 2021 (*Table 1*). In total, we received 92 responses from companies that have moved towards digital transformation. Most of the responses came from middle managers, business leaders, or ICT professionals.

The questions in the survey describe the key benefits of digital transformation and the introduction of digital technologies. The questionnaire was based on research by leading consulting companies (*Yurchak, 2019*; *Yanovska et al., 2019*) and on successful cases of digital transformation of Ukrainian enterprises (*Supporting…, 2023*). The Questionnaire consisted of two parts: an introduction, which includes 4 questions that give a general idea of the business, and the main part, which assesses the effectiveness of digital transformation at the enterprise by providing a list of digital transformation benefits.

The author proposed to evaluate the benefits of business transformation on a 5-point scale, where a score of "0" means that the company either does not have a corresponding benefit or this benefit does not increase the efficiency of the enterprise, and "5" means that the company receives the corresponding benefits from the digital transformation, and these benefits have actually increased business efficiency. The essence of the estimation is not to identify potential opportunities for increasing business efficiency through the use of digital technologies, but to identify real fundamental changes that have already taken place in the company.

Since our research aimed to assess the effectiveness of digital transformation, we excluded answers in which the respondents' assessment of the intensity of digital transformation, implementation and use of modern technologies was critically low. In addition, we also excluded responses that skipped more than 4 questions, which is likely due to a potential lack of respondents' knowledge of the subject matter. Based on these criteria, we excluded 8 responses and continued the analysis with 83 units. Table 2 summarizes the general characteristics of the companies included in the sample (*Table 2*). The resulting sample includes 60% of small businesses, the vast majority of which are representatives of the third sector of the economy, with responses coming mainly from middle managers, while for small businesses, responses were provided by business leaders.

The cluster analysis made it possible to determine the distribution of enterprises into segments that received key benefits from digital transformation and to determine the effectiveness of digital

business transformation by assessing the impact of these benefits on the enterprise. Using the SPSS Statistic program, we performed hierarchical clustering using the Ward's method and obtained a dendrogram showing the distribution of the sample into clusters (*Figure 1*)

The first cross-section of the dendrogram shows that our sample can be divided into two clusters, but the sampling size allows for a more detailed segmentation, so we consider the allocation of two clusters to be irrational. We can see that the second and third sections are quite significant, with the division into three and four clusters, so in our opinion, it is advisable to test two hypotheses regarding the division of respondent groups into three and four clusters. We test the hypotheses using frequency analysis, the results are presented in Appendix (*Table 3*). Thus, we see that the segmentation of the sample into 4 clusters is carried out by dividing the first into two relatively equal parts with the same score values, so in our opinion, it is advisable to accept for further analysis the first hypothesis with the division into three clusters that satisfy the conditions of distribution by the Ward method, that is: a cluster of high DT efficiency, which implies a strong impact of the previously identified benefits on business activities, medium efficiency, respectively, the business receives temporary benefits and digital transformation is incomplete or the process is still ongoing.

To clarify and identify the clusters, it is necessary to analyze the average values for each of the above DT benefits according to each cluster (*Table 4*). The symbols in Table 4 correspond to the numbers of questions in the survey questionnaire. We also calculated the average assessment of a particular benefit from digital transformation within the formed clusters, which makes it possible to identify the clusters. The conditional formatting of the table values allows us to visually determine that the second cluster corresponds to a higher level of DT efficiency compared to the others, the first cluster – to an average level, and the third cluster – to a low level of digital transformation efficiency.

To get a complete picture of the general characteristics of each segment, a statistical analysis was carried out using contingency tables in SPSS Statistic to obtain the frequency distribution of variables. The results of the calculations are summarized in Appendix (*Table 5*).

Our calculations allow us to make the following conclusions about each of the clusters we have identified, starting with the highest efficiency cluster:

The second cluster includes 33 enterprises with the highest level of digital transformation efficiency; according to our research, this cluster unites mainly small enterprises of the tertiary sector of the economy, since this sector of the economy is quite sensitive to changes in digital technologies and the introduction of innovations, enterprises in this sector are among the most digitized. Due to the widespread use of e-commerce tools, the introduction of automated service systems, and the improvement of digital communication channels, which makes it possible to obtain a wide range of benefits from the DH processes and influence business efficiency.

The first cluster with an medium level of digital transformation efficiency includes 40 enterprises and is the largest of the identified clusters, which includes a larger number of medium-sized enterprises and almost as many small ones as the previous cluster, it should be noted that this segment includes almost all of the large enterprises we surveyed. As for the economic sectors, the majority (60%) of the enterprises are in the tertiary sector, 30% are in the secondary sector, and the rest are in the primary sector. A characteristic feature of this cluster is that there is a gap between the maximum average values of preferences and the minimum values at the surveyed enterprises.

The maximum average values mainly relate to the benefits associated with increased staff efficiency and the benefits of modern marketing tools and the use of software for behavioral analysis, information collection and processing, forecasting, and proposal generation. The minimum values are in terms of the introduction of a new technological infrastructure and the constant updating of business processes. That is, the digital transformation at these enterprises is not fully implemented and is fragmented, which is quite common, as a significant number of enterprises in Ukraine do not yet fully use digital technologies, which significantly slows down the pace of digital economy formation.

The third cluster with low efficiency of digital transformation, includes 10 enterprises, medium and small, several from each sector of the economy. Average estimates of the benefits from digital transformation in this cluster are half as high as in the previous ones, with only a few aspects of digitalization mentioned by respondents at the level of the high and medium clusters, such as the use of modern digital communication tools, automation of accounting and reporting, and the ability to organize remote work

Thus, the results of the cluster analysis prove that digital transformations taking place at Ukrainian enterprises can effectively improve business performance. However, even the study of such a limited sample shows that the efficiency of digital transformation of business operations at most enterprises hardly reaches the average level, and a high level of efficiency is represented by small enterprises in the tertiary sector, while the catalyst for the formation of the country's digital economy is automation and the introduction of technologies in the primary and secondary sectors, where the key measures should be the development of technological and digital infrastructure, the use of automation systems and modern software

Discussion

The current context makes it important to perform researches aimed at studying the effectiveness of digital transformation of business processes. For this purpose, cluster analysis was used to systematize and classify enterprises according to their efficiency in the context of digital transformation. The cluster analysis methodological approach seems to be an important tool for gaining a better understanding and improving the strategic process of digital transformation. Some of the key aspects of the importance of cluster analysis in this context are the ability to classify enterprises according to their performance characteristics, optimize resource utilization, understand successful scenarios, increase manageability, and assess individual contributions.

Focusing on digital transformation research makes it possible not only to identify specific aspects of efficiency, but also to implement targeted and optimized strategies to achieve success in this strategic direction. Consideration of industry specifics, interaction of technologies, adaptability of strategies, and the influence of the human factor are essential aspects for future research in this area.

Conclusions

The results of the cluster analysis indicate the potential for efficient improvement of the productivity of Ukrainian enterprises as a result of digital transformation. The author notes that, even with the limited scope of the study, the efficiency of digital transformation of business processes at most enterprises is still low, while a high level of efficiency is found in the service

sector, in particularly in small enterprises. Among the key conclusions is that automation and the implementation of technologies in the primary and secondary sectors play an important role in building up the digital economy. This emphasizes the necessity of focusing on the development of technological and digital infrastructure, as well as the use of automation systems and the introduction of modern software in these sectors.

Regarding potential further ways of development and improvement, there are several key aspects to consider (*Melnyk, 2021*):

- *Infrastructure development:* emphasis should be placed on the development of technological and digital infrastructure to sustainably support digital transformation at all levels.
- *SME's supporting in services:* It is important to identify and support small enterprises in the service sector that are showing high performance in digital transformation.
- *Efficient implementation of technologies:* Promote the effective implementation of automation systems and modern software in the primary and secondary sectors.
- *Innovation stimulation:* Encourage enterprises to be innovative through the provision of opportunities for the introduction of advanced technologies and practices.
- *Expanding R&D:* Continuing research on digital transformation in different markets and industries to gain a deeper understanding of existing challenges and potential.

Such measures can help improve the efficiency of digital transformation in the Ukrainian business environment and contribute to the development of the country's digital economy.

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Appendix

Table 1. Questions of the survey in the format of a table (main part) with symbols

Please rate on a 5-point scale the increase in your company's efficiency due to the following benefits of digital transformation. A score of "0" means that your company either does not have a relevant benefit or that the benefit does not increase your company's efficiency. A score of "5" means that your company receives relevant benefits from DT, and these benefits have actually increased business efficiency. It is not the potential to increase business efficiency through the use of digital technologies that is being assessed, but the actual fundamental changes in your company.	
Questions (digital advantage)	**Symbolic designation**
1. There has been an increase in the quality of goods or services	Q_1
2. Increase in sales of goods/services	Q_2
3. Emergence of new sources of income	Q_3
4. Simplification of communication processes within the company and with partners	Q_4
5. Reduction of logistics costs	Q_5
6. Cost optimization through the digitalization of the procurement process	Q_6
7. Reducing the time of delivery of goods (provision of services)	Q_7
8. Optimization of production processes	Q_8
9. Optimization of operating costs	Q_9
10. Ability to organize remote work	Q_10
11. Remote access to information	Q_11
12. Ability to monitor and evaluate staff performance	Q_12
13. Reduction of errors due to human factor (incompetence, fatigue, inattention).	Q_13
14. Increase in staff efficiency	Q_14
15. Automation of accounting, financial and other reporting.	Q_15
16. Increasing the speed of product or service development	Q_16
17. Increasing the effectiveness of marketing tools and promotion of goods/services	Q_17
18. Customization of a product or service to the needs of the client	Q_18
19. Reduction of customer service time	Q_19
20. Improving the customer experience	Q_20
21. The ability to make online orders	Q_21
22. Automation of data collection, processing and storage	Q_22
23. Increased efficiency of decision-making and forecasting	Q_23
24. Reducing the risks of the main activity	Q_24
25. Increased flexibility and acceleration of business processes	Q_25

Table 2. General characteristics of the sample for cluster analysis

Criterion		Number of respondents	Total %.
The size of the enterprise (Number of employees)	small (up to 50)	51	61,4
	medium (up to 250)	22	26,5
	large (from 250)	10	12,1
Economy sector	Primary	6	7,3
	Secondary	22	26,8
	Tertiary	54	65,9
Position of the respondent	ICT specialist	15	18,1
	middle manager	33	39,7
	head of the company	28	33
	department head	7	8,1

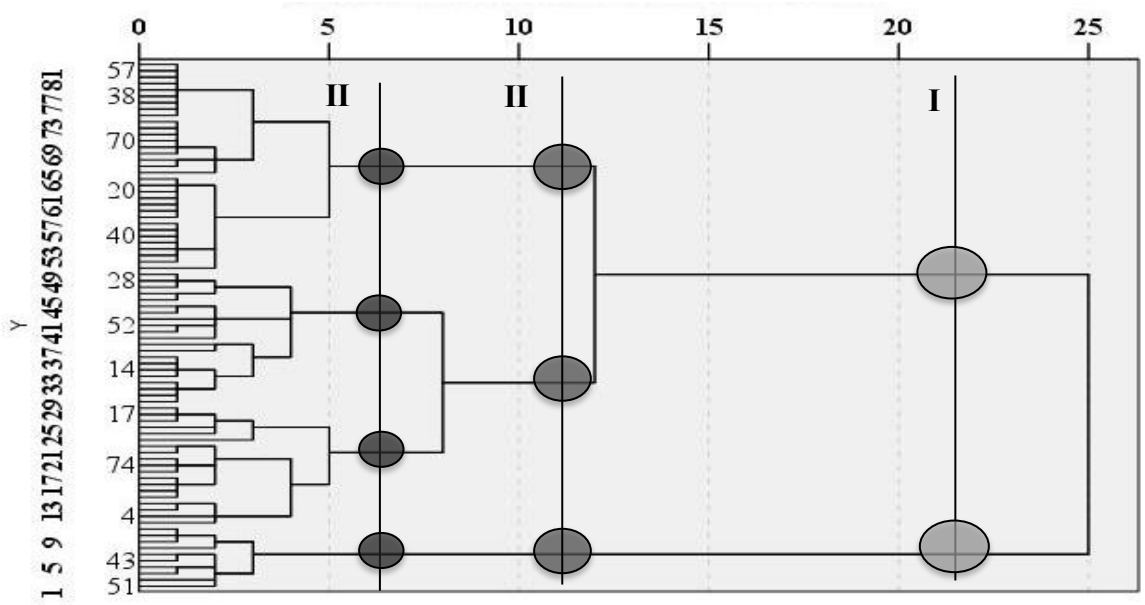

Figure 1. Dendrogram of cluster analysis by Ward's method

Table 3. Frequency analysis of sample segmentation

	Clusters			
	1st	2nd	3th	4th
Hypothesis 1 (division into 3 clusters)	*48,2%* **40**	*39,8%* **33**	*10%* **12**	
Hypothesis 2 (division into 4 clusters)	*25,3%* **21**	*39,8%* **33**	*22,9%* **19**	*10%* **12**

Table 4. Analysis of average scores of digital transformation benefits

Advantages (questionnaire questions)	Clusters		
	1st	2nd	3th
Q_1	3,18	**3,55**	1,80
Q_2	3,90	**4,24**	1,80
Q_3	3,05	**3,76**	1,60
Q_4	4,05	**4,39**	2,70
Q_5	2,50	**3,48**	0,90
Q_6	2,00	**3,70**	1,40
Q_7	2,48	**3,73**	1,40
Q_8	2,85	2,73	1,10
Q_9	3,05	3,39	1,50
Q_10	3,68	3,30	2,50
Q_11	4,15	4,70	3,10
Q_12	3,58	4,15	2,00
Q_13	3,45	3,76	2,10
Q_14	3,23	3,70	1,40
Q_15	4,55	4,73	3,90
Q_16	2,50	3,55	1,00
Q_17	3,35	4,27	1,70
Q_18	2,45	3,67	1,30
Q_19	3,15	3,97	1,20
Q_20	3,05	4,12	1,50
Q_21	2,90	4,55	1,30
Q_22	4,33	4,27	2,90
Q_23	3,43	3,76	1,30
Q_24	1,63	2,88	0,50
Q_25	3,53	4,06	1,90
Average for each cluster	**3,20**	**3,86**	**1,75**

Table 5. Distribution frequency of variables according to general features by clusters

Features		Clusters			Total
		1st	2nd	3th	
The size of the enterprise (Number of employees)	small (up to 50)	20	24	7	51
	medium (up to 250)	13	6	3	22
	large (from 250)	7	3	0	10
Total		*40*	*33*	*10*	
Economy sector	Primary	4	1	1	6
	Secondary	12	7	3	22
	Tertiary	24	25	6	55
Total		40	33	10	