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THE IMPACT OF APPLYING ADVANCED TECHNOLOGIES ON THE CONCEPT OF MASS CUSTOMIZATION IN STARTUP COMPANIES

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Abstract: *Startup companies have a vital role in developing modern economies and societies. In their business models, these companies rely primarily on the application of innovations and modern and sophisticated technologies. That allows startups to create unique products and services according to customer requirements and offer them higher value and quality levels. It represents an excellent basis and driving force for the development of a successful concept of mass customization (MC). Startups can apply the MC concept or use some advanced technologies connected with MC to, among other things, increase their sales and market share, provide customized products and services to their customers, as well as increase their visibility and build their brand. In this research, data was collected through an online questionnaire that was created using Google forms tool and tested on a sample of 106 startup companies in the Republic of Serbia. For processing the collected data and answering the research question, a statistical $\chi 2$ test for one variable is used. This paper aims to present the research results on the application of advanced technologies among startups in the Republic of Serbia and to consider the possibilities for the application of the MC concept by these companies and the benefits it brings them. Research has shown that the mass customization technologies most often used by startup companies in the Republic of Serbia are the fallowing: social media ad crowdsourcing, online interactive product configurators, flexible production systems, enterprise and production software, etc. These results are very important for startup companies, but also for all other participants in the innovative startup ecosystem. This research also contributes to the literature, regarding the connection between the concept of mass customization and startup companies.*

Key Words: ***Startups, Mass Customization, Technology, Business, Strategy***

1. INTRODUCTION

Increasingly pronounced differences in customer needs are an important driver of innovation today. Therefore, this indicates that demands for variety and customization have an upward trajectory. The market for personalized custom-made products and services is also growing rapidly. The biggest obstacles to this growth are related to higher prices of customized products and services, and fact that the mass market could only be served with relatively standard products and services offerings [1]. In order to overcome these obstacles, it is necessary to develop adequate Mass Customization (MC) strategies and apply modern technologies in companies.

MC has the main aim to meet individual customer needs, which implies a full understanding of customers' values and preferences [2]. The concept of Mass Customization was introduced in literature more than three decades ago, and was popularized by Pine in his book »Mass customization: the new frontier in business competition« [3]. According to this author, the goals of MC can be viewed "as providing enough variety in products and services so that nearly everyone finds exactly what they want at a reasonable price" [3]. Also, MC corresponds to "the technologies and systems to deliver goods and services that meet individual customers' needs with near mass production efficiency" [4]. Mass customization as relating to the ability to provide customized products or services through flexible processes in high volumes and at reasonably low costs [5]. One newer definition states that "MC is customer co-design process of products and services, which meet the needs of each individual customer with regard to certain product features" [6]. MC concept has changed over time and has shifted from craft production to electronic mass customization and personalization. This is illustrated in the following picture (*Fig.1).*

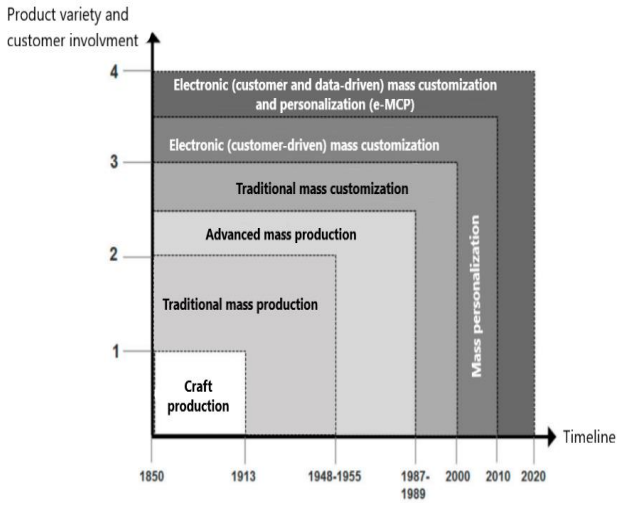

Fig.1. *Historical background and evolution of MC concept [7] based on [8]-[10]*

This transformation move orientation to customer to customer centric approach, demand-driven supply and value creation via online and digital environment, platforms, or other tools with strong content impact and development of these two paradigms [11-16]. The modern approach recognizes Digitalization and Personalization as one of the key research sub-domains in the MC field. Therefore, MC appears in the new and modern form with different theoretical and practical implications in terms of [17]:

- digital customer experience and journey management
- digital touchpoints set up
- digitalization of customization process
- creation and usage of online customization frameworks

By considering different types of mass customization their basic characteristics can be determined, which is shown in *Table 1*.

Table 1. *Types of MC and its characteristics* [18-19]

Type of MC	Characteristics
Distribution customization	Customers may customize product/service packaging, delivery schedule and delivery location but the actual product/service is standardized.
Assembly customization	Customers are offered several pre-defined options. Products/services are made to order using standardized components.
Fabrication customization	Customers are offered several pre-defined designs. Product/services are manufactured to order.
Design customization	Customer input stretches to the start of the production process. Products do not exist until initiated by a customer order.

Today, special attention is paid to design customization, because the digital era brings new tools and new technologies. This has led to the increasing number of online businesses worldwide, which allows rapid transformation of individual ideas and customers' requests into physical products. Also, this trend has important implications for services, due to certain difficulties that accompany their introduction. One of these limitations lies in the easy imitation of innovative services, which reduces the space for gaining a competitive advantage based on their creation.

Consumers, as never before have dominated how nearly every industry is driving product strategy—from design and planning to supply and production. Buyer attitudes have changed due to recent changes in the market, largely fueled by the pandemic, which has propelled technology and businesses to quickly develop new services and solutions for consumers, which better suit their individual needs [20].

From online teaching, grocery pick-up and food delivery, different mobile experiences, and virtual doctor visits, to a wide range of work-from-home options, consumers become even more accustomed to having more options to create their customized lifestyle. Realization of this aim requests strong technology support and changes in business concept [20].

Implementation of advanced technologies can help to alleviate the challenges of MC. Some of the most important information technologies which significantly contribute to the development of the MC concept are [21]:

1) a multi-source cross-media heterogeneous database
2) big data for determining design feature requirements
3) virtual experience systems and virtual manufacturing
4) information acquisition, production control, and collaborative system optimization for the entire process

2. STARTUP COMPANIES AND THEIR ROLE IN MASS CUSTOMIZATION

Startup companies are looking for innovative products and services to fit a market and meet customer requirements. Startups and their founders are one of the prime forces in modern economic development and the main promoters of entrepreneurship and innovation. A startup can be defined as “a human institution designed to create new products and services under conditions of extreme uncertainty“ [22]. A group of authors defined a

startup "as a new and temporary company that has a business model based on innovation and technology. In addition, these types of companies have the potential for rapid growth and scalability [23].

According to the European Startup Monitor defining a startup is related to three criteria [24]:

- established less than 10 years
- bring innovative technologies
- new business model sales

Startups are specific entities based on opportunity, idea, creativity, innovation and new technologies, new product or service development, etc. This type of company has its life cycle, which consists of three essential stages and this is shown in the following picture *(Fig.2):*

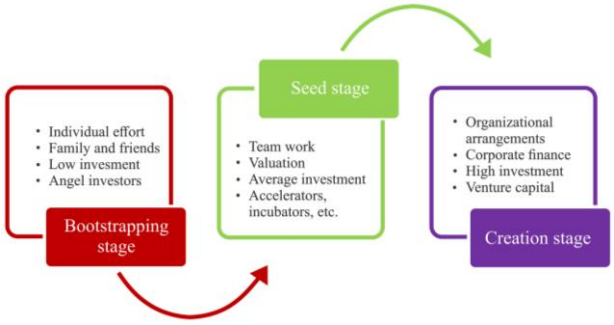

Fig. 2. *Lifecycle of startup company [25]*

Bootstrapping stage – founder of a startup undertakes a set of activities to turn his business idea into reality and make it profitable. This phase is characterized by a high level of uncertainty and risk, and low interest in investment. For the survival of startup companies, supports from the startup team, family and friends are crucial. They have special importance in collecting initial funds and the first step in business. Significant support in this phase can be provided by angel investors. They are wealthy individuals with great business experience, willing to invest and offer their wealth and knowledge to owners and to entrepreneurs to start or develop their businesses [26]. The goals of this stage are to allow venture growth by demonstrating product feasibility, cash management capability, team building and management, customer acceptance, etc. [25, 27].

Seed stage – this is the first official equity funding stage and a great number of startups fail in this phase. Within this phase, all efforts are made to develop and improve the product prototype. Interest in investing during this phase is growing, especially from the angel investors' side. Now, they are more ready to make an investment decision. Also, a large number of support mechanisms are being developed by accelerators, incubators, startup centers, science and technology parks, and other important actors in the startup ecosystem.

Creation stage- occurs when companies commercialized their innovative products or services (sets out to conquer the market) and hires their first employees [25,28]. This phase involves proving the business model and preparing the startup company for the scale business. Companies need to make a huge effort in expanding their customer base and creating sustainable competitive advantages. After this phase, an organization/company is usually created, which leads to a change in the way of doing business and further financing. Also, the venture capitalists have the power to improve and facilitate the scale of business and enable faster growth and development of the company [25].

The importance of startup companies is also recognized by the Government of the Republic of Serbia and all important institutions. At the end of December 2021, the National Assembly of the Republic of Serbia adopted the new Law on Innovation Activity and in that way improved the regulatory framework. This law defines the term startup company for the first time: "startup is a newly established company or entrepreneur who develops an innovative product or service and who has the potential for rapid and large growth " [29].

The main goals of the Strategy of startup ecosystem development in the Republic of Serbia in the period 2021-2025 are [30]:

1. Raising startup entrepreneurial capacity through educational programs;
2. Improving infrastructure and software support for startups;
3. Improving the startup financing mechanism;
4. Improving the conditions for startup business;
5. Promotion of startup culture and global ecosystem recognition.

2.1. Startups and mass customization

Entrepreneurs have started new ventures in an attempt to exploit the trend toward a growing demand for variety and personalization [31]. Today, there are a large number of startup companies in the world whose business models are based on the strategy of mass customization. These business models have to provide customized products or services, based on consumers' requirements. The development of startup companies is largely conditioned by the application of modern technologies, and their success is largely related to that. The internet has become an everyday part of life and that is increasing customers' demands for tech-enabled customized products and services [12].

Some of the main contributions of the application of mass customization in startup companies are [12]:

- increasing revenue
- gaining competitive advantage
- improving cash flow
- improving customers' and users' experience
- reducing waste through on-demand production
- reducing operating costs
- generating valuable data for the development of standard products, online marketing, and public relations campaigns

Startup companies whose business model is based on mass customization aim to grow through economies of scale and by increasing productivity and market share, whereas constantly innovating aims at making them more profitable and adaptive to market dynamics [32]. Startup companies are very sensitive to changing environmental conditions and need to pay special

attention to this issue when determining their business strategies. One of the basic prerequisites for establishing a startup company is innovation. Previous researches show that innovations by startups are positively correlated with the mass customization concept and product standardization.

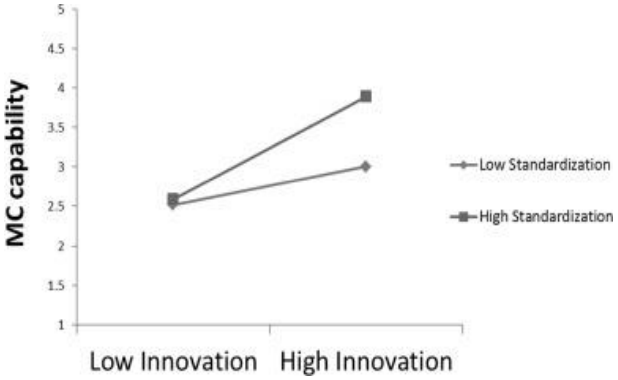

Fig. 3. *Correlation between Mass Customization Capability, Product Standardization, and Innovation [32]*

Fig.3 shown that innovation and standardization have a significant influence on MC capability. Innovation can enhance the flexibility and responsiveness of a company, and standardization enables the company to achieve economies of scale and scope, both of which are necessary for developing MC capability [32] in all companies, also in startups.

3. MASS CUSTOMIZATION AND ADVANCED TECHNOLOGIES

Advanced technologies have significantly facilitated the integration of customers' preferences and needs into manufacturing processes and consequently provided mass customers with innovative opportunities and solutions [33]. According to the European Commission, advanced technologies are: "a fusion of digital and key enabling technologies, and the integration of physical and digital systems. They give rise to innovative business models and new processes, and the creation of smart products and services [34]. Advanced technologies are "a group of integrated hardware-based and software-based technologies, which if properly implemented, monitored, and evaluated, will lead to improving the efficiency and effectiveness of the firm in manufacturing a product or providing a service [35].

The use of advanced technologies in mass customization concept is widespread, and some of the main ones are:

Information Systems - is an integrated set of components for collecting, storing, and processing data and for providing information, knowledge, and digital products [36].

Blockchain Technology - refers to "fully distributed system for cryptographically capturing and storing a consistent, immutable, linear event log of transactions between networked actors. This is functionally similar to a distributed ledger that is consensually kept, updated, and validated by the parties involved in all the transactions within a network. In such a network, blockchain technology enforces transparency and guarantees eventual, system-wide consensus on the validity of an entire history of transactions" [37].

Internet of Things (IoT) - refers to the ''things or devices and sensors'' that are smart, uniquely addressable based on their communication protocols, and are adaptable and autonomous with inherent security [38].

Mobile and Portable Technologies - is a type of technology in which a user utilizes a mobile phone to perform communications-related tasks, such as communicating with friends, relatives, and others. It is used to send data from one system to another. Portable two-way communications systems, computing devices, and accompanying networking equipment make up mobile technology [39].

3D Printing- is a process of making three-dimensional solid objects from a digital file. The creation of a 3D printed object is achieved using additive processes. In an additive process, an object is created by laying down successive layers of material until the entire object is created [40].

Autonomous Systems – are advanced intelligent systems for implementing complex cognitive abilities in machines aggregating from reflexive, imperative, and adaptive intelligence to autonomous and cognitive intelligence [41].

Artificial Intelligence and Machine Learning – is the science and engineering of making intelligent machines, especially computer programs [42]. This term is usually used when machines simulate functions that humans associate with other human minds, such as learning and problem solving [43]. Machine learning is a subfield of artificial intelligence that allows software applications to become more accurate at predicting outcomes without being explicitly programmed to do so [44].

Virtual and Augmented Reality - is the integration of digital information with live video on the user's environment in real time [45]. A primary difference between virtual reality (VR) and `augmented reality' (AR) is in the complexity of the perceived graphical objects. In AR systems, only simple wireframes, template outlines, designators, and text is displayed. An immediate result of this difference is that augmented reality systems can be driven by standard and inexpensive microprocessors [46].

Big Data and Business Analytics - is the often complex process of examining big data to uncover information - such as hidden patterns, correlations, market trends, and customer preferences that can help organizations make informed business decisions [47].

Some of the technologies that are also used in mass customization are: social media ad crowdsourcing, online interactive product configurators, flexible production systems, enterprise, and production software, etc.

All startup companies strive to survive in the dynamic market and a high level of uncertainty conditions. Applying advanced technologies in startup businesses plays an increasingly important role in realizing their business goals. Therefore, it increases the possibilities for their survival in the market and the chances of business success.

4. METHODOLOGY AND RESEARCH RESULTS

This research is part of large research on the innovative startup ecosystem of the Republic of Serbia. The research instrument is an online questionnaire created via the Google form tool, and the founders of startup companies appear as respondents. The research was conducted in the period May-October 2021 and included startup companies on the territory of the entire Republic of Serbia (all five statistical regions). The total number of respondents in this study is 106. Research sample includes startup companies that use some of the advanced and mass customization technologies, which does not mean that they are mass customizers.

Advanced technologies used within startup companies and associated with mass customization, were tested using the $\chi 2$ test for one variable. $\chi 2$ test for one variable is applied here because differences in the frequency of individual answer categories are examined in the context of one question /variable.

Research question (RQ): Which advanced technologies connected with the mass customization concept are applied in startup companies in the Republic of Serbia?

The results of the research are presented in the following *Table 2*. and *Fig. 4.:*

Table 2. *Use of advanced technologies in the startup companies in the Republic of Serbia*

Category	Observed N	Expected N	Residual
IT systems (ERP, CRM)	17	10.6	6.4
Blockchain technology	6	10.6	-4.6
IoT (Internet of Things)	9	10.6	-1.6
Other technologies	41	10.6	30.4
Mobile and portable technologies	8	10.6	-2.6
3D printing	8	10.6	-2.6
Autonomous systems	5	10.6	-5.6
Artificial Intelligence/Machine learning	6	10.6	-4.6
Virtual and Augmented Reality	3	10.6	-7.6
Big data and Business Analytics	3	10.6	-7.6
		χ^2 (9) = 110.4, p = .000	

Legend: N- Number of responses, Residual – the difference between the observed and expected number of responses

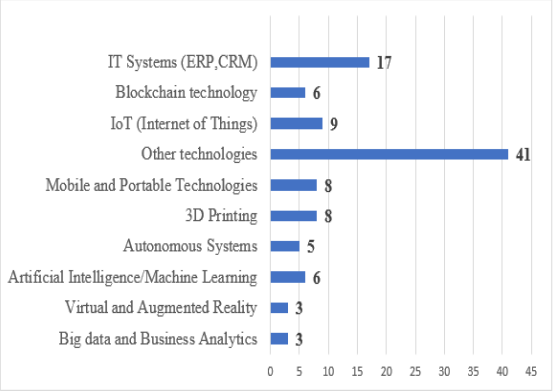

Fig. 4. *Applying advanced technologies in startup companies in the Republic of Serbia*

Research has shown that technologies such as: social media ad crowdsourcing, online interactive product configurators, flexible production systems, enterprise and production software, etc., are most often used in the startup companies in the Republic of Serbia. The number of respondents who state that they apply these technologies in their startup business is 38,68%. Also, surveyed startup companies often based their business on advanced technology such as: IT systems (16,04%), Internet of Things (8,49%), Mobile and portable technologies (7,55%), and 3D printing (7,55%). One of the determinants of startups' success is the business models, especially those related to technology [48]. This research shows that the business models of startup companies are based on various advanced technologies, which has a positive impact on achieving diversity in business and business success. According to Startup Genome, the most developed sectors in the Republic of Serbia, where startups operated are: gaming and blockchain [49]. The biggest development is currently recorded by companies in the IT sector and this sector exceeded 1.5 billion euros in export revenue in 2021. This indicates an increase of more than 30% compared to 2020 [50].

5. CONCLUSION

The emergence of startup companies in various areas of business leads to the strengthening of the country's economy. Startups are based on the innovative ideas of one or more entrepreneurs, characterized by a strong desire to succeed. The main challenges for startups are achieving productivity and sustainable growth. In the initial stage, startups need to provide stable sources of funding and a skilled workforce, make good business strategies for market entry, and further development of innovation-based products. In compliance with these objectives and to survive in the competitive market, startup companies need to introduce advanced and the latest technologies in their business. To achieve greater success in the market, startup companies need to adapt their business (especially products and services) to the specific requirements of their customers. Achieving this goal can be greatly facilitated by implementing a strategy of mass customization in startup companies. This strategy focuses on customers and recognizes their need to provide appropriate products or services, by using advanced and highly developed technologies. Implementation of these technologies connected with mass customization also contributes to innovativeness growth, reduction of operating costs in startups, increase visibility, and building of their brand. Possibilities and challenges around the introduction of new advanced technologies in startup companies, and businesses based on mass customization will be an increasingly topical issue in the future. Further research can be conducted in terms of determining the adoption rate of advanced technologies connected with mass customization in startup companies, using the mass customization strategy and measuring their impact on the main business parameters. Also, the research can be extended to all other types of companies, in order to get a more complete picture of their business.

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