

INTERDISCIPLINARY DESCRIPTION OF COMPLEX SYSTEMS

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WHAT KIND OF MO(VE)MENT IS FRIDAYS FOR FUTURE? MOTIVATION, SUCCESS PERCEPTION AND CLIMATE ACTION FRAMING IN FRIDAYS FOR FUTURE CROATIA

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ABSTRACT

Fridays for Future climate protests, which began as individual actions, soon morphed into a powerful global youth movement, with millions participating in Global Climate Strikes in 2019. In this study, we conducted 19 semi-structured interviews with the organizers and participants of the Fridays for Future Croatia movement and we aimed to examine the main characteristics of these protests in the context of new social movements theory and contemporary movements research, as well as in the specific national context. Challenging the suitability of the new social movements theory to adequately explain the Fridays for Future movement, we found many connections with contemporary social movements: participants are a new generation of first-time activists; social media use is crucial and qualitatively different; the organisational structure is completely loosened; and the issues encompass environmental protection and political economy, urging the transformation of both individual and social identities and socio-economic systems.

KEY WORDS

new social movements theory, contemporary social movements, environmental movements, Fridays for Future, Croatia

CLASSIFICATION

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INTRODUCTION

On 20th August 2018, a 15-year-old Swedish high school student, Greta Thunberg, sat in front of the Swedish Parliament in Stockholm with a sign 'School Strike for the Climate' [1]. Her lone strike continued as she began to boycott school every Friday, urging the Swedish government to honour the Paris Agreement on climate change [1]. This 'Fridays for Future' campaign soon had millions of followers, who joined the four Global climate strikes in 2019 [2]. Their goal was to facilitate climate change mitigation by pressuring policymakers and raising public awareness about climate change [3]. The campaign was met with some criticism as well, most prominently from heads-of-state, such as the U.S. President, Donald Trump [4].

This study analysed the Fridays for Future (FFF) youth climate strikes to deepen our understanding of the protests in Croatia, the motivation behind it and efficacy perceptions. We conducted a sociological qualitative analysis using semi-structured interviews with FFF Croatia organisers and participants, one of the FFF's national variants. Participants were asked about their involvement in the organizing and participation of the protests; and how they experienced the many different aspects of the protests in Croatia. The new social movements (NSM) theory and theoretical contributions from recent research on contemporary (post 2008) movements were employed to inform our understanding of this phenomenon. Croatia is a particularly interesting case because of the complex socio-political context of this Central European post-socialist EU country, which has a recorded passivity with regards to activism, even among young people, and a somewhat lower level of environmental concern, specifically about climate change.

THEORETICAL APPROACH: NEW SOCIAL MOVEMENTS THEORY AND CONTEMPORARY SOCIAL MOVEMENTS CHARACTERISTICS

Although the NSM theory has been around since the 1960s, it is still a widely acceptable model for the analysis of social movements, protests, and collective actions. NSMs, which arose from the developed countries entering a stage of late modernity as described by Giddens [5], differed largely from traditional social movements in their topics of interest, goals, and ways of mobilising. New social movements are defined as anti-fundamentalist, anti-hegemonic, anti-totalitarian, and anti-bureaucratic in their aims and practices, pointing to the growing politicisation of everyday life in postmodernity and the intrusion of the political and economic sectors into everyday life [6-10]. NSMs turned their attention toward identity-related topics, post-materialistic social values, and lifestyle [11, 12]. Environmentalism was a key NSM from the 1970s onward, and was one of the first (and, as it turns out, the longest lasting) movements considered in literature as 'new'. It is also one of the more successful NSMs, succeeding in achieving its goals and continuing to mobilise the public [9; p.114]. Modern environmentalism had unprecedented mass mobilisation, and relied on the achievements of modern science, mass media, new open political space, and expanding proportions of an educated middleclass population, who saw environmental problems as a consequence of modernity [9, 13, 14].

However, as Buechler [11, 15] warned, despite the ideal type characterisation of NSMs, many theoretical approaches make an epistemological mistake when analysing collective action as one-dimensional (see also [16]). Rootes [14] underscored this problem by discussing environmental movements' history and development, which at least partially, and at times completely, broke the NSM rules. For example, having a non-formal organisation and adhering to postmodern values is certainly prominent in environmentalism, but they often do not completely reject or exclude the role of large organisations existing alongside non-formal, localised, ad-hoc practices [14]. In addition, their actions are based on

post-materialistic green values, but they have also pointed to the material issues of individuals and communities who are directly affected by environmental degradation in discussing their modes and perspectives of survival (e.g. the prevention of agricultural activities because of environmental pollution and climate change; see, for example, [17]).

At the beginning of the 21st century, an increasing number of authors detected additional novel elements in NSMs as well, especially in the context of mobilisation, technology use, and social movements' goals and collective identification [18-21]. These authors defined them as postmodern [22; p.19], which may not be the most precise assessment, since postmodern key characteristics (as well as the defined period of postmodernism, which overlaps with NSMs' development) do not differ that much from NSMs. Just like other NSMs, they also rallied around post-materialistic values, had informal organisations, horizontal leadership/participation structures, and were largely reliant on mass media and technology mobilisation, mostly of the middle class. However, at the same time, there are some undeniable differences between the 'new' and what we term as 'contemporary' social movements.

A prominent characteristic of contemporary social movements in the new century has been using the Internet as a primary means of communication and mobilisation. The new generation of activists, especially those associated with post-2008 social movements, rely on the Internet and social networks to an extent that was not present before, and in a qualitatively different ways than earlier movements' use of the mass media [18, 19]. The Internet and social networks also contribute to developing a collective identity, combining technology and participation, and providing a source for peer pressure to recruit participants and development of so-called 'self-mobilisation' [22; p.14].

Besides the internet, the social and political context of the 21st century has also had a defining influence on contemporary social movements as well, especially the period after the 2008 Great Recession [19]. For example, Milkman [19], referring to the precariousness of the labour market and describing American Millennials as highly educated but unemployed, stated that contemporary social movements are led 'by the graduate with no future' [19; p.5] who, although 'economically inactive are not necessarily politically inactive – can form powerful constituencies that lobby for a reduction in inequality or even a fundamental change in the system itself'. Consequently, alongside the affluent white middle class that is still predominantly present in some movements, other contemporary movements also attract people from lower income households, the unemployed, the educated, and those who bring issues of class and resource distribution back into social movements – issues that have not been represented since the 1980s [19, 21, 23].

Following Kerb's 1982 theory, Vrablikova [21] made a distinction between 'movements of affluence', which correspond to NSMs, and 'movements of crisis', which are more in line with contemporary social movements of the post-Great Recession period. Returning questions of capitalism to the centre of interest, a dominant socio-economic system is seen as the root of inequality and injustice that inspires collective mobilisation (e.g. in the Occupy and Anti-Austerity movements in the U.S. and Europe) [19, 21]. For more on Occupy as a 'new new social movement', see [24].

Although Vrablikova and Milkman focused more on the Anti-Austerity and Occupy movements and did not include environmental movements in their analyses, a theoretical connection can be drawn based on the mobilisation in contemporary climate movements where the crisis is visible and life conditions are threatened not only for the present, but for future generations as well, motivating further mobilisation of the movement. The climate movement is much like other contemporary movements in its intersectional framing of the issues, informal organisation, and use of the Internet and social networks for mobilisation [25, 26]. Within the climate

movement (since 2009, with mobilisation around the UNFCCC Summit in Copenhagen), a climate justice movement has been growing [26-29], connecting the issues of environmental degradation and climate change with broader issues of human rights and perceived injustices in the economic system.

There has been several research on FFF movement describing its organization, mobilisation, problem framing, motivation etc., and to analyse how protesters frame climate action, Marquardt [30] finds that although FFF protestors call for deeper societal transformation their strong focus on science-driven politics overshadows broader societal debates, leaving space for only techno-centric, apolitical and market-driven solution framing. Perhaps most comprehensive comparative survey has described in two rounds the attitudes, motivations, and affiliations of young protesters who took part in Global Climate Strikes in 2019 (in first round conducted in 13 EU cities, and in second with added 6 EU cities [31, 32]). The studies showed that young first-time activists were significantly more present in school strikes, with a predominance of female organisers and that there were no formal organisations behind the school strikes. In addition, protesters had both instrumental (pressure government to change) and expressive (expressing identity) motivations. The study further revealed that young protesters place importance on the need for individual behaviour changes, put their trust in science, but not politicians, and that they are politically inclined, despite not yet being politically active (not yet having the right to vote).

Since there has been no research on FFF movement in Croatia, nor has Croatia been included in comparative studies mentioned before, we conducted a qualitative analysis of FFF Croatia to gain a deeper understanding of the movement and protesters motivations and perceptions, and to identify similarities and differences with already published research.

FRIDAYS FOR FUTURE CROATIA

Croatia is geographically, historically, and culturally a Central and South-East European country with a post-socialist legacy. Its legacy is particularly reflected in the lack of citizens mobilisation to social or political action, especially around NSM topics of interest. The European Value Survey reported a low percentage of citizens engaged in activism, volunteering, voting, and other forms of political and civic activism [33-35]. However, the passivity among Croatian citizens cannot be exclusively attributed to the older generation who experienced an authoritarian socio-political context. Ilišin [36] reported a noticeable civic passivity among 15- to 29-year-olds, see also [37]. It should be mentioned here that there is a noticeable rise in neo-conservative activism in Croatia, especially during the last decade, which defies the previous statement. However, there is yet no substantial research about this kind of activism. Youth activism and volunteering that is relevant for this paper, however, is still reported to be generally low [37]. Furthermore, the author showed that Croatian youth were mostly worried about materialistic rather than post-materialistic issues, such as their low standard of life, lack of life perspectives, and unemployment [36]. Some authors explain this as more than the inherited passivity from the socialist period, reflecting the process of post-war re-traditionalization of Croatian society from the 1990s onward, which was further reinforced by the period of social depression following the 2008 economic crisis [38, 39]. In addition, there is a reported general decline of trust in key democratic institutions and the state [40-42], which all contribute to general dissatisfaction, social anxiety, and passivity [43; p.105]. This inherited lack of interest in activism has translated into a lack of education for civil society [44; p.799].

Croatian citizens rate lower than the EU average regarding climate change concerns [45]. This can also be attributed to inherited lack of education on such topics, the process of

re-traditionalization, and a general feeling of futility regarding social actions. Given this, it was surprising that the FFF strikes took hold in Croatia despite its low activism, low environmental and climate change concerns, and a more materialistic orientation.

FFF Croatia began with the first Global Climate protest and the protests and activities continued throughout 2019. The high school students had Facebook [46] and Instagram [47] pages, which, to date, have 3 002 and 2 566 followers, respectively. Their goals were very much in line with the general FFF goals, but also emphasised some local issues (e.g. the consequences of climate change that can already be felt in Croatia, such as floods, droughts, and temperature change, and about Croatian contributions to climate change through deforestation, traditional agriculture, tourism, etc.). The largest strike attracted around 1000 to 2 000 pupils in the capital Zagreb with a hundred or two more in six other cities across the country. The protesters compiled an official document with eight specific climate demands addressed to the government and the Parliament: 1) the government must publicly acknowledge that climate change poses existential danger and act accordingly; 2) the Parliament must declare a reduction of greenhouse gas emissions; 3) formation of an interdisciplinary 'Climate Commission' of scientists; 4) stopping all fossil fuel projects and investing in renewable energy; 5) ban plastics; 6) ban the sale of fossil fuel powered vehicles and provide incentives for electric vehicles and public transport; 7) ensure quality waste management systems; and 8) the Ministry of Education must introduce education on anthropogenic climate change in school curricula.

Between protests, they remained active on social media, participated in public panels and interviews about climate change, and organised or promoted additional activities, such as tree planting, clean ups, etc. For the most part, their actions were not radical. The only exception was a public performance on April 24, possibly influenced by Greta's speech in Strasbourg, when some of the organisers brought a coffin in front of the government with the message: 'You have killed our future'. There were also some posts supporting some of the actions from the Anonymous or leftist Green parties, but mostly they claimed political neutrality. They rarely officially responded to negative criticism in the media or on their social pages. Once they reacted with a longer post explaining that they were not protesting 'to become famous' or 'to avoid school and schoolwork':

We are doing this not only for ourselves but for everyone who will suffer the consequences of climate change (...) We refuse to be the ones who did not do anything. Also, some say that all we do is protest. We also organise clean-ups, tree plantings, we have a panel this week (...) [46] (post from 1st May 2019.)

As the protests continued every Friday, they began to falter in support and participation, especially with the COVID-19 pandemic, although there was another online protest organised in April 2020. The protests did receive public support from the Ministers of Education and Environment, celebrities, media, (especially green) NGOs, and the Prime Minister, who talked officially to the representatives.

METHODOLOGY

SAMPLE

The qualitative empirical data were collected through 19 semi-structured interviews with high school student FFF Croatia strike organisers ($n = 13$) and participants ($n = 6$), of which 16 were female and three were male. All were between 16- and 19-years- old. Five of the interviewed students were first year university students at the time of the interview but were still in high school during the 2019 protests. The interviewees were from the capital Zagreb

(15) and the city of Split (4), the two largest cities in Croatia, where the most and largest FFF strikes and actions were held. Initial contacts with high school students were established via their Facebook page and snowball nonprobability sampling was used to recruit additional interviewees. Saturation and overall information density and quality in qualitative research and thematic analysis is not an easy task and according to recent theoretical and practical findings [47] a term information power is found to be more adequate ([48; p.28]. Accordingly, “information power” was reached when major themes and experiences of interviewees started to overlap causing bigger bodies of data to occur during the coding and interpretation process. Basically, as more and more interviews were analysed, themes became clearer and interviewees accounts have been satiating the themes even more.

DATA COLLECTION

The results presented here are part of a broader two-year study of Croatian high school and university students’ environmental attitudes and behaviour, funded by the Faculty of Humanities and Social Sciences, University of Zagreb (‘School Strike 4 Climate Croatia: Environmental Attitudes and Activism of High-School Students in the City of Zagreb’, 2018-2019; ‘Environmental Knowledge, Attitudes and Behaviour of Croatian Students’, 2019-2020). The interviews were conducted between January and June of 2020. This qualitative section of the research was approved by the Research Ethics Committee of the Department of Sociology at the Faculty of Humanities and Social Sciences in Zagreb (05-2019/20). Students who were under age 18 were required to inform their parents to be allowed to participate.

Anonymity was secured by giving all respondents alternative code names with a random number and letter for their gender (for example 3F, 9M). No person names or other identifying information was included in the transcripts. Interviews lasted between 30 and 60 minutes and were conducted and transcribed verbatim by the authors and sociology students from the Faculty of Humanities and Social Sciences face-to-face in public places, schools, and universities. Sociology students already have some experience and were also additionally instructed by the authors on the interview conduction and transcription procedures in line with sociological ethical research standards before they went out to field research. Because of the COVID-19 pandemic, seven interviews were conducted online via Skype. Interviews were conducted in the Croatian language and all the quoted citations were translated into English by the authors. Interviews were recorded using a voice recorder or a mobile phone and all interviewers, especially students, as part of their initial education before conducting the interviews, were instructed to delete all contacts, files, and interview transcripts to ensure the participant’s anonymity. After the transcripts were checked, they were stored in the project leader’s archive. The data can only be used by project team members for scientific purposes.

DATA ANALYSIS

The interview protocol included the following topics: personal motivation for involvement, how the strikes were organised, reception, perception of the goals and success of the strikes, whom they considered responsible for climate change mitigation, and participant socio-demographic characteristics. The semi-structured nature of the interview allowed the interviewer to ask additional questions to probe deeper responses, and the interviewees to add things they deemed important. Data were analysed using MAXQDA 2020 software for qualitative data analysis. Thematic analysis was used, defined by Braun and Clarke [49] and King [50] as a useful method for examining the perspectives of research participants, the similarities and differences in their responses. We inductively generated codes directly from

the data and themes were generated from the generated codes. Regarding the coding procedure, all three of the authors of this article worked on coding and there was a uniformity of response for multiple coders which is a commonly used credibility method. Peer debriefing among authors was used to check the credibility of the analysis. The results were further checked against the existing FFF quantitative study. Finally, the theoretical background of NSM theory was used to analyse our results to respond to the main research objective of the article.

RESULTS

PERSONAL ACTIVISM AND SOCIO-DEMOGRAPHIC CHARACTERISTICS

While some interviewees were volunteers at one of the largest Croatian environmental non-governmental organization (ENGO) 'Zelena akcija' ('Green Action'), only a few of them were active members of it or any other ENGO. Regardless of this, some of them still emphasized that they were personally practicing pro-environmental behaviour and implementing it in their households. Regarding their socio-demographic characteristics, most of the interviewed students' parents had university degrees. Interestingly, all interviewed students stated that they plan to continue their education after they finish high school. There are again similarities with Wahlström et al.'s [30] research, where most of the protesters had never demonstrated before. Another similarity was that the organisers of the school strikes were predominantly women. While this is a qualitative study and we do not pertain to make conclusions on the entire population of highschool student organizers and participants of FFF strikes in Croatia, we find it interesting to point out the similarities between Croatia and other international research of these protests.

THEME 1: PERSONAL MOTIVATION FOR PARTICIPATION AND ORGANIZATION OF THE FFF STRIKES

The source of students' motivation to organise or join the FFF strikes in Croatia was diverse. Most stated two main sources of motivation: their parents, who either had pro-environmental attitudes or were activists themselves, and a general sense of necessity to raise awareness about ecological issues. The students' altruistic motivation was obvious throughout the interviews, as some exhibited a sense of urgency regarding the subject that they felt directly affected them and future generations (e.g. there will be no more clean air, water, or natural world as we know it today). This can also be seen in expressing care for other people, and more generally other living beings which is an interesting source of motivation exhibited by some of the participants in FFF strikes. From altruistic motivations stems also the expressed secondary motivation to raise awareness about anthropogenic climate change, and to participate in protests. Furthermore, the so called "Greta effect" [51] was also noticeable as some interviewees pointed out Greta Thunberg and their friends or peers as important motivators for participation and organization of FFF strikes in Croatia. In their own words:

"My parents have always been very ecologically aware and when you realise what is really going on and that there is a possibility that your children will be living in a world in which they won't be able to breathe normally (...) for me that is, like, saddening." (4F)

"Mostly I was motivated by Greta Thunberg. I first found out about her when my mother pointed her out ... since then I had seen several of Greta's speeches and her TED Talk which really made me realise how this is a big thing." (9M)

Interviewees responses to some extent correspond to Wahlström et al.'s research [31] in which Greta Thunberg was a powerful motivator for strikes along with a sense of importance regarding the climate change topic. In addition, it seems that Croatian parents' support was

very important for some students; while the students themselves were not activists, their parents either were or supported activism, at least on this topic.

THEME 2: STRUCTURE OF THE PROTESTS

Students unanimously reported that the protest organisation was done by them alone. However, they also spoke of assistance from their schools and teachers, support from one of the leading ENGOs in Croatia ('Green Action'), and networks they created between schools, cities, and internationally. This kind of network building is not only important for building a movement [14], but it seemed to provide the interviewees with know-how on both protest organization and protest outreach:

“They totally supported us logistically, financially and psychologically, we had numerous meetings with them, they gave us all of their knowledge and advice how to use peaceful protests to arrive to a solution, how to approach media with symbolic actions, how to communicate with the media.” (7F)

Although they had organisers and participants, there was no real hierarchy and many of our interviewees said they soon became organisers themselves, recruiting others, writing slogans, contacting the media, etc. They also said that many of their peers who were not directly involved, helped with recruitment and disseminating information about the protests through their own social media and personal networks.

Students also talked about the key role of the Internet, especially social networks such as Instagram and Facebook in organising the strikes, spreading information, and recruiting others; they largely credited social media for the success of the strikes.

“It was positive, because when you put an event on social media, one student confirms that he or she is coming, the second one sees that and confirms that they are coming, and the same for the third, and that’s how it spreads. Really, social media platforms really helped, because young people are present there 24/7.” (19F)

With regard to organization and mobilisation of the protest, our results correspond with results of a comparative quantitative study of 13 EU cities [31], which reported the same lack of formal and overarching organisation behind the protests because the students were mostly the lone force behind organising and leading the strikes there as well. It also reported that social networks were a powerful marketing and recruiting tool, as well as personal connections, which was highlighted and accounted for by our interviewees as well.

THEME 3: PUBLIC RECEPTION OF THE PROTESTS IN CROATIA

Interviewed student organizers and participants highlighted the mixed reception they received. Although they appeared in the media and prominent politicians and celebrities expressed public support, some participants felt that their demands and protests were disregarded by the government, particularly because of their young age (for analysis of media coverage and ageist *linguae* see [52]). Nevertheless, some participants were quite aware of their future roles as voters, activists, politicians, and policymakers. They felt that other negative criticism was related to the general apathy in Croatia; the overwhelming sense that protests are futile; the belief that citizens, especially young people, lack the power to influence government decisions; and a general lack of understanding regarding climate change as an important topic for Croatia. Aforementioned is perceived as learned behaviour where lack of citizens engagement is passed on from generation to generation, and is supported by external locus of control:

“I think it is in some way instilled upon us, the adults put it in our heads, that we can’t make a change, so you rather don’t bother with that. I also heard this from my professors when I came to them with the idea to organise the protests, they also said: ‘Why bother, you won’t do anything, it’s not realistic’.” (6F)

“Protests in Croatia are not so well known, we rarely protest, and when we do rarely anyone comes, and that’s the Croatian problem because we expect someone else to do it for us.” (5F)

Students also said they received mixed support from their teachers. A very small number supported by coming to the protests themselves, but others showed their support by allowing absence from their classes or more often included climate change as a topic in their classes. Only a small number were unsupportive or openly denied climate change.

THEME 4: PERCEIVED SUCCESS OF THE PROTESTS’ GOALS

According to some interviewees, the most important strike goals were to educate the public and raise awareness about the importance of the environment protection and the importance and consequences of climate change. They felt that these goals were achieved and they largely considered the protests successful:

“The goals are that the public opens their eyes and sees what’s going on in the world, what is happening to the environment, what is going on with climate change...” (19F)

Additional goals mentioned by some students were putting pressure on the Croatian government to act by adhering to FFF Croatia’s eight specific climate demands and solving some local environmental issues, such as waste management, which effects both cities in which the interviews were conducted, Zagreb and Split. When discussing whether they thought the strikes could influence Croatian as well as global politics, some of the interviewed students exhibited a rather sceptical view of Croatian politics. So, although interviewees had a notion that one important goal was achieved (influencing the public perception), the another goal (influencing the government) was seemingly given up on *a priori*.

“The problem is that our politicians are always looking at momentary profit, they will do anything to get money now. No one looks to invest for a better future.” (13F)

Regarding the future of the strikes and the movement in general, some students also felt that protests will not be enough, and that movement should include other forms of public/collective actions. They recommended further education through workshops and similar peaceful activities.

“The protests are, how to say, a good way to turn the attention towards a certain problem, so I think that the protests should continue, but they alone are not enough, and alongside the protests some other events or workshops should be organised.” (1M)

THEME 5: RESPONSIBILITY FOR CHANGE

Regarding the responsibility for addressing climate issues and challenges, interviewed students in general agreed that new laws should be implemented to regulate and support ecologically responsible and climate positive behaviour from citizens. They felt that the responsibility is on everyone equally, but they did note that it is not reasonable to expect people with a lower economic status to contribute the same as wealthier individuals:

“The role should be on the citizens to change their lifestyle (...), but the government has to have some policies, something that will change.” (8F)

“I think its best solved on local jurisdiction, but for it to happen locally there has to be a want from the leading party, we can all buy electric cars, but it is in vain when we don't have a station where we can charge those cars (...) So there should be some sort of cooperation and cohesion between the government, local jurisdiction and citizens themselves.” (7F)

Although some interviewees expressed the need for lifestyle change, a strong sense of need and urgency was felt for systemic changes and convergent politics in Croatia. This deviates from both Wahlstrom et al. [31] and De Moor et al. [32] comparative studies where there was a stronger emphasis from respondents on lifestyle change, despite climate justice discourse from the movement ‘leaders’ [53]. This, however will be more accurately confirmed in future quantitative research on this topic in Croatia.

DISCUSSION

There is sufficient evidence identifying FFF as a collective movement rather than individual sporadic social ‘moments’ or actions, including its evident organisational and participatory structure, goals, and (however limited) power to influence change in public and political perception. However, using the NSM theory framework to inform our understanding of the FFF movement revealed that at least some of the FFF characteristics stretch that frame and make it more like other ‘contemporary’ movements of the 21st century, such as Occupy or Anti-Austerity. In the case of Croatia, besides the need to raise awareness on environmental issues and the care about other living beings, there is also a sense of urgency regarding threatened life conditions (i.e. consequences of climate change), and a notion of systemic change regarding climate action. Those are some of the prominent characteristics of contemporary movements that bring back the material issues and resource distribution in the way that problems are framed by the movements. In that way we can say that our interviewees combine post-materialistic (in line with NSM theory) with more materialistic issues (e.g. feeling that their life conditions are threatened, and an awareness of climate change consequences and climate change policy effects on specific local issues that directly affect them, such as waste management in their cities).

Specific to our case, interviewees find themselves within the wider socio-political context where they feel discriminated against because of their age and lack of economic and political power, leaving them sceptical and distrustful. However, they place that distrust in the wider socio-cultural context while deciding to break from that context with regard to climate action. In that sense, there is a perception of lack of responsibility and action on behalf of government, but also a positive perception of collective efficacy regarding protest influence on public awareness about climate change.

In the organizational sense, FFF Croatia, like other national variants have loose organizational structure and informal networks which they form partly ad hoc (between different schools and cities), and partly with receiving support from other formal environmental organisations (and even international networks). They use spontaneous mobilisation through mass media to recruit adherents, allowing each fraction of the movement to decide on the mobilisation process and the mode of protest. Just like in other national variants [31] reliance on mass media, especially social media and the Internet, is supported by personal connections and acquaintances.

Finally, FFF Croatia have mostly remained moderate and peaceful in their requests and actions (unlike some other contemporary movements, but similar to other FFF national variants). However, a moderate approach is often connected to the idea that the solution lies primarily in individual choices and non-radical social changes toward pro-environmental behaviour, while a more radical notion often requires fundamental changes of the socio-economic system. In this sense, goals that our interviewees put forward are both moderate and radical, because they ask for individual and social change, but also systemic change in the way the government approaches and handles the climate crisis.

The main limitations of this research are its lack of a control group and low sample variability. Future research would benefit from including high school students who were not involved in the strikes, to gain a more thorough account on youth perception about importance and urgency of climate action, problem framing outside or within climate justice discourse, and perception on protest success. Furthermore, some topics emerged during the interviews that will be explored further through a quantitative survey of high school students in Croatia, including activism and collective efficacy beliefs as potentially important predictors of student engagement. Lastly, a study relying on ethnographic methods of data collection and analysis can be a potential avenue to provide clarity and solidify the interpretation of the FFF movement in the Croatian context.

CONCLUSION

Our qualitative analysis of FFF Croatia revealed that, in theoretical sense, while NSM theory is useful for understanding some of the FFF characteristics, it is clearly not a perfect fit. With motivation both materialistic and post-materialistic and the goals that include individual as well as systemic social and political changes, FFF Croatia retain both NSM characteristics and contemporary movement characteristics. Contemporary social movements are characterised by a very different socio-political context of the new century, an increasingly precarious labour market, insecure futures in the economic and environmental (climate) sense, and the development and widespread use of new communication technologies.

The significance of this movement is that a typically voiceless group of high school students spoke on a topic they felt greatly affects them, despite their lack of political or economic power, mixed public support, and in countries like Croatia, where such movements are quite unexpected. They used all means available to their generation to promote their goals (skipping school, relying on the social media, engaging their parents, peers, teachers, creating international networks, and eliciting help from other NGOs, celebrities, politicians etc.). Thus, they contributed to the changing socio-political landscape of civic activism and raised public awareness on the often-abstract topics of environment protection and climate change. They also started a wider discussion on class inequalities as they warned that a greener lifestyle is not affordable for everyone. Therefore, this and similar contemporary environmental movements warrant sociological attention.

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IMPACT OF SERVICE LEARNING ON SOCIAL ENTREPRENEURSHIP AND YOUTH EMPLOYMENT IN CROATIA

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ABSTRACT

Youth employment in Europe as well as in Croatia presents to be a substantial issue. Service learning fosters a strong relationship with community engagement offering hands-on experience. In this way, it may potentially prepare graduates from higher education institutions for an easier transition into the labor market. As to be able to address the question of whether service learning influences youth employment in Croatia, a study was conducted on 291 participants. The purpose of the research was to strengthen the links between service learning and youth employment in (social) enterprises. Methods applied two separate surveys, covering the topic of service learning and social entrepreneurship and youth, and the research was conducted from February to August 2021. The main findings point to the partial influence of service learning on youth employment in Croatia. Although it provides community engagement by introducing some hands-on experience, these skills and knowledge are still insufficient for the graduates' competitiveness on the labor market. In order to increase the impact of service learning on youth employment in Croatia, some service learning-related enhancements are proposed but, more importantly, reforms are needed in the (higher) education system in general as well as in the strategic framework on the social entrepreneurship.

KEY WORDS

service learning, social entrepreneurship, youth employment, Croatia

CLASSIFICATION

JEL: D83, J13, L31

INTRODUCTION

Universities are key institutional players within their localities since they have been shown to have significant economic and social impacts on their communities [1]. In the 21st century, universities are changing and trying to be closer to their communities and the social problems they have. This, among other, entails introducing new skills in their students, which would make them more competitive in the ever-changing labor market.

A number of studies demonstrated the need for experiential learning [2-6] as university graduates are not sufficiently prepared for entering the labor market [7] and due to a lack of provision of appropriate skills by university programs, there is a decreased employability of graduates [8]. This is why an increase of businesses working with schools has been noted [9] as also employers require readiness of workforce [10], alongside willingness of graduates for work-related experience [11] as to increase their own competitiveness and assign a meaning to the taught theoretical classes. Experiential learning may be performed in many forms, e.g. internships, classes in cooperation with businesses, simulation of projects, study abroad, etc., which Kuh [12] termed as high-impact practices. This also entails service learning as participating in voluntary programs, working in social enterprises or civil society organizations. Service learning is a learning methodology which addresses real community issues and problems [13]. It puts together both learning as well as social objectives, thus improving the quality of education as well as increasing employability of graduates [14].

As a specific experiential learning form, service learning has demonstrated to increase students' problem-solving abilities but also has a positive impact on their communication skills [15, 16]. It furthers the students' ability for transferring abstract concepts into practical activities [17], enhances their entrepreneurship, leadership and team skills, feelings about self [18], improves critical and creative thinking [19], their presentation skills and decision-making [20]. Most importantly, it increases the likelihood of graduates' employment by as high as 30 % [17].

On the other hand, although globally, the introduction of social entrepreneurship courses is on the rise [21], there is still a relatively low number of service learning dedicated courses offered, which was evidenced in Croatia (three dedicated courses and 25 of them applying service learning principles).

When we look at the definitional features of social entrepreneurship the main goal of the endeavor of social entrepreneurship is to create a positive social impact. The key difference between entrepreneurship in the traditional sector and social entrepreneurship is that the latter prioritizes welfare and social goals. So traditional entrepreneurship is primarily undertaking entrepreneurial activities to make a profit for its owners or stakeholders. On the other hand, social entrepreneurship is undertaking entrepreneurial activities as means to achieve some social goals. Thus, social enterprises have the focus on social mission but also have financial goals, so it could be said that social entrepreneurs expect double return, both economic and social [22-24].

Service learning entails an experiential approach to education based on mutual learning [25], thus being complementary with social entrepreneurship. Connections between concepts are noticed by different authors [26-30], such as collaborative relationships, orientations towards community, local embeddedness and experiential learning. Service learning could be a good interdisciplinary approach to teach social entrepreneurship as a connecting theory; practice and real-life social problems can foster the development of competencies of future social entrepreneurs. Brock and Steiner's analysis [31] showed that a number of educational institutions teaching social entrepreneurship are assigning service/experiential learning projects to give students hands-on experience. Some experiences state that service learning

and social entrepreneurship can co-exist on college and university campuses with little or no collaboration or communication between the two programs [27]. The same authors also note that they have several qualities they share so could not only work together but could benefit from one another's strengths. McCrea [4], on the other hand, finds that service learning nature is perceived by faculty members as irrelevant for entrepreneurship.

Further on, business education is usually perceived as entailing overly profit-oriented approach without moral values [32] so matching it with service learning may complement for those deficiencies by introducing the concept of social responsibility. Moreover, Mueller, Brahm and Neck [26] suggest that service learning is one of the best learning approaches to social entrepreneurship education. Interestingly, it also offers students an opportunity to tackle problems which really matter to them while business education often deals with problems which are too specific and difficult to understand for inexperienced students. Although widely applicable, service learning usually finds a strong spillover in the social entrepreneurship.

Geographical context shows that social entrepreneurship has been developing in Europe for the last few decades [33]. The big push for institutional recognition of social entrepreneurship on the EU level was Social Business Initiative [34]. Currently, Social Economy Action Plan [35] is oriented towards creating the conditions and opening opportunities as well as a wider recognition of social economy and social entrepreneurship.

In Croatian terms, development of social entrepreneurship is a relatively new phenomenon, although social economy has a distinctive history. The promotion of social entrepreneurial activity in Croatia began approximately 15-20 years ago, mainly through foreign organizations [36, 37] while its institutional recognition came with the Strategy for development of social entrepreneurship 2015-2020 [38].

The number of social enterprises in Europe varies from country to country, with Italy (102 461), France (cca. 96 603) and Germany (77 459) being the leading ones [21]. Although the data provided are not completely reliable and sometimes hardly comparable as social entrepreneurship is still not sufficiently regulated and therefore under-researched, according to the existing report in the European context [21], Croatia ranks rather modestly (526 social enterprises in 2018). Comparing it with other ex-Yugoslav countries with available data, it ranks lower than Slovenia (1393) and Northern Macedonia (551) but higher than Serbia (411) and Montenegro (150) [21].

It may well be that the number of social enterprises in Croatia differs from the Borzaga et al. report [21], which may be detected only after a thorough mapping exercise. Other estimates range from around 100 [39] to around 300 [33] social enterprises in Croatia. When it comes to legal types of social enterprises in Croatia, they may be divided in the following groups:

- social entrepreneurship associations registered for economic activities;
- social cooperatives;
- veterans social-working cooperatives;
- cooperatives pursuing social aims;
- foundations registered for general interest and economic activities;
- companies founded by associations;
- institutions founded by associations;
- other companies pursuing explicit social aims and operating as not-for-profits;
- sheltered workshops [40].

Vidović and Baturina's analysis [33], in trying to assess types of social enterprises in Croatia, suggest three types: social enterprises driven by employment purposes, social enterprises

driven by financial-sustainability goals and social enterprises driven by the search for innovative solutions.

Looking at the status of social entrepreneurship, the recent analysis [33, 40] recognizes the lack of visibility and recognition of social entrepreneurship in Croatia. Other research also notes that social entrepreneurship is not recognized among citizens [41].

Service learning in Croatia, as well as globally, is mostly implemented within the university educational curricula. It is still underrepresented in academic curricula [42], mostly offered as an elective course, and is currently conducted at humanities-oriented faculties. For the first time, service learning entered the educational system in Croatia in 2006 at the Faculty of Humanities and Social Sciences (course: Service Learning) in Zagreb, as part of the graduate study of Information and Communication Sciences. It is also carried out at the University of Split – Faculty of Economics (course: Professional Practice – Service Learning) and at the University of Zagreb – Social Work Study Centre at the Faculty of Law (course: Service Learning and Social Interventions). The concept of service learning, however has also been introduced within other courses at different faculties where it is used as a pedagogic tool for promoting community development. The faculties closely cooperate with other educational institutions, associations and civil society organizations (CSOs) [43]. But, the experiences from service learning implementation as a specific course at the University of Rijeka suggest challenges in the implementation itself, such as the integration of the course content and community activities, and the lack of university support [44].

Research [45] shows that students were willing to consider and showed a substantial interest in enrolling in an elective course with a component of service learning. Teachers in Croatia are generally interested in the possibility of engaging in service-learning [46]. On the other hand, students have generally not heard of the service learning method and have no experience with it, but express a desire to enroll in such a course and using the service learning method [47]. Although the service learning topic at Croatian universities is not a novel concept (first introduced in 2006), it still has not succeeded to gain a greater attention in a wider society.

One would expect that this type of learning offers students greater opportunities at the labor market as it provides them with hands-on experiences and practice-oriented learning.

However, it seems that this is not the case as Croatia still has a high rate of youth unemployment, which makes up 27 % (or 33 090 persons) of the entire registered unemployment (123 445) [48]. Within the EU context, in 2021, Croatia was ranked 9 for its overall unemployment rate (7,4 %) and its youth unemployment rate is also among the highest ones [49]. When looking at the specifically vulnerable neither in employment nor in education and training population (NEET), Croatia's NEET unemployment rate has been consistently above EU average since 2011 [50]. Besides, relevant analysis [51] notes that there is a general problem of lack of care of society and politics about young people in Croatia.

This fact was a leading motivation for this study and its importance is seen in a direct contribution to solving the youth unemployment problem. It was assumed that both formal and informal service learning programs offer skills young people lack when entering the labor market when compared to other theory-based educational curricula. In this way, they should be more competitive in getting a job or more prepared for self-employment. This is why we conducted a study with the aim to explore the connection between service learning and youth employment in social enterprises in Croatia, as it was assumed that social enterprises were more acquainted with the service learning concept valuing the skills such educational

programs offer to young people. The goal of the research was to assess the possibilities of service learning in the Croatian social entrepreneurship ecosystem and what is its potential for contributing to youth employment. Therefore, the main research question was the following: does service learning influences youth employment in Croatia, and if so, how?

Therefore, the purpose of the work was to strengthen the links between service learning and youth employment in (social) enterprises. Based on the research results, some recommendations are put forward, which may serve in strengthening this link and eventually enhance youth employment. Therefore, significance of the study is seen in giving input into potential decrease of youth unemployment rate, development of service learning and social entrepreneurship in Croatian context.

The structure of the article is as follows: after this Introduction, methodology of the research is explained in the section Materials and Methods, followed by the Results of the research. Finally, the Discussion offers interpretation of the research results putting it in the context with the existing theory and offering recommendations for the increase of youth employment in Croatia, especially in social enterprises with service learning being a “helping hand” in that respect.

MATERIALS AND METHODS

In order to investigate connections between service learning and youth employment in social enterprises in Croatia, two separate surveys have been designed, the first one covering the topic of service learning and the other one social entrepreneurship and youth. Each survey consisted of ten multiple choice questions, some of them offering a possibility for a larger selection of possible answers, while the others were yes-no questions. Some multiple-choice questions allowed only one answer as to detect the key answers while two of them allowed for several answers. Data collected in both surveys were statistically analyzed using MS Excel. The survey has been conducted within the European Social Fund supported project “Using Dialogue for the Croatian Network for Social Entrepreneurship” from February to August 2021. The research sample covered 291 participants from different existing social enterprises in Croatia, new social entrepreneurs (legal subjects planning to start or to change their business principles harmonizing them with social entrepreneurship), project partners’ employees and stakeholder¹, different veterans social-working cooperatives, and young people who had participated in both surveys. This constitutes a part of the wider ecosystem of social enterprises and their supporters in Croatia.

The survey on service learning focused on the topics of the participants’ awareness of the service learning concept; their knowledge about the existence of service learning study programs in Croatia; their own educational background in service learning, formal or informal; the need for formal or informal service learning study programs; the need of formal education in service learning in the selection of job candidates; on the job training; the relationship between service learning and social innovations; and the detected lack of key knowledge/skills among young employees in social enterprises.

In the survey on youth employment in social enterprises, the questions covered the number of young people employed in social enterprises; their reasons for seeking jobs in social enterprises; utilization of youth employment policy measures by the employers; (dis)advantages for employing young people in social enterprises; youth recruitment for job openings; length of youth employment in social enterprises alongside durability and security of employment in social enterprises; key incentives for youth employment/willingness to keep jobs in social enterprises; and biggest advantages social enterprises can offer young people.

Research respected ethical principles in quantitative research. Respondents were honestly familiarized with the goals of the study and gave informed consent to participate in the study. The anonymity of respondents was ensured as the survey did not ask personal data or had questions that would reveal respondents' identities. The obtained data was stored appropriately and only project leaders and researchers doing analysis had access to the data.

RESULTS

Results of the study are first presented as separate findings of the two surveys, the first one focusing on the topic of service learning and the other one on social entrepreneurship and youth. Further on, they are cross-fertilized as to find possible relations between the topics.

SERVICE LEARNING

When asked if they are familiar with the term 'service learning', 289 (99,3 %) out of 291 participants answer affirmatively, whereas 285 (97,9 %) respondents are aware of the existence of studies related to service learning in Croatia. None of the participants have attended any course or study related to service learning during their formal education or any informal service learning course. Participants believe that the existence of formal service learning educational programs are necessary for becoming a social entrepreneur (286 or 98,2 %), but also agree that informal service learning course may substitute for formal education (289 or 99,3 %). The vast majority of participants say that upon recruitment they do not select candidates who have taken a service learning course within their formal education (284 or 97,5 %), and all participants believe that it is possible to educate candidates through work. This proves the prevalence of on the job training over formal service learning study programs. Also, all participants agree that service learning influences the development of innovations in social entrepreneurship in Croatia. The key skills or knowledge that employees in social entrepreneurship lack is ranked as follows: financial management ($n = 185$), human resources management ($n = 177$), creativity and innovation ($n = 133$), knowledge about the very concept of social entrepreneurship ($n = 81$), communication and marketing ($n = 48$), presentation skills ($n = 44$), general knowledge of project management ($n = 40$) and sales ($n = 30$), see Figure 1.



Figure 1. Key skills/knowledge employees in social entrepreneurship lack.

SOCIAL ENTREPRENEURSHIP AND YOUTH

As for the number of young people employed in their social enterprise, participants mainly answer that the number varies between 5-7 (40,89 %) and 3-5 young persons (27,84 %). When they are looking for new employees, the vast majority of participants recruit young people from the Croatian employment service (92,78 %) and 95,88 % of them say that they are benefitting from some of the public policy measures to employ young people. 92,44 % of respondents think that social enterprises offer young people permanent and secure employment, while young people mostly stay 2-3 years (39,86 %) or 1-2 years (36,77 %) in the participants' enterprises. Participants believe that the key incentives for encouraging the employment of young social entrepreneurs or for their stay in the social entrepreneurship sector can be the general climate that encourages the development of social entrepreneurship (48,45 %), financial incentives (24,74 %) and education on social entrepreneurship in existing educational institutions (19,24 %).

According to the participants, the primary reasons why young people choose to become social entrepreneurs are their social awareness (54,64 %), the fact that they need employment (15,46 %) or their willingness to help others (12,03 %). A key advantage of employing young people in social enterprises over employing people of another age group is seen in the fact that they quickly respond to social changes/trends (59,11 %) and have specific knowledge that older employees do not have (14,43 %). On the other hand, its shortcomings are the fact that formal education does not guarantee their readiness for the labor market ($n = 173$ or 59,45 %), a lack of experience ($n = 85$ or 29,21 %) and a lack of independence at work ($n = 33$ or 11,34 %), see Figure 2. Participants reckon that the main benefits that young people can gain from working in their enterprises are a general knowledge of project management (34,36 %), creativity and innovation (25,09 %), financial benefit (12,37 %) and business readiness that they would not get in 'classic' enterprises (11,68 %), see Figure 3.

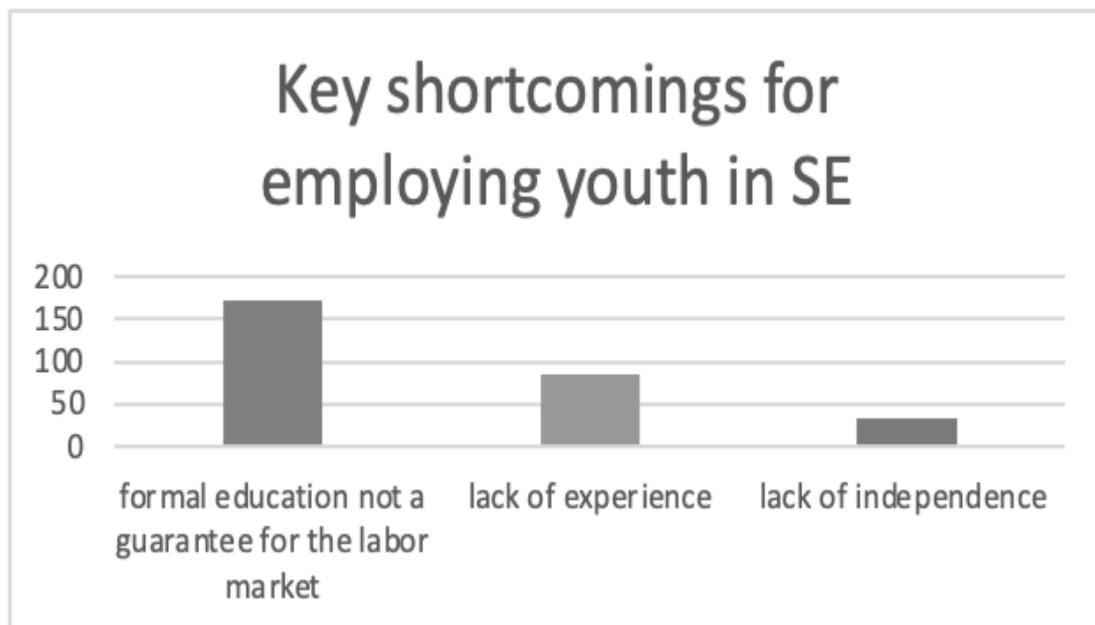


Figure 2. Key shortcomings for employing youth in social enterprises.

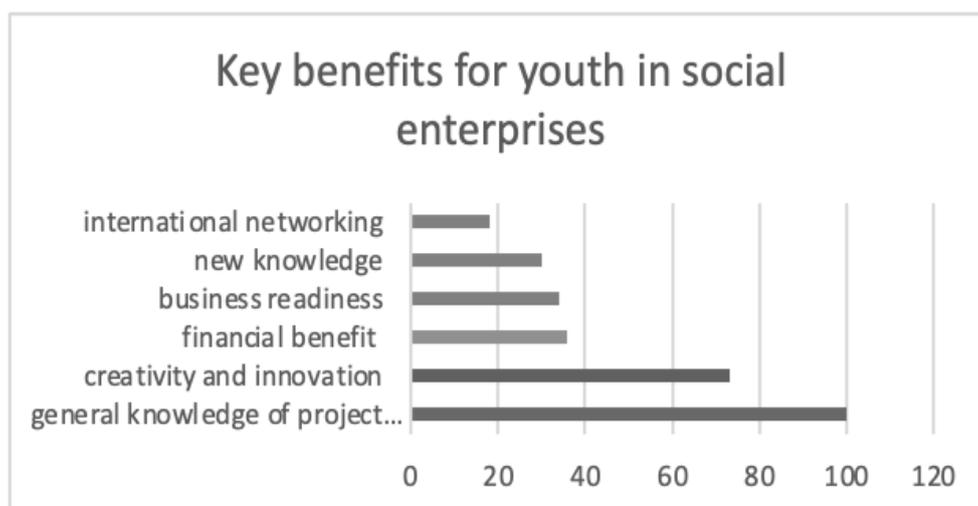


Figure 3. Key benefits for youth in social enterprises.

RELATIONS BETWEEN SERVICE LEARNING AND YOUTH IN SOCIAL ENTREPRENEURSHIP

Establishing relations between the answers to both surveys allowed us a further exploration, which detected some overlaps but also inconsistencies in participants' opinions and actions. Thus, project management (13,75 %) was detected as one of the areas in which employees in social entrepreneurship lack general knowledge (service learning survey) for which working in social enterprises easily compensates (social entrepreneurship and youth survey) since it is detected as one of the main benefits that young people can gain (34,36 %). Thus, on the job training seems to complement this educational shortage.

While education on social entrepreneurship in existing educational institutions (19,24 %) is seen as one of the key incentives for encouraging the employment of aspiring young social entrepreneurs and for fostering their stay in the social entrepreneurship sector, majority of participants (59,45 %) think that one of the shortcomings of employing young people in social enterprises is the fact that formal education does not guarantee their readiness for the labor market. This also relates to the opinion all of the participants (291) who agree that it is possible to educate candidates through work, firmly confirming doubts related to the curricula taught at the existing study programs. This raises questions why employers do not select candidates who have taken a course in service learning (97,5 %), which may potentially compensate for that. The reason behind it is unknown, though. The fact that none of the participants, who are also social entrepreneurs, have attended any course or study related to service learning but that they believe it to be essential for becoming a social entrepreneur (98,2 %) is possibly tied to their own past education through work which lacked service learning courses. Their belief that education is essential for working in service learning may still suggest that education would make it easier for young people to become social entrepreneurs.

All participants of the service learning survey acknowledge that service learning impacts the development of innovations in social entrepreneurship in Croatia, but at the same time part of them (45,70 %) perceive creativity and innovation as one of the key skills that employees in social enterprises lack. Equally, participants of the social entrepreneurship and youth survey believe that one of the main advantages of working in social enterprises for young people is the development of creativity and innovation (25,09 %). This may mean that on the job training again complements the shortages in study programs. Further on, such assertions raise questions about whether all social enterprises offer this sort of opportunities and how often. In

the same way, the question of whether social enterprises that bring benefits of developing creativity and innovation are only individual cases and the question of to what extent do service learning study programs introduce these skills, remain to be further explored.

These inconsistencies lead to a conclusion that although employers in social entrepreneurship are highly aware of the existence of study programs related to service learning, they still lack a profound knowledge on them as they do not employ service learning graduates. Further inconsistencies in answers concern the social entrepreneurship and youth survey in which respondents agree that social enterprises offer young people permanent and secure employment (92,44 %), what is not reflected in the statements that young people mostly stay only 2-3 years (39,86 %) or 1-2 years (36,77 %) in their enterprises. It remains unclear whether young people continue to work in other social enterprises or seek and find employment elsewhere.

DISCUSSION AND CONCLUDING REMARKS

This research connects three relevant topics in Croatia, service learning, social entrepreneurship and youth. The research showed that almost all respondents are familiar with the term service-learning and agree that these courses can be useful. That is similar to the experience of other research conducted in Croatia [45, 46].

The total absence of attendance of any course or study related to service learning during the formal education detected in this research may not be surprising as most of the respondents attended higher education in the years before the introduction of service learning in the Croatian higher education system. Previous research in Croatia [45] states that students who previously heard about this teaching method and those who have experience of volunteering are more interested in enrolling in an elective course with a service learning component. Therefore, service learning is considered highly useful as it enables knowledge and skills for easier integration on the labor market.

Service learning perspective is very close to the third mission of the university i.e. economic and social mission and its contribution to communities and territories. Croatia still faces significant challenges in creating an enabling environment for the integration of the third mission into universities. Research [52] shows that the connection of teaching and community engagement, as per service learning methodology defined by Dixon [13], is absent which could also be an obstacle for service learning development.

The fact that almost a third of the respondents in the research asses that employees' in social enterprises lack knowledge about the very concept of social entrepreneurship is worrying but also suggest that this field is not sufficiently developed in Croatia. Underdevelopment of the field is recognized in recent analysis [40]. The first Strategy of development of social entrepreneurship in Croatia [38] put forward increasing visibility and clarifying legal and policy status of social entrepreneurship as one of its major goals but the evaluations of the Strategy showed that those goals were not achieved [53]. This points to the greater need for promotion, visibility and understanding of the social entrepreneurship concept among entrepreneurs as well as citizens.

The fact that participants consider that the general climate should be the key incentive for encouraging the employment of young social entrepreneurs or for their stay in the social entrepreneurship sector is in line with another analysis, which assessed it as a relatively unfavorable with the lack of political will to prioritize the development of this sector [40, 54]. While other incentives are also important (e.g. financial support, education), the general

climate has the greatest impact on the young people's employment in social enterprises. Clear strategic framework fostering youth employment and social entrepreneurship development is, therefore needed.

Key skills or knowledge that employees in social entrepreneurship lack, per research respondents, are mostly related to financial and human resources management. This corresponds with the early development phase of the social entrepreneurship in Croatia in which key business skills are still missing within a sector [40]. Participants in the research state that service learning influences the development of innovations in social entrepreneurship in Croatia. This contradicts McCrea's [4] findings on the perception by faculty members of the irrelevant nature of service learning for entrepreneurs. Also, it can be interpreted as one of the possible ways to overcome the lack of creativity and innovation by employees in social entrepreneurship that respondents also recognize. A relatively small number of young people employed in social enterprises detected in this research is aligned with the previous study suggesting that the number of persons employed in social enterprises in Croatia is usually small [39]. This points to the conclusion that service learning may be beneficial for developing creative skills and innovation but is still not sufficient for mastering key business skills. Eventually, it also results in a small number of young people employed.

When employing young people, most of the respondents use the usual recruitment channels such as the Croatian employment services and active labor market policies. This result does not surprise as these are the main channels for employment in Croatia. However, recent research [55, 56] states that young people and experts recognized different limitations in the work of the Croatian employment services and their cooperation with different stakeholders. Along the same line, active labor market policies in Croatia are only partly efficient and appropriately targeted [57, 58]. Still, the existing public policy measures for employing young people are benefitted from. Also, it should be noted that active labor market policies do not have tailored measures for employment in social enterprises, however social enterprises can use available measures as any other enterprise. In this sense, proactive recruitment past the usual recruitment channels is advocated (e.g. at educational institutions, volunteering organizations). Likewise, labor market policies would benefit from revisions, involving also social entrepreneurship.

The research results show that social enterprises, although ideologically attractive, do not offer stable and secure employment for young people. This is in line with the research done by Šimleša et al. [39], which demonstrated that most of the social enterprises in Croatia were operating only a few years. Also, recent European social fund tenders for the development of entrepreneurship contribute to the development of new social enterprises in Croatia. These facts suggest that it is likely that in most social enterprises in Croatia young people cannot find stable jobs. This calls for further research which should detect the reasons behind inability of social enterprises in Croatia to remain operational.

Further on, formal education does not guarantee the graduates' readiness for the labor market and a lack of experience is seen as an obstacle for their integration on the labor market. This is in line with another research [55] which shows that young people estimate the education system as offering them outdated knowledge and methods of work, connected to the lack of their practical skills and experiences. Likewise, it also corresponds with research studies [2-6], which detected the need for experiential learning. Further on, it goes in hand with Polk-Lepson Research Group's results [7] which showed insufficient preparedness of university graduates for entering the labor market. Changes in the Croatian education system are necessary, which could tackle the incompatibility of educational programs with the labor market and an increased need for practice. This has been noted both by researchers [59] and the public.

Education on social entrepreneurship in existing educational institutions can be, per our respondents, one of the incentives for encouraging the employment of young social entrepreneurs. However, social entrepreneurship is only marginally represented in the educational system although there are some positive developments like the new courses and educational programs [40]. Toplek [60], further on, detected that higher educational institutions are increasingly recognizing the importance of social entrepreneurship and the benefits that come with introducing such subjects into the teaching content. So continuing with this practice, especially in the form of service learning can create better readiness for the labor market of young people (for working in social enterprises and on other jobs) coming from the higher education system.

According to the participants, the primary reason why young people choose to become social entrepreneurs is their social awareness. This is similar to the theoretical social motivation connected to social entrepreneurship. Some authors even go further, and given the motivation to help others and the community, describe characteristics of social entrepreneurs idealistically [61, 62]. Bull and Ridley-Duff [63] also discuss ethics and positive ethical connotations connected with social enterprises. Similarly, research on the third sector in Croatia [64] states the prevalence of prosocial motivation in the third sector of human resources. The social awareness, therefore exists, both in the private sector as well as in the CSOs.

Bigger prevalence of service learning programs connected to the development of social enterprises, or students contributing to social enterprises in the framework of the service learning courses can be close to the “critical” approach to service learning [65] with an explicit social justice aim or even close to the concept of the transformational learning [66]. Although service learning can have positive outcomes on students in different ways, we can also assess it critically and note limits of service learning in higher education (pedagogical, political and institutional) [67]. This may especially be relevant for the Croatian context in which (very) gradual transformation of the education system is noted [68], with a lack of entrepreneurial spirit in the universities. However, Croatian HEIs have been modestly improving their capacity to collaborate with external stakeholders to exchange knowledge and promote innovation [69] which opens space for the development of service learning and social entrepreneurship.

The idea of service learning is gaining rising support. Although already at the beginning of the century the questions about the institutionalization of service learning were raised [70], some authors recognize that service learning is rarely “hard-wired” into institutional practices and policies [67]. This is also the case in Croatia. There is a growing interest which can be witnessed by the successful implementation of the service learning projects in cooperation of universities and civil society organizations or the development of service learning centers or offices (e.g. at the University of Split – Faculty of Economics and the University of Zagreb) but with recognized challenges in implementation and lack of support [44]. This article highlights the additional need for further development of service learning courses connected with social entrepreneurship, which could contribute to the employment of young persons, development of social entrepreneurship but also development of perspective of purpose-driven universities [71].

In answering the research question, the article showed that so far service learning only partially influences youth employment: it enables some practical knowledge and skills for easier integration on the labor market but they, however, are still insufficient and point to the fact that the shortages in study programs are complemented with on the job training. Further on, the educational reform as well as a strong strategic framework for the social entrepreneurship are considered to be essential for increasing youth employment in Croatia.

This article represents one of the first examinations of the relationship between service learning and social entrepreneurship in the Croatian context. The following recommendations are put forward based on the results of the research:

- higher visibility and promotion of service learning is needed in the society in general and its stronger integration in the (higher) education system in Croatia as it may offer the required knowledge and skills for easier integration of youth on the labor market;
- direct connections between teaching and community engagement is necessary as it directly contributes to the third mission of universities;
- youth employment and social entrepreneurship development is to be fostered by way of clearly defined strategic framework;
- recruitment of young employees should go beyond the Croatian employment services as they often fail to provide excellency in their services – this calls for reform and/or revisions in labor market policies, which involves also the Croatian employment services;
- reform of the Croatian education system is also needed for matching the content and methods in educational programs with the labor market; interdisciplinary approach should be fostered as it possibly provides for new knowledge, skills and innovation.

Future research may assess further the overlaps among service learning and social entrepreneurship and potential collaborations. Also, the reasons behind inability of social enterprises in Croatia to remain operational should be tackled in the future research. The dyadic nature of social entrepreneurship, which includes entrepreneurial skills and behaviors, and orientation towards the social mission, can present challenges for teaching social entrepreneurship. New careers in social entrepreneurship are on the horizon for young people in Croatia, so for the enhancement of their chances on the labor market and development of the field, students should be taught about social entrepreneurship in a proactive way, using the service learning methods. Service learning can be one of the ways to overcome those challenges and connect university education with the quest to solve social problems of the local community and help young people gain relevant skills for the labor market.

REMARK

¹LAG Cetinska krajina, LAG Međimurski doli i bregi, LAG Vinodol, LAG Posavina, LAG Izvor, LAG Papuk, LAG Laura, LAG Brač, LAG More 249, LAG Krka, Center for Sustainable Development, Croatian County Association, Croatian Employment Services – Regional Office in Split, Union of Association of Croatian Defenders Treated from PTSD Republic Croatia, Social Cooperative Humana Nova Čakovec, Association for Democratic Society, Veterans social-working cooperative Dalmatia Ruralis, Association of Unemployed Croatian Homeland War Veterans.

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STUDY OF PROFESSIONAL HEALTH OF HIGHER EDUCATION TEACHERS IN UKRAINE UNDER QUARANTINE

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ABSTRACT

The problem of changes in educators' various health aspects in the context of transition to distance learning during the COVID-19 pandemic, caused by changes in professional activities, is not sufficiently studied. This study aimed to identify and analyze physiological, psychological, and professional changes in scientific and pedagogical staff of Ukrainian higher education institutions, associated with the transition to distance learning under quarantine, which affected social, psychological, physical, and mental aspects of their health. A total of 254 educators of Ukrainian higher education institutions were surveyed and their responses analysed. The study revealed certain physiological, psychological, and psychosomatic indicators showing that online work leads to health deterioration. The survey showed that educators consider online learning to be ineffective, opting for a mixed form of education under quarantine. It was found that scientific and pedagogical staff is divided into two clusters according to their state of health as a result of new conditions of professional activity due to the COVID-19 pandemic. Two-thirds of educators coped with the challenges quite well, while the remaining third felt severe aftereffects on their physiological and psychological health. The distinct features that differentiate these two clusters were identified and discussed. Most of scientific and pedagogical staff of Ukrainian higher education institutions pointed out that the lockdown and quarantine measures and the consequent transition to distance teaching had a significant impact on their social, psychological, physical, and mental health. Though the majority of educators confirmed their adaptation to the new working conditions, there was a cluster of teachers for whom the process of adjustment was quite psychologically traumatic.

KEY WORDS

COVID-19 pandemic, teaching and research staff of higher education institutions, physiological changes, psychological changes, professional changes

CLASSIFICATION

APA: 5900, 7000
JEL: I12, I23

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INTRODUCTION

In the context of the forced transition to online learning and remote work caused by the COVID-19 pandemic, various aspects of the physiological, psychological and professional well-being of higher education teachers are of particular importance. The restructuring of life and professional rhythms, the situation of uncertainty and the general information saturation have greatly influenced various health disorders of scientific and pedagogical staff. Such changes are characteristic not just for higher education teachers, however, the teaching specifics contribute to a more acute development of the above changes.

Lockdown during COVID-19 undoubtedly affected professional activities, but to a greater extent it affected the employees, who continued working during the pandemic, including higher education teachers. The COVID-19 pandemic has led educators to an unpredictable scenario where the lockdown situation has accelerated the transition from traditional teaching methods to the Internet, and relationships have changed by avoiding direct contact with other people, which has significant aftereffects on their health.

According to research in Spain, the situation of lockdown has led to serious problems in the personal and professional life of teachers, in particular due to the pressure exerted on them by online educational methods: many hours of work and difficulties due to lack of physical contact or obstacles to reconciling personal life with family. On the other hand, the situation caused by the COVID-19 pandemic has demonstrated the advantages and disadvantages of online learning, as it can help to expand borders and provide education to every house [1].

The COVID 19 crisis has also exacerbated risk factors, that are usually associated with deteriorating mental health – financial insecurity, unemployment, fear, while protective factors – social ties, employment and education, access to exercise, routine day, access to medical services – fell sharply [2]. The Health Survey circulated by Kaiser Family Foundation in July 2020 also found that most adults report some negative effects on their mental health and well-being, such as sleep problems (36 %) or eating disorders (32 %), exacerbation of chronic diseases (12 %) due to anxiety and stress caused by coronavirus infection.

A large number of people who continue working during a pandemic face a problem that is caused by a higher risk of coronavirus infection compared to those who do not work during lockdown. In contrast to employees whose work is suspended during this period, employees who provide vital communications are more likely to report symptoms of anxiety or depressive disorder (42 % vs. 30 %) during a pandemic [3].

In present research, we are focused on the professional teachers' activities. Teachers were found to be concerned about the uncertainty of their professional activity during the COVID-19 pandemic. The rapid transition to online learning has led to a significant increase in the teachers' workload, as they work not only on the creation and placement of teaching materials on the Internet, but also on the development of skills in using the necessary software. However, for a large number of educational institutions, the transition to the Internet is a significant challenge, as teachers try to adapt to forced working conditions in a relatively short time, while this may be a completely “new normal” phenomenon if it occurs over a long period of time [4].

Because lockdown during the COVID-19 pandemic affected almost every aspect of society, people had to learn to organize communication and interaction in a new way. In May-June 2020, a study was conducted in Germany that raised the question of how teachers in the quarantine restrictions early stages caused by COVID-19 adapted to teaching via the Internet. Most teachers noted that they updated the curriculum and supplemented it by providing feedback to their students. However, problems that clearly require the integration of information and

communication technologies, such as teaching and assessment on the Internet, have been mastered to a lesser extent [5].

The situation with the COVID-19 pandemic has made significant demands on teachers. In the USA, researches of the teachers' needs were conducted during the first months of the pandemic. On average, teachers experienced seven stressors (out of 18 suggested in the survey) and four protective factors (out of six suggested in the survey). Teachers who have been exposed to more stressors have reported on deterioration in mental health due to difficulties in teaching and learning. On the other hand, the feeling of more protective factors among the respondents was due to the fact that they do not have difficulties in teaching and learning. The results of the study showed that teachers experienced significant stress as a result of the COVID-19 pandemic, which was associated with deterioration in mental health, coping and learning [6].

According to the analysis of scientific publications in Ukraine and Russia on the COVID-19 pandemic impact on the higher education sector, it was found that the main issues studied by scientists concerned with the higher education institutions orientation to the distance learning technologies development; the level of educational process participants' satisfaction with the remote work technologies used in the universities; identifying distance learning opportunities; organization of the educational process by distance learning technologies and its impact on the psyche of students and teachers, etc. [7-12].

However, along with a wide range of issues related to the educational process organization in higher education institutions in the COVID-19 pandemic context, the deformations problem in various teachers' health aspects caused by changes in professional activities is not sufficiently covered.

The purpose of this study was to identify and analyze teachers' physiological, psychological and professional changes, which are associated with the educators' transition to distance learning during quarantine and solving a wide range of professional problems, and which in some way affected various aspects of their health (social, psychological, physical and mental).

METHODS

The following theoretical and empirical research methods were used in the study: theoretical analysis and literature data generalization on the research problem, survey method using the Google Forms cloud service. Statistical methods of survey results analysis included determining the significance of differences in frequency tables and $r \times c$ -contingency tables using Pearson's χ^2 test. When comparing two proportions, the Z-test was used. The Cramer's V correlation coefficient was used to estimate the relationship between qualitative variables in $r \times c$ -contingency tables. Hierarchical methods of cluster analysis were used to determine homogeneous groups in the survey data, namely, Ward's method was used as a linkage rule with (1 % of disagreement) metric, which is most acceptable for clustering qualitative data. When comparing the two clusters by ordinal variables (stressors number, quantity of distance learning advantages/disadvantages, etc.), the Wilcoxon-Mann-Whitney test was calculated. All calculations were made at 95 % confidence level.

RESULTS

The survey of teachers was conducted during January-February 2021 using a questionnaire created by the Google Forms service. The survey was held among research and teaching staff of 42 Ukrainian institutions of higher and professional education. The main part of the questionnaire contained 30 questions, 10 of which concerned with teachers' physiological changes, 10 – with psychological changes and 10 – with changes in the pedagogical process.

254 teachers took part in the survey, among which 36,6 % there are researchers and teachers aged from 41 to 50 years, 24,8 % – from 31 to 40 years and 21,3 % from 51 to 60 years. The scientific and pedagogical experience of teachers who took part in the survey is from 5 to 20 years (44,5 %) and over 20 years (44,1 %). Thus, we covered an audience of different ages of educators with different teaching experience. This allows us to more objectively analyze the changes that teachers have experienced during online studying.

To study *the physiological state* of health the objects were weight, sleeping, appetite, the presence of headaches, feelings of stress and fatigue, changes in physical activity, work and repose. Respondents' changes observations in general health, as indicated by the state of nails, hair, skin, and self-care, were studied separately.

It was found that in quarantine conditions 50 % of teachers noted appetite disorders ($\chi^2 = 3,5433, p = 0,0598 > 0,05$), and more than half-weight fluctuations ($\chi^2 = 5,1024, p = 0,0239 < 0,05$). The vast majority of respondents (81,1 %) indicated a significant decrease in physical activity ($\chi^2 = 98,2835, p = 0,0000 < 0,05$, Figure 1a). Sleep disorders were detected in more than half of teachers ($\chi^2 = 4,0315, p = 0,0447 < 0,05$), while insomnia and cases of drowsiness were presented in equal proportions ($\chi^2 = 1,5734, p = 0,2097 > 0,05$, Figure 1b).

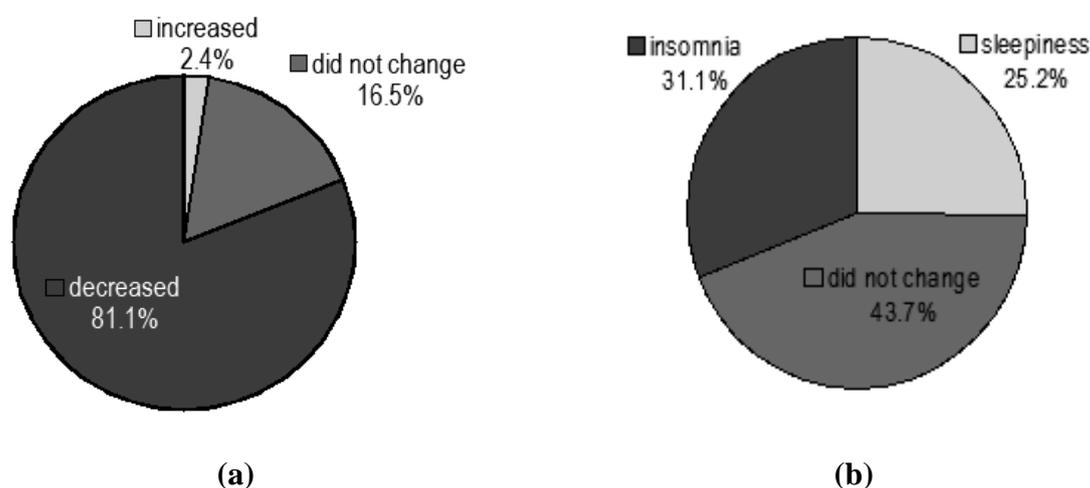


Figure 1. Change in physical activity (a) and sleep disturbances (b) during quarantine.

Analysis of the contingency tables of weight fluctuations with the above factors showed that weight gain was not statistically significantly associated with sleep disorders ($\chi^2 = 8,899665, p = 0,06366 > 0,05$). At the same time, there was a very strong relationship between weight fluctuations and changes in appetite ($\chi^2 = 70,56832$, Cramer's $V = 0,3727, p = 1,7219 \times 10^{-14} < 0,05$) and a fairly strong correlation between weight gain and changes in physical activity due to quarantine ($\chi^2 = 22,98413$, Cramer's $V = 0,2127, p = 0,00012755 < 0,05$).

The presence of headache was noted by half of the respondents ($\chi^2 = 0,7717, p = 0,3797 > 0,05$), however the vast majority ($\chi^2 = 19,2, p < 0,0001$) do not associate it with quarantine, but with other reasons, such as large amount of work at the computer during online classes, weather conditions, anxiety, etc.

Analysis of survey data on changes in work and repose suggests that only less than 15 % of teachers ($Z = 2,1262, p = 0,033483 < 0,05$) followed the same distribution of time for work and repose, as before the quarantine restrictions. Among the majority in the same proportions were those who noted a decrease in free time, and those who recognized the loss of the boundary between work and rest ($Z = 1,7456, p = 0,0809 > 0,05$). The reason for this

phenomenon is the necessity to work at home, which blurs the balance of work and repose. The introduction of quarantine restrictions and the transition to online learning significantly affected the leisure of most teachers ($\chi^2 = 60,5354, p < 0,0001$), significantly reducing their time to communicate with family and friends ($Z = 3,147046, p = 0,0008246 < 0,05$).

Thus, working online increases the time a teacher spends working at the computer, which in turn leads to increased stress, fatigue, anxiety, and disruption to work and repose.

The obtained data indicates that half of the teachers did not experience changes in general health and well-being ($\chi^2 = 1,9055, p = 0,1675 > 0,05$), but at the same time more than 50 % noted changes in self-care ($\chi^2 = 6,2992, p = 0,0121 < 0,05$). Deterioration of health was recognized by the majority of those who noted changes ($Z = 7,3362, p = 1,099 \times 10^{-13} < 0,05$), as well as the majority indicated deterioration in self-care ($Z = 4,0918, p = 2,1405 \times 10^{-5} < 0,05$). Our data show a strong direct significant relationship between changes in health and changes in self-care ($\chi^2 = 53,20654, \text{Cramer's } V = 0,32363, p = 7,7145 \times 10^{-11} < 0,05$), confirming the conclusion that work online reduces the responsibility for one's own appearance.

The study of teachers' *psychological changes* was aimed at self-assessment of emotional state, the emotional stress level and means to seize it, the features of adaptation to changing conditions of professional activity and communication. The survey showed that most respondents rated their emotional state as changeable ($\chi^2 = 109,6614, p = 0,0000$), Figure 2a, declared the feeling of psychological stress by assessing its level as medium ($\chi^2 = 133,9528, p = 0,0000$) (Fig. 2b), a slight increase in anxiety was also observed in most of the interviewed teachers ($\chi^2 = 33,3622, p < 0,0001$).

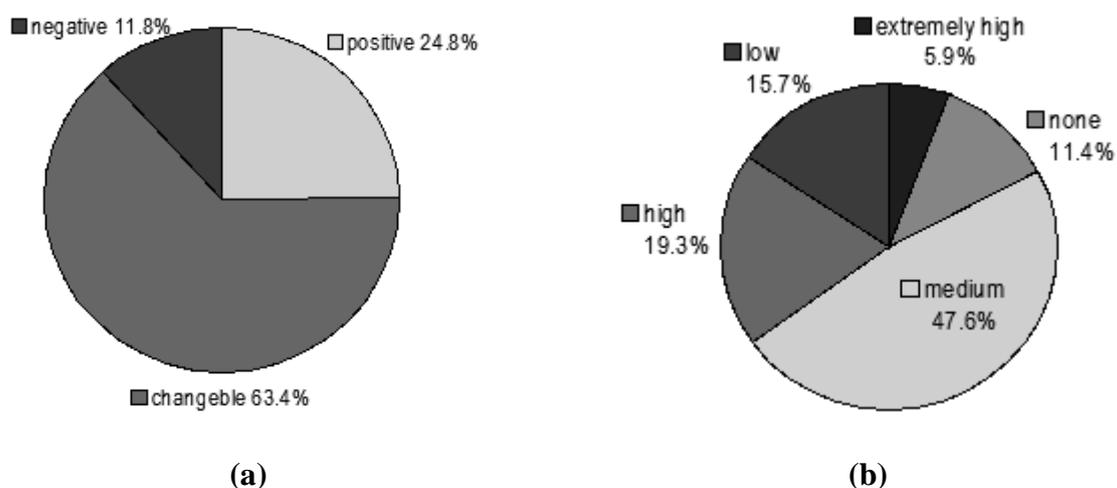


Figure 2. The results of the study of the respondents' emotional state (a) and of respondents' self-assessment of the level of psychological stress (b).

In the survey, respondents were asked to choose the strongest stressors for them during quarantine due to the COVID-19 pandemic. On average, higher education teachers indicated 3 stress factors out of 8 proposed options, which is consistent with the data of the study [6], in which US teachers noted 7 stress factors out of 18 on average ($Z = 0,0674, p = 0,473143 > 0,05$). According to the results of the survey, possible stress factors are sorted by frequency of choice by teachers, and the significance of differences in the frequency of their occurrence is determined (Table 1 and Figure 3), which allowed to rank stress factors from the most significant to the least significant. Thus, the leading stress factor during the pandemic, according to the study, was fear for the health of close people, the second important factor

Table 1. Frequency of occurrence of stress factors during quarantine measures due to the COVID-19 pandemic according to the results of a survey of higher education teachers.

Stress factor	Count	%	Rank	Statistical significance of differences compared to the previous (larger) percentage
Fear for the health of close people	175	68,90	1	–
Uncertainty of the situation	133	52,36	2	$Z = 3,8699,$ $p = 5,44397 \times 10^{-5} < 0,05$
Lack of treatment system	102	40,16	3	$Z = 2,7794, p = 0,0027227 < 0,05$
Danger to the own health	90	35,43		$Z = 1,0993, p = 0,13580829 > 0,05$
Forced isolation	78	30,71		$Z = 1,133097, p = 0,1285867 > 0,05$
Changing working conditions	76	29,92		$Z = 0,19307,$ $p = 0,4234519 > 0,05$
The rate of the disease spread	56	22,047	4	$Z = 2,03159957,$ $p = 0,021097 < 0,05$
Deficiency of means of protection	11	4,33	5	$Z = 6,1137,$ $p = 4,86725 \times 10^{-10} < 0,05$

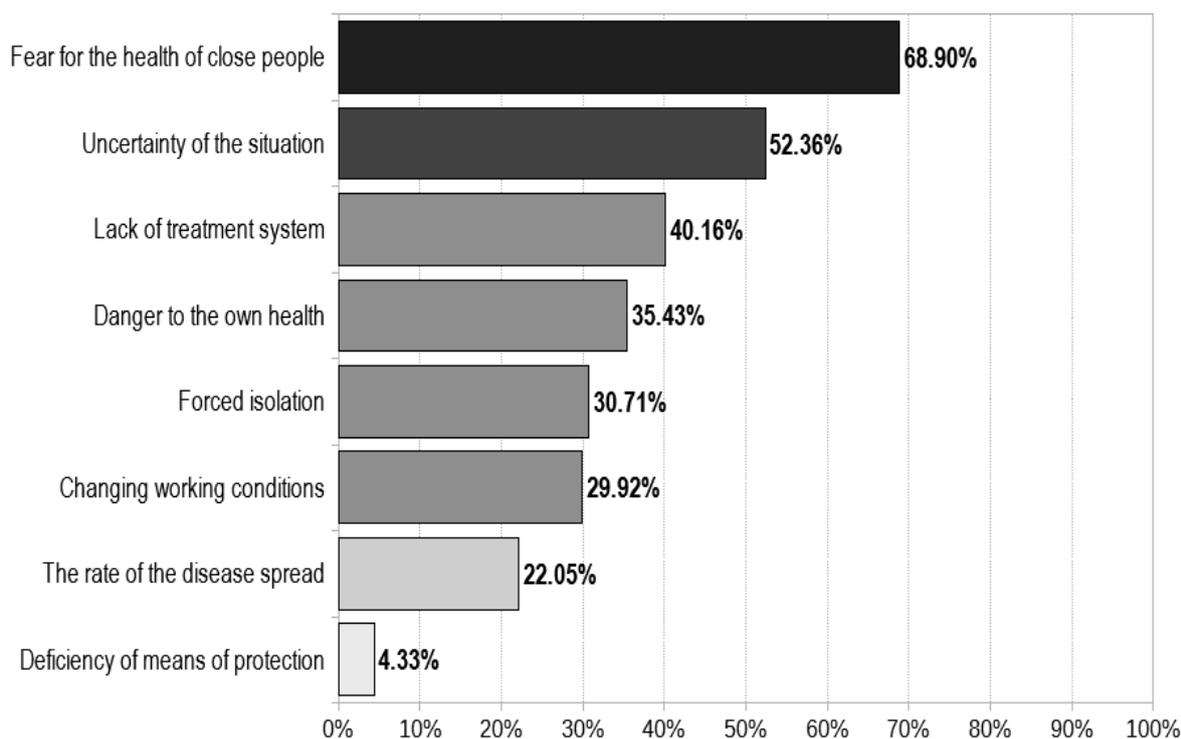


Figure 3. Ranking of stress factors during quarantine measures according to higher education teachers in Ukraine.

was the uncertainty of the situation, the third rank were such stressors as lack of treatment, danger to their own health, forced isolation and change of working conditions. The rate of the disease spread frightened not such a large proportion of respondents and was in 4th place among all stressors. The least stress was caused by the shortage of remedies, which may be related to the time of the survey, when this deficit was no longer as relevant as at the beginning of the quarantine restrictions in the country.

Analysis of respondents' answers (Table 2 and Figure 4) revealed that teachers often resorted to such psychological stress relievers as watching movies and TV shows, the second most popular way of psychological relief were walks in the open air, and the third - communication on social networks and by phone. In fourth place were physical exercises and reading fiction. Handmade, art (music, painting, poetry etc.) and games ranked only fifth in prevalence among stress relievers. Among other means of overcoming stress, respondents indicated learning a foreign language, communicating with children, writing articles, textbooks, and so on.

Table 2. Frequency of occurrence of different methods of psychological relief in the conditions of quarantine measures due to the COVID-19 pandemic according to the results of a survey of higher education teachers in Ukraine.

The method of psychological relief	Count	%	Rank	Statistical significance of differences compared to the nearest larger percentage
Watching movies, TV shows	181	71,26	1	–
Walking in the open air	150	59,06	2	$Z = 2,91061,$ $p = 0,001804 < 0,05$
Communication on social networks, by phone	126	49,61	3	$Z = 2,14737,$ $p = 0,01588194 < 0,05$
Exercise	81	31,89	4	$Z = 4,13096,$ $p = 1,80629 \times 10^{-5} < 0,05$
Reading fiction	79	31,10		$Z = 0,19104,$ $p = 0,4242465 > 0,05$
Hand-made	36	14,17	5	$Z = 4,6550655,$ $p = 1,61939 \times 10^{-6} < 0,05$
Art (music, painting, poetry etc.)	28	11,02		$Z = 1,07085,$ $p = 0,14211769 > 0,05$
Games	20	7,87		$Z = 1,2152,$ $p = 0,11214231 > 0,05$
Other	9	3,54	6	$Z = 2,1128, p = 0,017309 < 0,05$

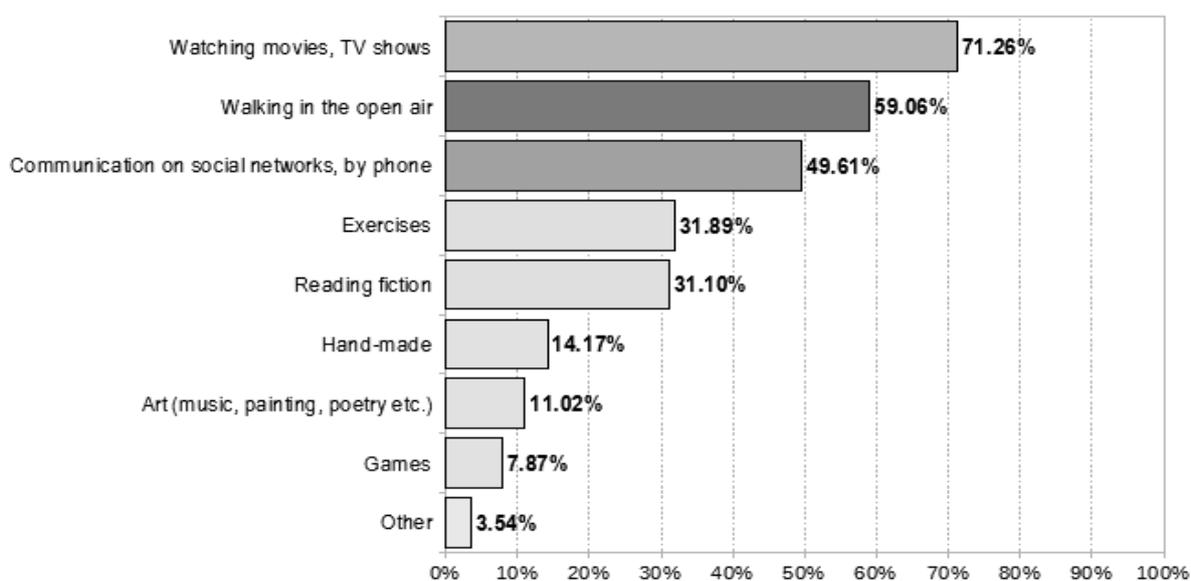


Figure 4. Prevalence of psychological relief methods during quarantine measures among higher education teachers in Ukraine.

Only 1,6 % of respondents sought qualified help from psychologists, and 12,2 % of teachers indicated that they would definitely consult a psychologist if they had the opportunity. But the vast majority ($\chi^2 = 324,0079, p = 0,0000$) of respondents, namely 86,2 %, did not feel the need for professional psychological help.

The quarantine measures have changed the professional environment of teachers. Educational institutions have switched to distance learning, which requires completely different professional skills from teachers. To the question “How was your process of adaptation to changes in working conditions?” 56,7 % of respondents said that it was difficult, but they coped, 37 % of respondents adapted without much effort, 4,3 % did not feel changes in working conditions, 0,8 % of people could not adapt to new forms of teaching. These figures shows that most Ukrainian teachers had difficulty adapting to new working conditions ($\chi^2 = 6,2992, p = 0,0121 < 0,05$).

The distribution of responses about the lack of communication during quarantine measures in the study sample was heterogeneous ($\chi^2 = 12,9291, p = 0,0048 < 0,05$) with a predominance of those teachers who lacked communication at the beginning of quarantine restrictions, but then in one way or another adapted to new conditions ($Z = 2,14948, p = 0,015798 < 0,05$).

When asked about communication with colleagues, 43,7 % of respondents said that quarantine did not affect communications in work teams, and they continue to communicate actively; 43,3 % of teachers indicated that they began to communicate scarcer with colleagues, and 12,2 % of respondents had almost no interaction with colleagues. Regarding changes in communication in the family, the majority of respondents (68,9 %) noted that quarantine did not affect their relationships in families ($\chi^2 = 150,2441, p = 0,0000$), in 21,7 % of people the relationship with family members became closer, and only 9,4 % of respondents have complicated family relationships.

The purpose of the survey was also to identify changes in the *professional pedagogical activities* of teachers during online learning and their impact on the quality and effectiveness of the educational process. The objects of study were the choice of educational platform; changes in the time allotted for work and repose; the quality of teaching the subject; quality of scientific and organizational work; feedback quality. The data showed that most teachers worked on a virtual platform chosen by their educational institution ($\chi^2 = 185,9685, p = 0,0000$), and were satisfied with its capabilities ($\chi^2 = 38,68, p < 0,0001$). On the other hand, given the obtained results, it is worth noting the existing internal discomfort in 13,4 % of teachers during online learning.

The identical number of educators note that during the teaching of their discipline the quality of teaching either did not change significantly or was significantly deteriorated ($Z = 0,178565, p = 0,42913958 > 0,05$), Figure 5a. Almost half of teachers surveyed acknowledged the decline in the quality of online learning.

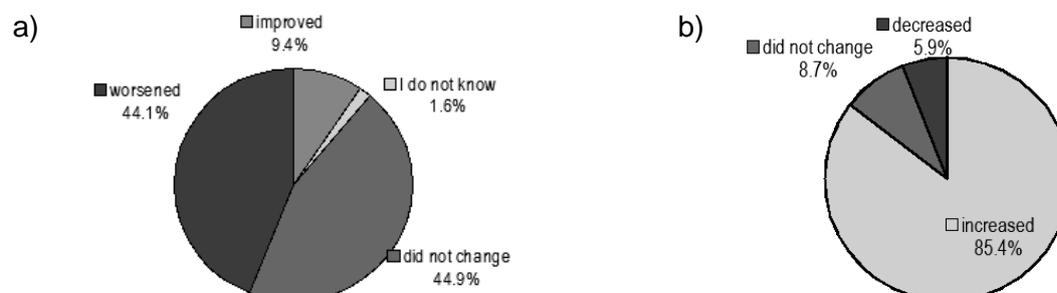


Figure 5. Assessment of teaching quality (a) and changes in time spent working in online learning (b).

An indicator of the change in time that research and teaching staff spend on preparing, giving classes and testing students' knowledge (Fig. 5b) significantly increased ($\chi^2 = 310,5433, p = 0,0000$). The data do not confirm the hypothesis that changes in the distribution of time for educational work were associated with changes in the quality of teaching ($\chi^2 = 8,890964, p = 0,06388 > 0,05$), scientific ($\chi^2 = 2,482111, p = 0,64784 > 0,05$) or organizational ($\chi^2 = 5,239044, p = 0,26364 > 0,05$) work.

The analysis of quality self-assessment of scientific work and organizational work testified that the vast majority of scientific and pedagogical staff did not notice significant changes in the quality of these activities (for scientific: $\chi^2 = 51,315, p < 0,0001$; for organizational: $\chi^2 = 139,5, p = 0,0000$). Among the reasons that hinder scientific work quality, 3.2 % of teachers pointed to the lack of time, as it is busier preparing for online classes. A significantly higher proportion of teachers reported a deterioration in the quality of teaching than a deterioration in scientific ($Z = 2,8564, p = 0,002142352 < 0,05$) or organizational work ($Z = 2,7601, p = 0,002889478 < 0,05$) (Table 3 and Figure 6).

The results of the survey on the use of various forms of organization of the educational process showed that an absolute minority of teachers consider online learning an effective tool for achieving program results ($\chi^2 = 117,1969, p = 0,0000 < 0,05$). The rest of the surveyed research and teaching staff shared their preferences in half between traditional offline and mixed form of learning ($Z = 1,6015, p = 0,054636743 > 0,05$).

Advanced analysis of the data showed the existence of several homogeneous groups (clusters) among higher education teachers in Ukraine, which significantly differs from each other. The dendrogram of combining respondents into clusters based on their answers to the questionnaire (Figure 7) suggests the existence of two clusters.

Table 3. Changes in the quality of scientific and pedagogical staff activities as a result of quarantine measures and the transition to online training based on the results of a survey of higher education teachers in Ukraine.

		Activities of scientific and pedagogical staff		
		educational	scientific	organizational
quality of activity	worsened	112 / 44,1 %	81 / 31,9 %	82 / 32,3 %
	did not changed	114 / 44,9 %	133 / 52,4 %	163 / 64,2 %
	improved	24 / 9,4 %	40 / 15,7 %	9 / 3,5 %
	difficult to answer	4 / 1,6 %		

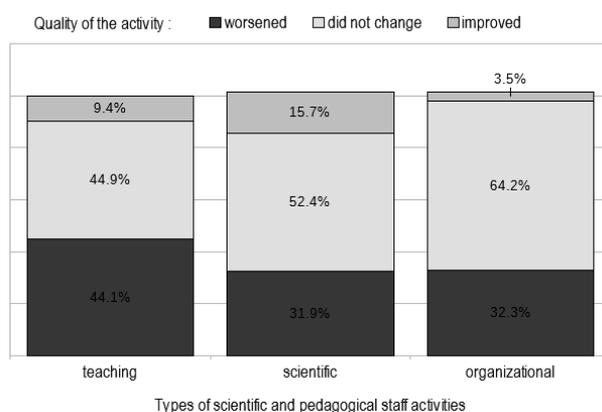


Figure 6. Changes in the quality of scientific and pedagogical staff activities as a result of quarantine measures based on the results of a survey of higher education teachers in Ukraine.

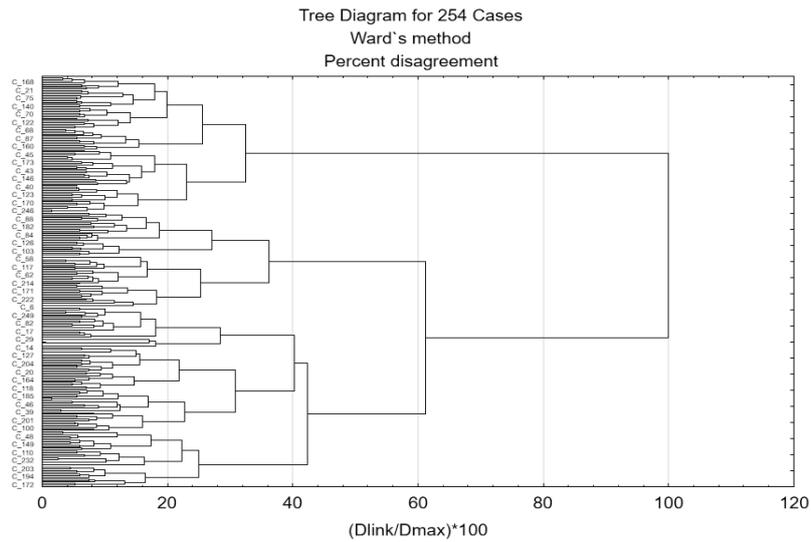


Figure 7. The results of clustering survey data.

A more detailed analysis of the obtained division into clusters showed that, first, they differed in the level of psychological stress, which was significantly higher in the first cluster ($M-W Z = 6,882, p = 5,91625 \times 10^{-12} < 0,05$, Figure 8).

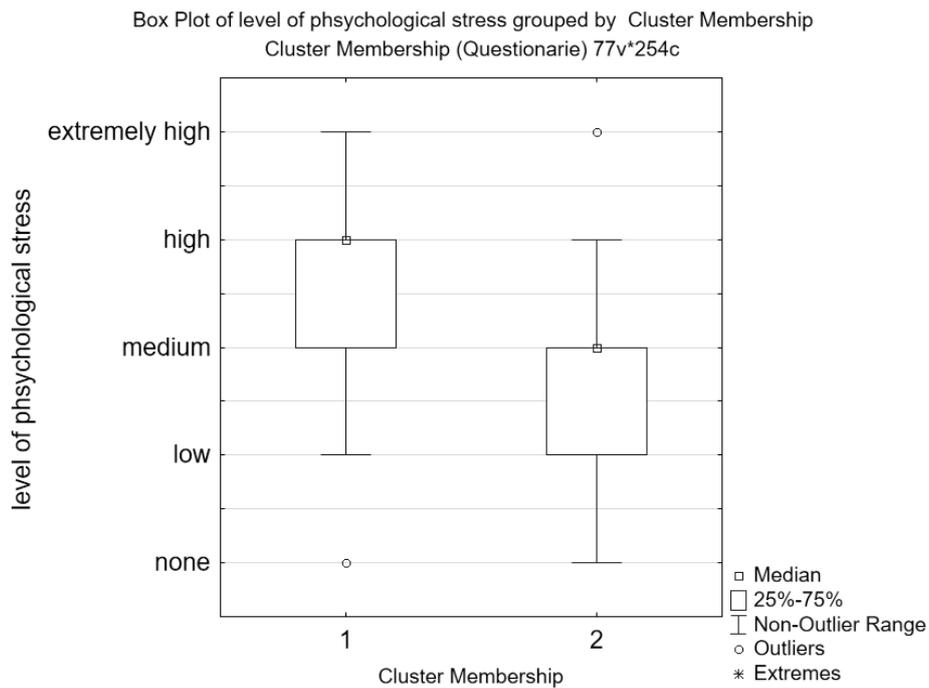


Figure 8. Boxplot of the level of psychological stress in two clusters.

A significant difference between clusters was also observed by the emotional state ($\chi^2 = 37,0999, p = 8,7874 \times 10^{-9} < 0,05$, Figure 9a). Despite the fact that in both clusters the majority characterized their emotional state as changeable, there was significantly greater proportion of teachers in a stable negative state in the first cluster (25 % vs. 5,3 %, $Z = 3,9200, p = 5,42732 \times 10^{-5} < 0,05$), and significantly less teachers from the first cluster, recognized their condition as stable positive (5,95 % vs. 34,12 %: $Z = 6,3159, p = 1,34295 \times 10^{-10} < 0,05$). At the same time, a significantly higher percentage of teachers from the first cluster, admitted that they needed the help of a professional psychologist during the lockdown related to the pandemic (25 % vs. 8,2 %, $Z = 3,2404, p = 0,00059682 < 0,05$).

The percentage of teachers whose anxiety increased significantly as a result of the COVID-19 pandemic was higher in the first cluster than in the second (38,1 % vs. 17,1 %, $Z = 3,4869$, $p = 0,000244355 < 0,05$, Figure 9b). At the same time, in the second cluster, compared to the first, the percentage of teachers who admitted no increase in anxiety was significantly higher (30 % vs. 16,7 %, $Z = 2,4808$, $p = 0,00655103 < 0,05$, Figure 9b).

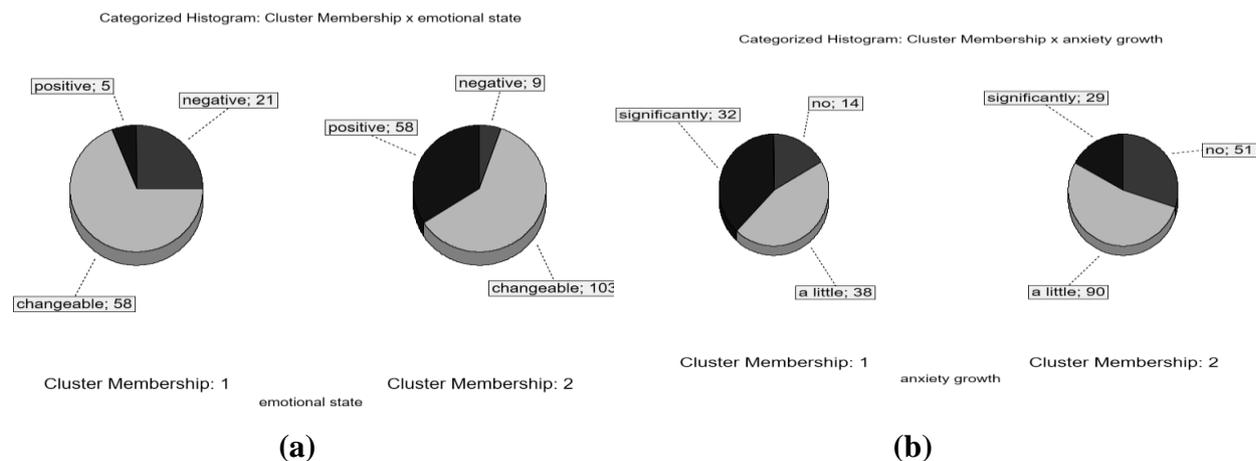


Figure 9. Distribution of teachers by their emotional state (a) and by level of anxiety growth (b) in two different clusters.

Also, teachers who were assigned to the first cluster marked more stressors that affected them during the COVID-19 pandemic and quarantine measures than teachers from cluster 2 (M-W $Z = 2,47339$, $p = 0,013384 < 0,05$). It is noteworthy that in the analysis of differences between clusters in relation to each individual stress factor, significant differences were not found for any of them except for such a stress factor as uncertainty ($\chi^2 = 5,796148$, $p = 0,01606 < 0,05$), i.e. in the first cluster a significantly higher proportion of people noted the uncertainty of the situation as the biggest stress factor compared to the second cluster (63,1 % vs. 47,1 %, $Z = 2,4635$, $p = 0,00687964 < 0,05$).

It should be noted that despite the above differences in psychological state and physiological changes due to quarantine measures between teachers of two clusters, the data of our study do not allow us to say the difference between them in the quality of their professional duties. Thus, the percentage of educators who indicated that their time for teaching during quarantine increased was significantly higher in the first cluster than in the second one (98,8 % vs. 78,8 %, $Z = 5,96684$, $p = 1,20944 \times 10^{-9} < 0,05$), but we find statistically significant differences between clusters neither in the quality of teaching ($\chi^2 = 0,0358$, $p = 0,98226 > 0,05$), nor in the quality of scientific ($\chi^2 = 3,8152$, $p = 0,05079 > 0,05$) so as organizational ($\chi^2 = 0,6695$, $p = 0,71552 > 0,05$) work.

CONCLUSIONS

Present study on the physiological changes and health of research and teaching staff in higher education in Ukraine during the quarantine related to the COVID-19 pandemic showed that online work leads to the deterioration of certain psychosomatic indicators, namely: sleeping disorders, headaches, decreased physical activity, increased anxiety, stress and fatigue, violation of the work-rest regime.

Analysis of the survey data on the psychological state of research and teaching staff shows that the situation caused by the pandemic affected their psychological well-being: most of them increased stress, but at the same time, they found various ways to overcome emotional stress. It was also found that the vast majority of respondents managed to adapt to forced

changes in the conditions of professional activity, the lack of both personal and professional communication; only a small number of respondents admit that they need qualified psychological help.

The study of the impact of the COVID-19 pandemic on professional changes in the pedagogical activities of Ukrainian research and teaching staff of higher education institutions led to the conclusion that educators consider ineffective the use of online learning to achieve learning goals, choosing as an alternative during quarantine, a mixed form of training. Changes in the professional activities of teachers during the distance learning have significantly affected the amount of time allocated to various areas of scientific and pedagogical activities, noting its significant increase in teaching and methodological work, characterized by a large overload of various additional types of work, including the development of distance learning courses, recording of video lectures, preparation and checking assignments, and as a result – lack of free time for repose, which poses a high risk of developing psychological deformations on this basis, and a threat to social and psychological health. Regarding changes in the quality of professional activities, the study showed that in online learning during quarantine, about half of research and teaching staff noted the decline in teaching quality and achievement of educational goals, while the quality of scientific and organizational work of most teachers did not change significantly.

The analysis of the research results revealed the division of teachers into two clusters - teachers who coped with professional changes and easily adapted to new teaching conditions (about two thirds of teachers), and teachers who are forced to work in new conditions according to modern requirements, but for whom the experience of transition turned out to be severe and traumatic. The last group consisted of about a third of teachers. It can be assumed that among the causes of such severe consequences are labor intensity, the need to increase the methodological load and intensity in educational work, as well as unwillingness to use information technology.

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PATH-GOAL THEORY – LEADERSHIP STYLES AND THEIR CHANGES DURING THE COVID-19 PANDEMIC

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ABSTRACT

The most significant leadership theory, within the frame of contingency and situational approaches, is the path-goal theory. This theory is an extension of Vroom's expectancy theory and defines four styles of leadership: directive, supportive, participative, and achievement-oriented. The theory was first defined in the '70s, and since then, numerous studies have been conducted on leaders and subordinates in different industries and countries. Research during the COVID-19 pandemic is underrepresented, especially in Croatia, and the authors identified a research gap. Primary quantitative research was conducted, and data were collected through the questionnaire developed by Northouse (A Path-Goal Theory Investigation of Superior Subordinate Relationships). The research sample encompassed 77 leaders of organizations in the private and public sectors in the Republic of Croatia, and the researchers analysed self-assessment results about leadership styles before and during the COVID-19 pandemic. Data were analysed to obtain insight into the frequency of leadership styles, differences in leadership styles before and during the COVID-19 pandemic, and the impact of gender, level of education, and organization size on leadership style. The results indicate that self-assessment defines minor changes to leadership style preference before and during the pandemic. The results indicate a difference in leadership styles according to gender; women more frequently choose the supportive style of leadership. Furthermore, it emerges that the level of education and the organization size have an impact on other leadership styles in the frame of the path-goal theory.

KEY WORDS

leadership, directive style, supportive style, participative style, achievement-oriented style, COVID-19

CLASSIFICATION

APA: 3640, 3660
JEL: D83, M12

INTRODUCTION

According to Northouse's [1] definition, leadership is a process in which an individual has an impact on a group with the purpose of achieving a common aim. The path-goal theory is one of the most significant approaches to leadership in the frame of contingency theories. Contingency and situational theories are valuable for recommending what leaders must or must not do in defined situations. Northouse [1] claims that this approach is useful in numerous situations and highlights the need for adaptability of the leader. The path-goal theory is focused on the behaviour style of leaders and consideration of the situation and defines the regulations and recommendations that enable achieving group aims [2].

The path-goal theory was established by Evans [3], analysing a leader's behaviour choices in relation to their behaviour style, employees' needs and conditions in the work environment. According to this perspective, the leader is not an individual who uses their power but has a role in support, and this approach is frequently defined as servant leadership. The most significant advancement in path-goal theory was provided by House [4], who examined situation elements within which leaders search for solutions to motivate subordinates. The leadership styles that leaders can implement are directive, participative, supportive, and achievement oriented. At the same time, the work environment has components such as the characteristics of a workgroup, task structure, and formal authority system. Subordinates have characteristics, abilities, and needs. The path-goal theory is based on the motivation theory developed by Vroom [5] and named expectancy theory. Since Vroom theory enables the identification of important things that can be done for the motivation of employees, it has important implications from managers' and leaders' standpoints [6]. According to this theory, subordinates will be motivated in the following situations: If they think that they are able to manage the task, if they believe that their efforts will result in certain success, and if they believe that compensation is in line with their effort [5].

Four types of leader behaviour according to the path-goal theory can be described as follows:

- 1) Supportive leadership includes a concern for the welfare of subordinates and the organizational climate. This type of behaviour tries to achieve a friendly environment [2]. Leaders attempt to meet the requirements, needs, and preferences of subordinates through the supportive style [7]. Subordinates are rewarded in the frame of this leadership style, and their motivation is encouraged. This leadership style accomplishes great results when subordinates are unsatisfied or frustrated.
- 2) Participative leadership enables subordinates to influence the decisions of leaders. Leaders encourage subordinates on critical considerations and suggestions, and leaders consult with them before decision-making [7].
- 3) Directive leadership includes specific guidelines for subordinates and explanations about the expectations for employees. Directive leadership attempts to reduce role ambiguity among subordinates and to clarify their perceptions, which is positive in situations when tasks are unclear and problems are unstructured. When the requirements of subordinates are clear, this type of leader's guidance can have the opposite effect.
- 4) Achievement-oriented leadership is defining challenging aims, searching for higher quality results, followed by the trust that subordinates will achieve the aims [2].

Adequacy of implementation of leadership styles is in a relationship with the situation. Leaders can change their style in line to best serve subordinates, and the same leader can simultaneously implement different styles; however, great leaders need to know when to apply which leadership style [8-10].

Supportive leadership is the most appropriate for subordinates who have the need for belonging, while directive leadership is a good choice for a group of subordinates who tend to need structure. For subordinates who have a need for control, participative leadership is appropriate because it provides them with satisfaction in decision-making. Achievement-oriented and directive leadership are appropriate when subordinates are focused on the possibility of solving the task. Those kinds of subordinates require directive leadership when they think that they have low capabilities, and with higher insight into their capabilities, these subordinates have a lesser need for the directive style. The aim of this leadership style is to boost subordinates' self-confidence. Numerous authors refer to the abovementioned styles of leadership, but Euwema et al. [11] point out directive and supportive behaviour because in previous research, these concepts have been successfully applied for years.

Related to subordinates' and leaders' behaviour, subordinates are allocated to a given type of task, which means that the type of task defines the leadership style. Northouse [12] states that directive leadership is motivating when tasks are complex and rules are unclear. Supportive leadership is motivating when tasks are repetitive. Unclear and unstructured tasks have a need for participative leadership, and challenges and complex tasks require achievement-oriented leadership.

According to the path-goal theory, the right and successful work of subordinates is possible when leaders clearly define tasks to them [12 p.500] and when leaders have the possibility to provide the required education for this work. In addition, leaders must help subordinates in work performance and provide a reward for successfully performing work.

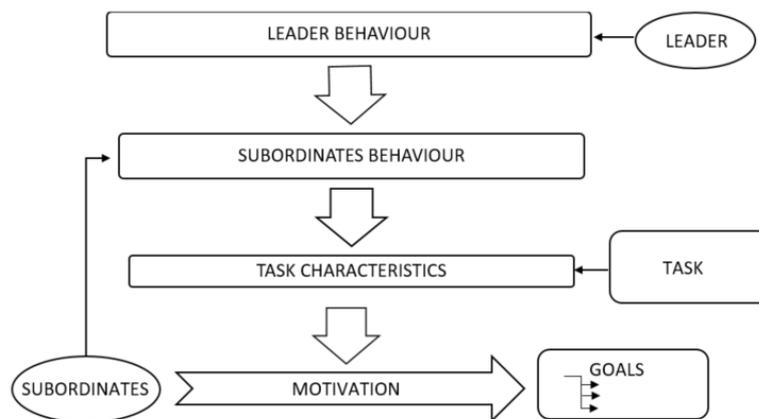


Figure 1. Factors that have an impact on path-goal [12].

The main features of the path-goal theory are clearly defined aims, providing support in performing tasks and rewards according to successful achievement of the aims. The approach to subordinates is relatively personalized because leaders have to define the approach that will be used for each individual and rewards for subordinates. Leaders must provide subordinates with conviction about their ability to meet expectations. Figure 1 shows the factors that impact subordinate motivation to achieve the goal.

LITERATURE REVIEW

In the field of path-goal theory, numerous articles have significantly contributed to this theory. Ever since the establishment of this theory in the '70s, a significant number of studies indicated empirical results in line with theory assumptions, although some results indicated opposite results, which can be explained in applied research methodology [7, 14].

Farhan [15] analysed the application of path-goal leadership theory in a learning organization. With the increasing importance of information and knowledge in the process of creating value, numerous leaders revert to creating learning organizations, in which the majority of employees are involved in the identification and solving of unstructured problems [16]. Farhan [15] states that leadership style is the key support tool for creating learning organizations, especially the participative style, which can be described as the architect of organizational learning. Sarti [17], in their research conducted on Italian human service organizations, validated a hypothesis about the positive relationship between work engagement (dedication and vigour) and implementation of the participative style. Additionally, in this article, Sarti [17] analysed the relationship between work engagement and directive leadership style, and the relationship involved vigour and absorption but not dedication. Another research article [18] defines the directive style as promoting task-oriented behaviour and a tendency to control discussions and dominate interactions. Bell et al. [19] researched the impact of the directive and participative style on organizational culture in university administrative departments in South Africa. The results indicated a positive and significant impact of both styles on organizational culture, which was measured by four cultural facets of involvement, consistency, adaptability, and mission. Furthermore, the relationship between directive and participative leadership styles and the performance of Israeli school staff teams were analysed in an article [20]. Somech [20] states that the directive leadership style has value, especially for leaders (teachers) who operate in an ambiguous work environment. Although participative leadership style is preferred in modern educational policies, that style is not always related to improvement. Depoo & Shanmuganathan [21] researched a multinational organization in the US and identified the relationship between brand management and leadership style within the frame of path-goal theory, and the most representative approaches are a coaching style (which contains the supporting style) and the directive style.

Supportive leadership style is a characteristic behaviour within the frame of path-goal theory and is indicated in most research articles. In the process of organizational changes and learning, it is important that leaders implement a supportive leadership style to manage subordinate anxiety [22]. Furthermore, House [7] indicated that causes of stress that can have an influence on employees dictate the implementation of a supportive leadership style. Khalid et al. [23], who analysed leadership in educational institutions in Pakistan, indicated that “when employees serving in any organization receive support from their leaders, the level of stress decreases and job performance is improved”.

La Rocco and Jones [24] researched the US Navy and indicated that supportive leadership contributes to both job satisfaction and the level of satisfaction with the organization, which was described in the book by Bass and Bass [25]. The relationship between the supportive leadership style and interpersonal helping behaviours was analysed by Rafferty and Griffin [26], under the guiding question “if it is supportive leadership style truly transformational?” Namely, supportive leadership is focused on the satisfaction of subordinates’ wishes, but this can result in the absence of organizational performance [7, 26]. Path-goal theory was analysed in the telecom industry of Pakistan [27]. An analysis of the relationship between all four leadership styles and job satisfaction in telecom companies in Chad was conducted by Dokony et al. [28].

Research in the field of leadership for several decades has focused on transformational leadership, so one-half of the articles are about transformational leadership [29, 30]. Consequently, the study of the path-goal model is not the focus of scientists; this is also the case in Croatia. Udovičić et al. [31] analysed leadership style based on the leadership model developed and established by R. Likert in Croatian entrepreneurship. Furthermore, Miloloža [32] researched the presence of autocratic, democratic, and laissez-faire leadership styles and the relationship between leadership style and the size, growth phase, and international orientation of the organization.

The impact of gender was researched by Van Emmerik et al. [33], who defined the hypothesis “female managers score higher on consideration than male managers”, which includes elements of classical leadership styles: consideration and initiating structure. Consideration refers to friendly and interpersonally supportive supervisory behaviour [34], while initiating structure refers to task-oriented and directive behaviour [34]. Van Emmerik et al. [33] conducted research on a database with 64 000 subordinates from GLOBE societal clusters. GLOBE is a project that addresses the research of practice and values in sectors of industry, organizations, and society [35]. GLOBE indicated ten cultural clusters that involve 61 nations [36]. GLOBE researchers measure culture and try to define its relationship to the effectiveness of leadership. Research results indicated a high mean of measures of consideration (supportive style) among subordinates who have female managers in Nordic countries in the frame of Globe Clusters. In line with expectations, research indicated female leaders achieved better results on measures of consideration style than male leaders. One insight that is outstanding is that female leaders also have a higher level of measures of initiating structure (directive behaviour) than male managers. A key finding of the analysis is “that female and male managers do not differ much in leadership behaviours”, which is related to existing stereotypes regarding gender [33]. Research results conducted by Kent et al. [37] indicated that men and women lead using the same behaviours.

Polston-Murdoch [10] researched the relationship between leadership style and commitment of subordinates according to leaders, relative to leaders’ gender. The results indicated no significant evidence that this relationship is dependent on leaders’ gender. Previous research indicated that “women may be viewed as more supportive and affective with characteristics involving the management of emotions” [38] as stated by Polston-Murdoch [10].

Thacker [39] states that expectations for female leaders are characterized by participative leadership style and behaviours focused on relationships. Lord et al. [40], according to an analysis of the literature, state that females are proven to be more successful leaders in the task of developing supportive relationships with subordinates. Becker et al. [41] state “that the female leaders work in nontraditional roles”. In recent times, the number of articles that are focused on female leadership has increased, and especially prominent examples include the book by Sally Helgesen [42] and the publication of Chamorro-Premuzik [43] on the topic of women’s leadership competency gap. Chamorro-Premuzik [43] argued why male leaders are more often chosen in practice and states that “leaderless groups have a natural tendency to elect self-centred, overconfident and narcissistic individuals as leaders and that these personality characteristics are not equally common in men and women”.

THE COVID-19 PANDEMIC AND LEADERSHIP

In December 2019, in the city of Wuhan, China, the appearance of a disease caused by a coronavirus was reported, which quickly spread to the whole country and later to the world. In February 2020, the meeting of the EU Health Council and Ministers of Health defined conclusions about COVID-19. At the end of February, the impact of the disease COVID-19 on the industry of the European Union was considered by the European Commission [44]. Later, measures defined in all countries had an impact on people’s behaviour, especially in organizations, by coordinating their movement, attendance in the workspace, and contacts, as leaders in organizations and their subordinates had to adapt to new factors in the environment.

One of the rare articles that analyses the path-goal theory in the COVID-19 pandemic situation is Mercedes & Burrell [45]. Their questionnaire (adapted by [46]) addresses assessments of the statement “I create a clear path and vision concerning problems and solutions,” which is related to ideas of the path-goal theory.

The majority of articles related to the COVID-19 environment are not structured within the framework of leadership theory. Leader behaviours in COVID-19 pandemic time, especially in the health system in England, were analysed in a article [47], where academics concluded that “leaders who have excelled are those who have shown compassion, empathy, connectedness and even vulnerability”. Furthermore, leadership in school in the COVID-19 pandemic was researched by Harris and Jones [48], where the authors state that “leading in disruptive times means being able to navigate a different course, to create new pathways through the disruption”. Research conducted by Lee [49] in the United Kingdom analysed the need to create an environment where leaders support subordinates. Antonakis [50] claims that they trust that scientists will recognize the need to study leadership because it is an effective tool that has to be used in the fight against the viral pandemic.

Research that appreciates and refers to the leadership theory frame includes a article by Claus [51], in which she defines a new approach to leadership research, New Leadership Practices and Skills Due to COVID-19, with three dimensions: leading organizations in turbulent times, leading a distributed workforce (individuals and teams), and being a resilient leader. All of these dimensions [51] elaborate expectations from leadership. Watkins & Clevenger [52] analysed politicians in the US through the prism of two dimensions, context and control, and stated that the framework has the aim of demonstrating how leadership style affects crisis behaviour and communication. Behaviour in crisis leadership was described by Boin et al. [53]. Eichenauer et al. [54] researched leadership behaviour during COVID-19 through task assessment, activities (planning, clarifying, supporting, and empowering), and differences between female and male leaders. Furthermore, academics researched stereotypes that females lead to more communal behaviour and males lead to more agentic behaviour [55] and indicated a small difference in behaviour.

Chen and Sriphon [56] researched leadership in organizations in Asia according to the relationship between the following constructs: (1) trust, (2) communal relationships, and (3) social exchange relationships and characteristic factors of COVID-19. The most important results are that remote work interrupted trust and relationships between leaders and employees during pandemics.

RESEARCH GAPS AND RESEARCH ISSUES

Leadership research in the COVID-19 pandemic is present and growing, although the number of articles focusing on path-goal theory is not particularly exceptional; therefore, it is worth covering this area, especially in regard to the situation in Croatia. Furthermore, research on leadership styles of Croatian managers is relatively underrepresented. Among the potentially interesting issues here is the segment related to women in the role of leaders. Guided by these observed gaps, we formulated the following research questions:

- RQ1. Under pandemic circumstances, did leaders in Croatian organizations change their leadership style?
- RQ2. Do leaders in Croatian organizations have a difference in leadership styles based on gender?
- RQ3. Is the dominant leadership style subject to the influence of other factors, such as the leader’s age and level of education and the organization’s size?

METHOD AND RESEARCH

We conducted a survey of leadership practice in the Republic of Croatia through the PGT model at the end of 2021, with the aim of addressing research issues. It should be noted that in the middle of the last year, there were approximately 170 000 active business entities in the country. The corresponding questionnaire was sent by e-mail to approximately 1950 randomly

selected addresses of experts and managers, and we had no knowledge of the positions of individuals in their organizations. Therefore, it was suggested that the answer to the questionnaire be provided only by managers or leaders in their companies. The questionnaire, is presented in the Appendix section, is taken from the author Northouse [1, pp.145-146] and includes 20 self-assessment questions regarding the frequency of application of characteristic leadership styles, according to R. House theory [4].

We received 77 valid responses, of which seven respondents failed to give an overview of leadership practices before the COVID-19 pandemic. Since we did not have information about the positions of individuals in organizations when sending the questionnaire, the questionnaire also received a large number of experts who are not in leadership positions. They were not expected to send a response. Therefore, the real response rate of leaders is significantly higher than the 77/1950 ratio. The basic demographics of the sample relevant to the research questions is presented in Table 1.

Table 1. Leadership questionnaire – sample structure.

Characteristics	Number	Percentage, %
Gender		
Male	44	57,1
Female	33	42,9
Leader's education		
Up to Bachelor's degrees	21	27,3
Bachelor's, master's, or doctoral degrees	56	72,7
Organizational size		
Micro and small enterprises	40	51,9
Medium and large organisations	37	48,1
Sector		
Public or state	11	14,3
Enterprises	66	85,7

RESEARCH INSTRUMENT

For the purposes of this research, a questionnaire of the PGT model by Northouse [1, pp.145-146] was used, which is based on the self-assessment of the managers and is presented in the Appendix. The author adapted the questionnaire according to the works of Indvik [56, 57]. The questionnaire contains twenty statements relevant to leadership styles to which leaders responded by selecting numbers in the range 1-7, where one indicates disagreement with the statement and seven, full agreement. In concluding the frequency of application of a particular characteristic style, according to the PGT, the following rules are followed [1]: first reverse the scores for Items 7, 11, 16, and 18; then calculate for the directive style assessment: sum the scores on Items 1, 5, 9, 14, and 18; for supportive style assessment: sum the scores on Items 2, 8, 11, 15, and 20; for participative style assessment: sum the scores on Items 3, 4, 7, 12, and 17; for achievement-oriented style assessment: sum the scores on Items 6, 10, 13, 16, and 19. According to suggestions [1], the assessment of achievement (high, common, low) is presented in Table 2.

Table 2. Classifying achievements by styles.

	Considered high	Common score	Considered low
Directive style	above 28	23	below 18
Supportive style	above 33	28	below 23
Participative style	above 26	21	below 16
Achievement-oriented style	above 24	19	below 14

METHODS

The collected data were analysed using statistical methods, IBM SPSS FP v28 and JASP v0.16. Principal component analysis was applied to determine the components that describe and factorize the respondents' answers. Then, the t test was applied to the variants paired samples test and independent samples test. The paired samples test was used to determine whether there was a change in the frequency between the prepandemic and COVID-19 pandemic cases. In investigating the potential significant differences between groups (Table 1) regarding the frequency of choosing a particular leadership style, the independent samples t test was applied. Since the assumption of normal distribution was not met when testing some groups in the sample, the Mann–Whitney U test was also used to determine significant differences between groups in arrangement with independent groups. As an alternative to the t test, in the absence of conditions for distribution normality, the nonparametric Wilcoxon signed ranks test method was applied. This test was used in the analysis of data for related dependent groups, i.e., for the purpose of determining differences in the frequency of leadership styles in two time periods among the same respondents.

RELIABILITY AND VALIDITY ANALYSIS

Respondents' answers to 2 questionnaires (prepandemic leadership status and leadership styles during the COVID-19 pandemic) were tested using the Alpha-Cronbach method. These include 70 answers to the first questionnaire of 20 questions and 77 answers to the second questionnaire. It turns out that this factor indicating consistency for the overall set of responses results in a Cronbach's alpha = 0,92 (Table 3), which can be considered an excellent indicator of reliability, according to, for example, Cortina [58].

Table 3. Reliability Statistics.

Reliability Statistics		
Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
,924	.925	40

We also checked the internal consistency among the respondents' answers which focused on leadership during the COVID-19 pandemic (77 of them), and the result as a factor indicating consistency was Cronbach's alpha = 0,84. This can be considered a very good fulfilment of the conditions of reliability.

To determine the adequacy of the data, we also applied a validity analysis through the Kaiser–Meyer–Olkin (KMO) test. The idea behind this check is to gain insight into the adequacy of the sample data before performing the factor analysis procedure. The preferred value of the KMO test is 0.5 or slightly more [59], and Bartlett's aspherical value should have significance. We see that these conditions are met since the KMO factor is 0,711 (Table 4). This score suggests that there are sufficient items for each factor.

Table 4. Sampling adequacy – KMO test.

KMO and Bartlett's Test		
Kaiser–Meyer–Olkin Measure of Sampling Adequacy		0,711
Bartlett's Test of Sphericity	Approx. Chi-Square	660,070
	df	190
	Sig.	< 0,001

For the results of the leadership questionnaire during the COVID-19 pandemic, we performed an analysis using the SPSS tool, applying principal component analysis. In doing so, we preferred to identify four factors, expecting the agreement of the individual components

(Table 5) with the characteristic items of individual leadership styles. In addition, the rotation method varimax with Kaiser normalization (rotation converged in 6 iterations) was applied.

Table 5. Principal Component Analysis.

Rotated Component Matrix ^a				
	Component			
	1	2	3	4
Q1	0,049	0,384	0,656*	0,049
Q2	0,522*	-0,456	0,254	0,068
Q3	0,802*	-0,089	0,065	-0,035
Q4	0,708*	0,110	0,235	0,011
Q5	0,423	0,072	0,600*	0,007
Q6	0,038	0,722*	0,385	-0,009
Q7	0,493*	0,106	-0,339	0,352
Q8	0,447	0,160	0,192	0,099
Q9	0,152	0,141	0,797*	0,116
Q10	0,152	0,677*	0,228	-0,282
Q11	0,030	-0,111	0,146	0,814*
Q12	0,751*	0,329	-0,068	-0,102
Q13	0,573*	0,226	0,334	-0,083
Q14	0,358	0,616*	0,242	0,047
Q15	0,607*	0,093	0,341	0,067
Q16	-0,002	0,033	0,048	0,746*
Q17	0,701*	0,342	-0,010	-0,183
Q18	0,021	0,019	-0,027	0,689*
Q19	0,159	0,840*	-0,004	0,157
Q20	0,709*	-0,025	0,019	0,173

The obtained results can be interpreted in such a way that if we set the threshold of the importance of impact/weight to approximately 0.5 (allowing 0.49; marked with an asterisk *), then we determine the state of components in terms of leadership styles, taking into account the description of the research instrument by style:

- *component 1* – participative style (questions 3, 4, 7, 12, and 17) and supportive style (questions 2, 8, 11, 15, and 20) explain 8 of the 9 main contributions of component 1, which enter with weights $\geq 0,5$; (listed questions marked bold),
- *component 2* – achievement-oriented style (questions 6, 10, 13, 16, and 19) explains 3 of the 4 main contributions of component 2, which enter with weights $\geq 0,5$; (listed questions marked bold),

- *component 3* – directive style (questions 1, 5, 9, 14, and 18) explains 3 of the 3 main contributions of component 3, which enter with weights ≥ 0.5 ; (listed questions marked bold),
- *component 4* – inverted answers (questions 7, 11, 16, and 18) explain 3 of the 3 main contributions of component 4, which enter with weights ≥ 0.5 ; (listed questions marked bold).

Thus, the questionnaire distinguishes directive style and achievement-oriented style, while supporting and participative leadership styles place in the same factor (in component 1). What obviously had an impact on the respondents was the appearance of inverted answers where high agreement with the statement was converted into a small contribution to the corresponding leadership style and vice versa. Namely, if a certain model of selection that includes a frequent preference for higher grades (e.g., 6 and 7) suddenly asked for a grade that should be low (for example, 1 or 2), it is possible that this created some confusion among respondents.

Overall, we can assume that the self-assessment questionnaire on the frequency of leadership styles [1] contains relatively separate components that describe these styles.

RESULTS

THE DOMINANT STYLE IN THE REPERTOIRE OF LEADER BEHAVIOUR

Considering all the specific leadership styles that an individual leader can present in his or her repertoire of behaviours over time, we have formulated Table 6, which considers three levels of frequency of application of individual styles. It should be noted that the highest level regarding direct leadership is achieved in as many as 66.2 % of cases, while for this style, there are no cases of low performance. Results are similar to the style of achievement orientation, where as many as 74 % of respondents have a high level of achievement. The participative style has a highest level in 41.5 % of cases. It should be emphasised again how the path–goal questionnaire provides information about which style of leadership is applied how often [1, pp. 147].

Table 6. Frequency of leadership styles by level.

	Directive style	Supportive style	Participative style	Achievement oriented style
Average score	29,662	29,338	25,610	26,714
High level (No.)	51	9	32	57
Low level (No.)	0	2	0	0
High I. (%)	66,23	11,69	41,56	74,03

The supportive style stands out because only 11,7 % of respondents represent this style with the highest level of frequency, and in addition, there are established results of very low representation (in 2 cases), which was not noted in other styles. Therefore, this style has a low frequency given the basic, pre-survey expectations.

THE IMPACT OF THE COVID-19 PANDEMIC ON LEADERSHIP STYLE

Respondents answered questions about their approach to leadership during the pandemic (also when the questionnaire was implemented) and before the pandemic period. To determine possible changes in preferences regarding leadership style, in this part of the results, we analyse for each of the 20 questions — is there a statistically significant difference between the answers of respondents? The t test method was therefore applied for the same sample but with records for two time periods, meaning “the paired samples t test” (SPSS), which compares the mean values of two measurements taken from the same respondent.

Since we are not only interested in strict statistical significance, we performed this test first without checking the sample normality prerequisites (Table 7).

Table 7. Paired Samples Test (before the pandemic and during the pandemic).

Paired Samples Test										
Pair		Paired Differences					t	df	Significance	
		Mean	Std. Dev.	Std. Error Mean	95 % Confidence				One-Sided p	Two-Sided p
					Lower	Upper				
1	Q1 BCov - Q1	,000	,482	,058	-,115	,115	,000	69	,500	1,000
2	Q2 BCov - Q2	,129	,588	,070	-,012	,269	1,830	69	,036	,072
3	Q3 BCov - Q3	-,057	,447	,053	-,164	,049	-1,070	69	,144	,288
4	Q4 BCov - Q4	-,014	,399	,048	-,109	,081	-,300	69	,383	,765
5	Q5 BCov - Q5	-,071	,393	,047	-,165	,022	-1,522	69	,066	,133
6	Q6 BCov - Q6	,000	,417	,050	-,099	,099	,000	69	,500	1,000
7	Q7 BCov - Q7	,057	,508	,061	-,064	,178	,942	69	,175	,349
8	Q8 BCov - Q8	-,043	,464	,055	-,154	,068	-,772	69	,221	,443
9	Q9 BCov - Q9	-,057	,376	,045	-,147	,033	-1,270	69	,104	,208
10	Q10 BCov - Q10	,086	,474	,057	-,027	,199	1,514	69	,067	,135
11	Q11 BCov - Q11	,086	,474	,057	-,027	,199	1,514	69	,067	,135
12	Q12 BCov - Q12	-,071	,428	,051	-,173	,031	-1,396	69	,084	,167
13	Q13 BCov - Q13	-,029	,380	,045	-,119	,062	-,630	69	,265	,531
14	Q14 BCov - Q14	-,057	,336	,040	-,137	,023	-1,425	69	,079	,159
15	Q15 BCov - Q15	,029	,339	,041	-,052	,109	,705	69	,242	,483
16	Q16 BCov - Q16	,014	,399	,048	-,081	,109	,300	69	,383	,765
17	Q17 BCov - Q17	,014	,434	,052	-,089	,118	,276	69	,392	,784
18	Q18 BCov - Q18	-,071	,393	,047	-,165	,022	-1,522	69	,066	,133
19	Q19 BCov - Q19	,000	,241	,029	-,057	,057	,000	69	,500	1,000
20	Q20 BCov - Q20	-,043	,316	,038	-,118	,032	-1,136	69	,130	,260

In Table 7 and further in the article, BCov stands for “Before COVID-19“. Regarding stricter conditions, if we take into account the threshold $p < 0.1$ with two 2-sided p , we obtain the result that a significant difference exists only in question number 2. This second question concerns maintaining friendly working relations with subordinates (Appendix). With the criteria mitigated, considering one-sided p with significance ($p < 0.1$), i.e., looking at the indication in which direction the changes are going, then the following results are obtained for queries: Q5 (I inform subordinates about what needs to be done and how it needs to be done), Q9 (I ask subordinates to follow standard rules and regulations.), Q10 (I set goals for subordinates’ performance that are quite challenging), Q11 (I say things that hurt subordinates’ personal feelings), Q12 (I ask for suggestions from subordinates concerning how to carry out assignments), Q14 (I explain the level of performance that is expected of subordinates), and, at the end, Q18 (I give vague explanations of what is expected of subordinates on the job).

However, testing the normality for differences between pairs of scores on the same questions where significant differences are inferred, we obtain a result that indicates that there is not a normal distribution (Table 8).

Table 8. Normality-Paired Samples.

Tests of Normality						
	Kolmogorov–Smirnov*			Shapiro–Wilk		
Statistic	df	Sig.	Statistic	df	Sig.	Statistic
Q2	0,472	70	< 0,001	0,503	70	<0,001
Q5	0,486	70	< 0,001	0,445	70	<0,001
Q10	0,500	70	< 0,001	0,392	70	<0,001
Q11	0,515	70	< 0,001	0,295	70	<0,001
Q12	0,466	70	< 0,001	0,514	70	<0,001
Q14	0,482	70	< 0,001	0,448	70	<0,001
Q18	0,529	70	< 0,001	0,181	70	<0,001

*Lilliefors Significance Correction

Therefore, we cannot even accept the results from Table 7 for the t test, and consequently, we consider the solution provided by the nonparametric test below in question Q2. or the case of related samples it is possible to apply the Wilcoxon signed rank test (Table 9), which does not require the condition of a normal distribution of differences. The obtained result shows a statistically significant difference at the level of $p < 0.1$.

Table 9. Related samples – Q2 (PGT questionnaire) Wilcoxon Signed Rank Test.

Test Statistics ^a	
	2. I maintain a friendly working relationship with subordinates. – 2. I maintain a friendly working relationship with subordinates. (BCov)
Z	-1,812 ^b
Asymp. Sig. (2-tailed)	0,070

^aWilcoxon Signed Rank Test^bBased on positive ranks

The next thing that was done as part of the examination of the impact of the COVID-19 pandemic on leadership style was to summarize the answers to specific groups of questions to determine the results for specific leadership styles. Therefore, a calculation was made according to the instructions from the questionnaire [1] for each individual leadership style, and a characteristic sum is relevant, both at the time of the COVID-19 pandemic and before the pandemic period. Table 10 contains the results for the average values of the four PGT leadership styles.

Table 10. Paired Samples – Typical PGT leadership styles before and during a pandemic.

Paired Samples Statistics					
		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Directive style	29,44	70	3,713	0,444
	Directive style BCov	29,19	70	3,589	0,429
Pair 2	Supportive style	29,23	70	3,477	0,416
	Supportive style BCov	29,39	70	3,427	0,410

Table 11. Paired Samples – Typical PGT leadership styles before and during a pandemic. (continuation from p. 360)

Pair 3	Participative style	25,33	70	4,416	0,528
	Participative style BCov	25,26	70	4,393	0,525
Pair 4	Achievement-oriented style	26,43	70	4,060	0,485
	Achievement-oriented style BCov	26,69	70	3,794	0,453

Below, we analyse the overall results according to the preferred leadership styles because we are interested in the difference in the situation before and after the pandemic. Using two tests of normality, Kolmogorov–Smirnov and Shapiro–Wilk, we find differences in related pairs belonging to certain styles (before the pandemic and at the time of the pandemic) that do not meet the condition of normal distribution.

Therefore, we approached the application of nonparametric methods, specifically the Wilcoxon Signed Rank Test, for two samples of connected subjects. The final result indicates a statistically significant difference in the directive style, where the average frequency of this style before the pandemic was higher than during the COVID-19 pandemic. We interpret the results in Table 11 through the rule that a positive z score indicates a negative difference and vice versa.

Table 12. PGT leadership styles: Related Samples – Wilcoxon Signed Rank Test.

Test Statistics^a				
	Directive style BCov – Directive style	Supportive style BCov – Supportive style	Participative style BCov – Participative style	Achievement-oriented style BCov – Achievement-oriented style
Z	-2,517 ^b	1,093 ^c	-0,353 ^b	-1,659 ^c
Asymp. Sig. (2-tailed)	0,012	0,274	0,724	0,097

^aWilcoxon Signed Ranks Test

^bBased on positive ranks

^cBased on negative ranks

Using the nonparametric Wilcoxon Signed Rank Test, which is equivalent to the t test for dependent samples, we confirm a statistically significant difference in the frequency change of the directive style (with $p < 0.05$) and an indication of the change in the achievement-oriented style frequency (with $p < 0.1$) within the answers to both questionnaires (70 of them).

THE DIFFERENCE IN LEADERSHIP STYLES WITH RESPECT TO GENDER

To research whether gender influences the outcomes regarding the choice of leadership style, i.e., the frequency of certain styles according to PGT, a t test was applied to the answers related to the period of work and leadership in the COVID-19 pandemic. Data on the groups “male” and “female” are contained in Table 1, while in Table 12 there is a label 1 for the group of male respondents (44 of them) and a label 2 for the group of female respondents (33 of them).

Table 13. The influence of gender on leadership styles – group statistics.

Group Statistics					
	Gender	N	Mean	Std. Deviation	Std. Error Mean
Directive style	1	44	29,20	3,508	,529
	2	33	30,27	3,891	,677
Supportive style	1	44	28,70	3,638	,548
	2	33	30,18	3,066	,534
Participative style	1	44	25,66	4,446	,670
	2	33	25,55	4,459	,776
Achievement-oriented style	1	44	26,36	3,792	,572
	2	33	27,18	4,482	,780

The results of the t test method for independent samples are shown in Table 13. Given the prevalence of the supportive style, there is a visible difference between the two groups with a significance of $p < 0.1$ regardless of the assumption: “Equal variances (not) assumed“. The group of female respondents more often applies a supportive leadership style, at the level of significance $p < 0.1$.

Table 14. The influence of gender on leadership style: t test.

		F	Sig.	t	df	Significance		Mean Difference	Std. Error Difference	95 % Confidence	
						One-Sided p	Two-Sided p			Lower	Upper
Directive style	EV assumed	,461	,499	-1,262	75	,105	,211	-1,068	,847	-2,755	,618
	EV not assumed			-1,243	64,943	,109	,218	-1,068	,859	-2,785	,648
Supportive style	EV assumed	,699	,406	-1,883	75	,032	,064	-1,477	,784	-3,040	,085
	EV not assumed			-1,930	73,920	,029	,057	-1,477	,765	-3,002	,048
Participative style	EV assumed	,043	,836	,111	75	,456	,912	,114	1,025	-1,928	2,156
	EV not assumed			,111	68,974	,456	,912	,114	1,025	-1,932	2,159
Achievement-oriented style	EV assumed	,925	,339	-,866	75	,195	,389	-,818	,944	-2,699	1,063
	EV not assumed			-,846	62,226	,200	,401	-,818	,967	-2,752	1,115

In Table 13, “EV“ means equal variances. For the application of the t test, we wanted the tested and validated samples to meet the necessary prerequisites, such as independence, normality, and approximately equal variance [61]. The normality of the distribution was checked by the Shapiro–Wilk test (Table 14). Since the null hypothesis for the Shapiro–Wilk test is that the variable is normally distributed in some populations and that the null hypothesis is rejected if $p < 0.05$, we note here that the normality condition for the directive

style distribution is not met. However, for the supportive style, the condition of the normal distribution of the variable is satisfied.

Table 15. The influence of gender on leadership style – test of normality (Shapiro–Wilk).

Test of Normality (Shapiro–Wilk)			
	GG G	W	p
Directive style	1	0.949	0.051
	2	0.905	0.007
Supportive style	1	0.971	0.337
	2	0.957	0.219
Participative style	1	0.971	0.328
	2	0.960	0.266
Achievement-oriented style	1	0.982	0.716
	2	0.955	0.189

*Significant results suggest a deviation from normality

Thus, looking at genders, we obtained a statistically significant difference $p < 0.1$ in favour of females for the frequency of applying a supportive leadership style. No statistically significant difference was found between groups of respondents formed by gender for other leadership styles.

INFLUENCE OF OTHER FACTORS ON PARTICULAR LEADERSHIP STYLES – THE SIZE OF THE ORGANIZATION AND THE DEGREE OF LEADER EDUCATION

Investigating the impact of environmental factors related to the size of the organization, we identified two independent groups of respondents, 40 from the category “Micro and small enterprises“ (label 1 in Table 15) and 37 from the category “Medium and large organizations“ (label 2 in Table 15).

Table 16. The influence of organizational size on leadership style – group statistics.

Group Statistics					
	Size	N	Mean	Std. Deviation	Std. Error Mean
Directive style	1	40	28,90	3,740	,591
	2	37	30,49	3,501	,576
Supportive style	1	40	29,75	3,402	,538
	2	37	28,89	3,518	,578
Participative style	1	40	26,20	4,416	,698
	2	37	24,97	4,400	,723
Achievement-oriented style	1	40	26,38	3,940	,623
	2	37	27,08	4,278	,703

Using the *t test* method for independent samples formed on the basis of size, the results obtained on the frequency of styles are shown in Table 16.

Table 17. The influence of organizational size on leadership style: *t test*.

		F	Sig.	t	df	Significance		Mean Difference	Std. Error Difference	95 % Confidence	
						One-Sided p	Two-Sided p			Lower	Upper
Directive style	EV assumed	1,004	,320	-1,917	75	,029	,059	-1,586	,827	-3,235	,062
	EV not assumed			-1,922	74,988	,029	,058	-1,586	,825	-3,230	,057
Supportive style	EV assumed	,111	,739	1,088	75	,140	,280	,858	,789	-,713	2,430
	EV not assumed			1,086	74,065	,140	,281	,858	,790	-,716	2,432
Participative style	EV assumed	,168	,683	1,220	75	,113	,226	1,227	1,005	-,776	3,230
	EV not assumed			1,221	74,575	,113	,226	1,227	1,005	-,776	3,230
Achievement-oriented style	EV assumed	,090	,765	-,754	75	,227	,453	-,706	,936	-2,572	1,159
	EV not assumed			-,752	73,110	,227	,455	-,706	,939	-2,578	1,166

There was a statistically significant difference between the groups in terms of the frequency of application of the leadership style, with $p < 0.1$. For other styles, there was no difference with the feature of statistical significance.

Furthermore, we apply the test of normality (Shapiro–Wilk) to test the assumption of distribution normality, and here, we obtain a specific deviation result for Group 2 (medium and large enterprises) in the distribution for the directive leadership style (Table 17). Since the normality test for directive style suggests a deviation, we must seek confirmation of the results by another method. We therefore apply the nonparametric Mann–Whitney U test, which is commonly used when there is doubt about the normality of the sample distribution. This test is suitable for ordinal variables, such as scoring outcomes using the Likert 7-point scale, and can be applied to independent samples when there is no normal distribution of variables.

Table 18. The influence of size on leadership style – test of normality (Shapiro – Wilk).

Test of Normality (Shapiro–Wilk)			
	G	W	p
Directive style	1	0.967	0.282
	2	0.877	< .001*
Supportive style	1	0.966	0.276
	2	0.957	0.164
Participative style	1	0.970	0.370
	2	0.978	0.645
Achievement-oriented style	1	0.976	0.536
	2	0.976	0.578

*Significant results suggest a deviation from normality

The results obtained using both student’s t test and the Mann–Whitney U test are shown in Table 18. The JASP statistical tool was used to apply and compare both methods. The Mann–Whitney test also suggests a statistically significant difference in groups formed by organization size and for the frequency of directive leadership style, even with a stricter parameter for statistical significance ($p < 0.05$).

Table 19. The influence of size on leadership style – Student test and Mann–Whitney test.

Independent Samples T Test				
	Test	Statistic	df	p
Directive style	Student	-1.917	75	0.059
	Mann–Whitney	537.500		0.038
Supportive style	Student	1.088	75	0.280
	Mann–Whitney	846.500		0.278
Participative style	Student	1.220	75	0.226
	Mann–Whitney	848.500		0.269
Achievement-oriented style	Student	-0.754	75	0.453
	Mann–Whitney	654.000		0.382

The application of directive leadership style in larger organizations is more frequent in the sample, with statistical significance of $p < 0.05$. Frequency in other leadership styles does not “feel” the effect of the contingency size factor (Table 18). Since one of the conditions for the application of the Mann–Whitney U test states that the shapes of distributions by groups must meet the requirement of similarity, based on the analysis of Figure 2, we can say that a certain degree of similarity exists.

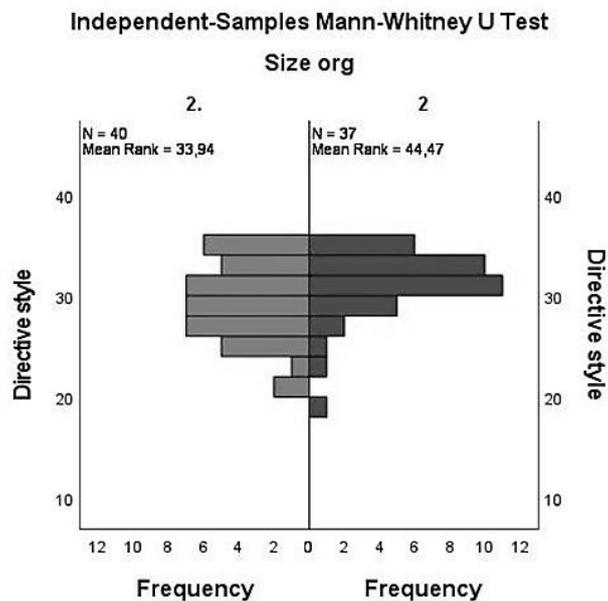


Figure 3. Sample similarity (size) – Mann–Whitney test.

Determining the impact of education level on the frequency of leadership styles according to PGT was the next task. As noted in Table 1, we identified two independent groups of respondents, 21 from the category “Up to Bachelor’s degree“ and 56 from the category “Bachelor’s, master’s, and doctoral degrees“. In Table 19, mark 1 is for the group “Up to Bachelor’s degree“, while mark 2 is for the group “Bachelor’s, master’s, and doctoral degrees“.

Table 20. The influence of education on leadership.

Group Statistics					
	Educational level	N	Mean	Std. Deviation	Std. Error Mean
Directive style	1	21	30,57	4,106	,896
	2	56	29,32	3,501	,468
Supportive style	1	21	29,38	3,918	,855
	2	56	29,32	3,314	,443
Participative style	1	21	26,24	5,674	1,238
	2	56	25,38	3,887	,519
Achievement-oriented style	1	21	28,29	4,256	,929
	2	56	26,13	3,908	,522

Table 20 contains the results of the t test, assuming a normal distribution. A statistically significant result was recorded in the PGT leadership style “achievement-oriented style“. The group of respondents who have lower formal education estimate a higher frequency of applying achievement-oriented leadership style compared to the more educated group. A statistically significant difference was defined as $p \leq 0.05$.

Table 21. The influence of education on leadership style – t test.

		F	Sig.	t	df	Significance		Mean Difference	Std. Error Difference	95 % Confidence	
						One-Sided p	Two-Sided p			Lower	Upper
Directive style	EV assumed	,102	,750	1,330	75	,094	,187	1,250	,940	-,622	3,122
	EV not assumed			1,237	31,542	,113	,225	1,250	1,011	-,810	3,310
Supportive style	EV assumed	1,223	,272	,067	75	,473	,947	,060	,892	-1,717	1,836
	EV not assumed			,062	31,356	,476	,951	,060	,963	-1,903	2,022
Participative style	EV assumed	6,027	,016	,761	75	,225	,449	,863	1,135	-1,397	3,124
	EV not assumed			,643	27,353	,263	,526	,863	1,343	-1,890	3,616
Achievement-oriented style	EV assumed	,245	,622	2,109	75	,019	,038	2,161	1,025	,120	4,202
	EV not assumed			2,028	33,433	,025	,051	2,161	1,066	-,006	4,327

Furthermore, we apply the test of normality (Shapiro–Wilk) to test the assumption of distribution normality, and here, we obtain the result of the deviation of both groups in the directive style and Group 2 in the supportive style. The results are shown in Table 21. The variables in the achievement-oriented style assessment satisfy the normality test.

Table 22. The influence of education on leadership style – test of normality (Shapiro–Wilk).

Test of Normality (Shapiro–Wilk)			
	G	W	p
Directive style	1	0.861	0.007
	2	0.955	0.035
Supportive style	1	0.937	0.191
	2	0.956	0.038
Participative style	1	0.956	0.439
	2	0.977	0.345
Achievement-oriented style	1	0.968	0.697
	2	0.969	0.159

*Significant results suggest a deviation from normality

Since in assessing the impact of a leader’s level of education on styles, we have a group with N = 21 members, this is an additional argument that the conclusions are checked using the Mann–Whitney test, as a nonparametric test for which there are no strict prerequisites.

Table 23. The influence of leadership style – Mann–Whitney test.

Hypothesis Test Summary				
	Null Hypothesis	Test	Sig.^a	Decision
1	The distribution of Directive style is the same across categories of education level	Independent-Samples Mann–Whitney U Test	,089	Retain the null hypothesis.
2	The distribution of Supportive style is the same across categories of education level	Independent-Samples Mann–Whitney U Test	,918	Retain the null hypothesis.
3	The distribution of Participative style is the same across categories of education level	Independent-Samples Mann–Whitney U Test	,315	Retain the null hypothesis.
4	The distribution of Achievement-oriented style is the same across categories of education level	Independent-Samples Mann–Whitney U Test	,041	Reject the null hypothesis.

^aThe significance level is ,050, asymptotic significance is displayed

Table 22 contains the results of the independent samples test, and the conclusion is unchanged, so with a significance level of $p < 0.05$, the hypothesis of equal distribution for achievement-oriented style in groups of more educated and less educated leaders is rejected.

Finally, regarding the similarity of the distribution samples, we analysed Figure 3, and we can conclude that a degree of similarity between the samples exists. The results for Group 1 on the y-axis appear at slightly higher levels and end at higher levels, and the highest frequency is also at higher levels compared to Group 2.

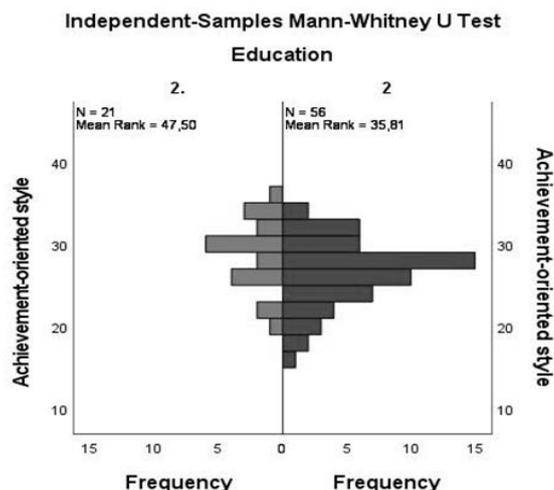


Figure 3. Sample similarity (education) – Mann–Whitney test.

DISCUSSION

The first goal of the research in this article was to determine whether and to what extent the impacts of the COVID-19 pandemic are reflected in leadership styles, defined through the PGT model. Using a questionnaire presented by Northouse [1], we examined the observations of leaders in Croatian organizations regarding the frequency of applying certain leadership styles. Looking at the individual questions contained in the instrument, only question Q2 (Appendix) was marked by a statistically significant difference ($p < 0.1$), so the statement “I maintain a friendly working relationship with subordinates“ in the period of a pandemic is less accurate, and the frequency of such behaviour of leaders is less present. Such a conclusion is in agreement with the discovery made by Chen, et al. [61] that during the pandemic, telework undermined trust and relationships between managers and employees.

In addition, indications of changes of no statistical significance relate to differences in behaviour with respect to statements Q5 (higher frequency), Q9 (higher frequency), Q10 (lower frequency), Q11 (lower frequency), Q12 (higher frequency), Q14 (higher frequency) and Q18 (higher frequency), and details of these queries can be seen in the Appendix section.

Using the nonparametric Wilcoxon signed rank test, we confirmed a statistically significant difference in the frequency of use of the directive style (with $p < 0.05$) and an indication of the change in the frequency of achievement-oriented style (with $p < 0.1$) for the behaviour of respondents who answered both questionnaires. The frequency of the directive style increased somewhat during the COVID-19 pandemic, which means that leaders, on average, are more likely to give specific guidance and various explanations to followers. Of course, during the COVID-19 pandemic, basic instructions were relatively often given to citizens and employees regarding the new rules, so the growth of the presence of the directive style was expected.

There are certain similarities between leadership in the general, undifferentiated work environment noted by the author [20] and the circumstances of the COVID-19 pandemic, which favour a task-oriented, directive leadership style. At the same time, with the onset of the COVID-19 pandemic period, the frequency of achieving the achievement-oriented style decreased. Since this style reflects a leader’s behaviour where he poses challenges seeking greater achievement with confidence in employees [20], it is not surprising that this approach has decreased. The conditions of the COVID-19 pandemic imposed healthcare priorities, models of working from home, isolation of individuals, and the like, which reduced attempts to raise the ladder of achievement.

In the general assessment of the achieved levels of PGT leadership styles at the present time of pandemic rule, the supportive style stands out. Although it is a style characterized by concern for employee welfare and the creation of a desirable organizational climate, with this model, only 11.7 % of respondents reported applying this style the most often. Furthermore, in accordance with the interpretation model for the questionnaire [1, pp. 146] in the supportive leadership style part, we also found a very low representation of this behaviour. Surprisingly, low levels were not observed in the remaining three styles of the PGT model. Good effects of the application of supportive style are recorded in the studies of Schein [22], Khalid, et al. [23], and Bass and Bass [25].

By testing groups of leaders formed by gender, the frequency of supportive style leadership results in a statistically significant difference ($p < 0.1$), in favour of female leaders. This result is in line with the findings of a study of subordinates from GLOBE societal clusters conducted by Van Emmerik, et al. [33], where a higher level of friendly supportive behaviour was found in female managers and is also consistent with the findings of Lord, et al. [40].

The influence of the organization's size in the conducted research proved to be significant in terms of the frequency of the directive style of the behaviour of leaders. The application of this style in leaders from larger organizations in the sample is more frequent with statistical significance ($p < 0.05$). It is possible that this circumstance has caused the initiation of structure, as noted [34], or perhaps the need to maintain structure. It is known that structure is more important in larger organizations.

A statistically significant result (with $p < 0.05$) was obtained for the analysis of the achievement-oriented style of behaviour of groups of more educated and less educated leaders using the Mann–Whitney test. Less educated leaders are more likely to apply an achievement-oriented style that Northouse [12] describes as desirable and challenging with complex tasks.

With regards to limitations of research instrument, we should stress that the applied Path – Goal Leadership Questionnaire [1] is based on self-assessment of leaders, thus providing “self-reported data“, potentially yielding undesirable biases such as selective memory and others. As far as we know based on the analysis of other publications, no more advanced version of this tool for verifying leader responses by subordinate employees or even colleagues has been applied. A comprehensive consideration of the application of 360-degree assessments can be found in study [63], while for example for management skills assessment research [62] is relevant.

CONCLUSION

Consistent with self-judgement, leaders in Croatian organizations have changed their leadership style in the circumstances of the COVID-19 pandemic, albeit not dramatically. To a lesser extent, it strengthened the directive leadership style. The application of the directive style by leaders from larger organizations is more frequent. A leadership style that is in some ways deficient in representation is supportive leadership. For this style, female leaders in Croatian organizations declare a higher frequency of application than their male counterparts. Leaders of Croatian companies with lower education prefer an achievement-oriented style. The frequency of using a participative leadership style has changed the least during pandemic conditions. In addition, for this leadership style, no differences were found between groups formed according to demographic criteria.

Future research on leadership in Croatian companies will be directed towards recent theoretical concepts such as team leadership and multilevel leadership.

APPENDIX: QUESTIONNAIRE (PATH-GOAL LEADERSHIP QUESTIONNAIRE [1])

Indicate how often each statement is true of your own behaviour.

1 = Never 2 = Hardly ever 3 = Seldom 4 = Occasionally 5 = Often 6 = Usually 7 = Always

1. I let subordinates know what is expected of them.
2. I maintain a friendly working relationship with subordinates.
3. I consult with subordinates when facing a problem.
4. I listen receptively to subordinates' ideas and suggestions.
5. I inform subordinates about what needs to be done and how it needs to be done.
6. I let subordinates know that I expect them to perform at their highest level.
7. I act without consulting my subordinates.
8. I do little things to make it pleasant to be a member of the group.
9. I ask subordinates to follow standard rules and regulations.
10. I set goals for subordinates' performance that are quite challenging.
11. I say things that hurt subordinates' personal feelings.
12. I ask for suggestions from subordinates concerning how to carry out assignments.
13. I encourage continual improvement in subordinates' performance.
14. I explain the level of performance that is expected of subordinates.
15. I help subordinates overcome problems that stop them from carrying out their tasks.
16. I show that I have doubts about subordinates' ability to meet most objectives.
17. I ask subordinates for suggestions on what assignments should be made.
18. I give vague explanations of what is expected of subordinates on the job.
19. I consistently set challenging goals for subordinates to attain.
20. I behave in a manner that is thoughtful of subordinates' personal needs.

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REVISIONISM OF REVISIONISM IN THE DEBATE ON FREE WILL

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ABSTRACT

In this article we critically examine Vargas's revisionistic theory about free will. Contrary to his claim that there is no empirical evidence for libertarian freedom of the will, we expose empirical results from Schultze-Kraft et al. experiment. We interpret these findings by invoking non-causal and agent-causal libertarianism. According to this, we conclude that Vargas's revisionistic theory that recommends that those who hold libertarianistic commonsense view should revise it towards compatibilism is not warranted and that those who hold libertarianistic commonsense view should retain it; moreover, those who hold compatibilistic or deterministic commonsense views on free will should revise them towards libertarianism.

KEY WORDS

revisionistic theory, free will, libertarianism, revisionism

CLASSIFICATION

APA: 2380, 2630
JEL: G41

A “revisionist theory” in the debate on free will would be any theory that claims that we should revise our thinking about the fundamental notions in this debate. Moreover, according to Manuel Vargas [1], revisionism should give two things: a *diagnosis* about what and how we think about free will and a *prescription* how we should think about it. When these two notions, diagnosis and prescription, differ, we have a revisionist theory. There are several revisionist attempts [2, 3], but we would like to discuss one important point in Vargas’s [1, 4] theory. His diagnosis is that the commonsense view on freedom of the will is mainly incompatibilist and libertarian, i.e. freedom of the will and determinism are incompatible, and humans have freedom of the will because determinism is false; then, his prescription aims towards the compatibilist view. Vargas does this because he is persuaded [1; pp.143-145] that *there is no empirical evidence that could show that human beings have freedom in the libertarian sense*. In this article, we would like to show that this is not warranted, and so revise his revisionist theory.

Before we get to the main point, and although it is very well known, we have to say just briefly in what incompatibilism, libertarianism and compatibilism consist.

Incompatibilism holds that determinism and freedom are not compatible. Basic requirement for freedom about which incompatibilists agree is that an agent could have done otherwise in completely the same situation in which an agent has done something. So, for incompatibilists, either we have freedom, which means that requirement is fulfilled, or if requirement is not fulfilled, determinism is the case and we don not have freedom. It could not be both that we have freedom and that determinism is the case: it could not be both that determinism holds and that we still have freedom. Incompatibilists can be either hard determinists or libertarians. Those who hold that determinism is true are hard determinists, and according to them, we have no freedom of will and no freedom of action. If determinism is the case, then our will and actions spring from initial states of the universe (or at least from distant past when there were no agents), and laws of nature. Since neither of these are under the control and influence of human beings, we have no any kind of freedom. The stronger variant of incompatibilism is hard incompatibilism which hold that both determinism and indeterminism are incompatible with freedom. This means that if anything is done indeterministically and that absolutely nothing determines what has been done, this is not freedom of the will and neither it is a freedom of action.

Those who are incompatibilists and claim that we have freedom of the will and action are libertarians. They think that at least in some situations, there is a possibility for an agent to do or not to do something, namely that if an agent did something, it was equally possible for him to do something else instead in this same set of circumstances. Libertarianism comes in three main ways: non-causal, agent-causal and event-causal form. For our purposes non-causal and agent-causal libertarianisms are important, so it is in order to say a few words about them.

Non-causal libertarianism is a form of libertarianism that enables freedom by dispensing with causation in relation to decisions and choices (and, derivatively, actions) altogether. Goetz [5; pp.8-9] in expounding a non-causal theory says: “... the power to choose is ontologically a fundamental and irreducible mental property of an agent, where exercising of that power by the agent is primitive or simple event in the sense that it has no parts (it lacks internal causal structure) and is intrinsically active and, thereby, essentially uncaused.” The decisions and choices (and, derivatively, actions) that an agent commits are uncaused events for which he had reasons, though the reasons are not their causes. An agent possesses adequate control over reasons, having fundamental non-analyzable direct power over simply making a choice or decision: since decisions and choices are such, an agent’s agency is free from any constraint that causation in any form may impose upon him in deciding and choosing (and, derivatively, in acting).

Agent-causal libertarianism is a form of libertarianism that designates the *agent* himself as the non-deterministic cause of his decisions and actions, and not some mental event that occurs

within him, the rationale being that to justifiably say that actions of an agent are truly his, it must be the case that the agent in his *entirety* causally contributes to his decisions and actions. And to justifiably say that *and* that the agent committed his action nondetermined, this variant of libertarianism posits the existence of a distinct kind of causation. Next to event causation, causation of an event by an event, which is the kind of causation that seemingly prevails in the natural world, there is agent causation, which is the kind of causation that operates in the realm of human decisions and actions. This causation is distinct because the agent is not an event, but a *substance*. And since the substance is not an event, the agent is not just a link in a causal chain, so it can not be an effect. O'Connor [6; p.71] in explicating agent-causal theory says that "...the agent, having the relevant internal properties will *have it directly within his power* to cause any of a range of states of intention delimited by internal and external circumstances". So, in a way, agent is an uncaused cause. Agent causation gives agents freedom for two reasons: agents cause their decisions and acts non-deterministically and are themselves uncaused, and because they cause their decisions and acts as individual substances, they are *sole and genuine sources* of their decisions, choices and actions.

Compatibilists, on the other hand, say that it is possible that determinism holds and agents have freedom of the will and freedom of the action. They have developed several different approaches and arguments to demonstrate this. Some compatibilists argue for the compatibility of determinism and freedom by reducing the freedom of the will to freedom of action. We act freely, according to these compatibilists, if we do what we want or desire to do when there are no any obstacles to do what we want and desire, and we can act freely under determinism since determinism does not entail that we cannot act according to what we want or desire. It is when we confuse freedom for something else, for example, for a will that can act contra causally or non-causally that we (according to them, wrongly) think that determinism undermines freedom. This deflation of personal freedom to unencumbered intentional actions, they say, in no way takes anything away from human dignity, happiness, and aspirations since it is this what ordinary people mean by the notion of freedom. They want to do what they want or desire to do and this is possible under determinism. Moreover, compatibilists would argue, that freedom presupposes determinism, for it bestows the causal link between us and our actions. Without that link between us and our actions, it would be hard, compatibilists think, for us to say that our actions are truly are own and that we can be held morally responsible for them.

Other compatibilists argue for the conditional analysis of freedom of the will: the ability to do otherwise than one actually does *is* compatible with determinism.

In the conditional sense, an agent would have done otherwise than he actually did *if he wanted or willed to do otherwise*. This would be possible under determinism as determinism is a thesis of a conditional physical necessity: there is a unique future given the laws of nature and the past. Had the past been different, then there would be a different unique future; or, had the laws of nature been different, then there would be a different unique future, again.

When this is applied on us, given the laws of nature and a different past, we would have wanted or desired otherwise than we do and would done otherwise than we do; given the same past and different laws of nature, we would have wanted or desired otherwise than we do and would have done otherwise than we do, again.

If this conditional sense is meant when we say that someone can do otherwise than he does, then we can do otherwise even if determinism is true.

Still other compatibilists, aware of the appearance of quantum mechanics in physics that made the concept of indeterministic causation legitimate, do not push for the necessity of determinism for freedom, nor do they, as the conditional analysis argument turned out to be too problematic, push for the compatibility of determinism and the ability to do otherwise.

Instead, they analyze free will as an action originating in an appropriate way: action has to spring out of an adequate *source*, and an agent has to identify himself with that source. If an agent can be identified with this source (for example, with the content of his mind, or particular desires, or certain mental history) then if his action is a result that came from this source in a non-deviant way, we may say that this action is freely done even though that source itself may be fully determined (say, by laws of nature and the past: all desires, beliefs, courses of thinking and so choosing and deciding may be fully determined, according to all who embrace determinism, so compatibilists too, by the past states and laws of nature, even before an agent has come into existence).

We think that compatibilism is an untenable position. All versions of compatibilism endorse determinism, and all compatibilistic determinisms entail that something other which is not in the control of an agent, should be different first, in order that an agent could have done otherwise. (Whether it be laws of nature, outer obstacles, the past, counterfactual situation or whatever else). It seems that this only means that “agents” are still fully determined (and in a new situation in which, seeing from that situation, they still can not do otherwise), only differently, not that in the same situation they can do otherwise. So, in fact, neither compatibilism can embrace freedom. Compatibilism is violence over freedom. But we shall not pursue detailed arguments against various kinds of compatibilism here because our aim here is to look for some empirical results that point against revisionism in Vargas’s sense.

As we already said, Vargas says [1; pp.143-145] that there is no empirical evidence that we possess libertarian freedom. In response, we shall offer results from research done by Schultze-Kraft et al. [7] suggesting that we do possess libertarian freedom. We shall not go into discussion about the methodology or processes how the experiment has been done, nor shall we discuss its technical points. We assume that the experiment has been done according to highest methodological and technical standards and demands. What is essential for our discussion consists in the following:

Schultze-Kraft et al. [7] conducted the experiment to see whether human beings have freedom of will and freedom of action. This experiment consisted in monitoring brain electrical activity and recording its neurological electroencephalograms.

The experiment had three stages. Let us have a longer citation from Schultze-Kraft et. al. [7; p.1080]: “Subjects were confronted with a floor mounted button and a light presented on a computer screen. Once the light turned green (‘go signal’), subjects waited for a short, self-paced period of about 2 seconds after which they were allowed to press the button with their right foot at any time. They could earn points if they pressed while the light was green, but lose points if they pressed after the light had turned red (‘stop signal’). The experiment has three consecutive stages (...) In stage I, stop signals were elicited at random onset times (sampled from a uniform distribution); thus, the movements were not being predicted. The EEG data from stage I were then used to train a classifier to predict upcoming movements in the next two stages of the experiment. In stage II, movement predictions were made in real time by brain-computer interface with the aim of turning the stop signal on in time to interrupt the subject’s movement. The term ‘prediction’ (is) used here to denote any above-chance level of predictive accuracy, not only perfect prediction. After stage II, subjects were informed that they were being predicted by the computer and that they should try and move unpredictably, and another otherwise-identical stage followed.”

For the complete results of the experiment, one should look at the Schultze-Kraft et al. [7; pp.1084-1085] article. The relevant part of the result for our purposes here was that the subjects indeed succeed not to press the button even when the unconscious onset of the brain activity has already begun (for pressing the button) and when the brain-computer interface predicted, based on that unconscious brain activity, that the subject will press the button.

Experimenters [7; p.1081] called such an outcome (among other possible outcomes) “aborted button press”: “In stage I, aborted button presses occur very rarely, (2,2 %), a rate that substantially increased in stages II and III (15,2 % and 16,3 %) ...”.

So, what does it mean?

Schultze-Kraft et al. [7] recorded that there is already brain activity before the subject became conscious of it, and it is a process that leads to an action. For the subject, it seems that he consciously decided to do what he did. But, the beginning of the (unconscious) brain activity could be about one second long [7; p.1083]), and, according also to another research of Soon et al. [8], even up to four seconds long, before it became conscious for the subject.

So, for the periods of one (and, possibly, to four) second(s), so-called readiness potentials in motor cortex, which led to the simple movements, were recorded [7].

It could seem then that there is only an illusion for the subject that he has chosen consciously what he did do; it seems that unconscious, purely physiological (chemical-physical), activity of the brain determined will and action which issued in the end and that consciousness and the subject itself in fact does not contribute, so that there is no free will and free action. Namely, if the conscious content of the will and action that follows from it, are the products of non-conscious brain processes, which in turn are governed by laws of nature, on which subjects can have no control, then it seems that something else fully determine will and action – initial states and laws of nature rather than subjects themselves. Subjects would be rather passive “observers” what happens to them along with getting the illusion as if they consciously decided, willed and did certain action. But, researchers [7; p.1080] then posed the following question: “... whether person can still exert a veto by inhibiting the movement after the onset of the readiness potential?”. The answer they have found in their experiments is that “there is a possibility for subjects to stop their intended action until 200 ms before the beginning of the physical execution of action” [9; p.9]. Schultze-Kraft et al. [7; p.1084] claim that their experiments “suggest that humans can still cancel or veto a movement even after onset of the readiness potential. This is possible until the point of no return around the 200 ms before movement onset. However, even after the onset of the movement, it is possible to alter and cancel the movement as it unfolds.”

Experiments of Schultze-Kraft et al. point towards the conclusion that agents can exert voluntary conscious influence to stop the action for which unconscious neurophysiological brain process has already started. We are not just illusioned passive observers of what happens, but we can voluntarily intervene to do otherwise than it would be done if that unconscious neurophysiological brain process goes through. “We can voluntarily change the course of our own actions.” [9; p.9].

Experimental subject simply could have done otherwise (until 200 ms before the execution of the action). Namely, if the subject simply decided in a split second, not to execute the action, for which the onset of the brain activity (brain process) already occurred, he could stop and could have not execute that action so that brain process which begun and last for some period unconsciously, is not carried out to its completion in executing the action. So, both possibilities are within the power of the subject, to execute and not to execute an action under the same previous conditions.

These experimental results can be interpreted in an incompatibilist libertarian way. We think that the outcome of the experiment is best captured by non-causal libertarianism; agent-causal also has merits, though we think that event-causal libertarianism is the most problematic kind of libertarianism by itself so we shall not explore the possibility of interpreting results of Schultze-Kraft et al. experiment in terms of event-causal libertarianism.

So, there are two possible libertarian options that can fairly accommodate these findings. First is non-causal for which we think is the best.

The Experiment by Schultze-Kraft et al. and its results suggest that at that level – elementary level but from which any other higher level depends – we plausibly have non-causal libertarian freedom. Experimental subject – as an agent – sometimes simply does not carry the action for which the first stages of (brain) process are already in progress. He has simply not done it through, contrary to the neurophysiological onset in the brain. Experimental subject – an agent – simply exercised decision (and accordingly, action) not to press the button with the right leg (though unconscious onset of the brain process for pressing the button is already present). An agent, in this situation, used his fundamental mental power and directly exercised it (refraining of the pressing the button). It is not mediated via any causal link. It is simply and directly exercised. We can invoke here only an intentional explanation. Namely, the experimental subject was told before the experiment that, at will, sometimes do not move the finger. So, he has internalized that instruction and has an intention with the intentional content “sometimes do not move the finger” and this intentional content is directly, immediately and non-causally efficaciously exercised in stopping the action for which unconscious neurophysiological process has already begun.

It seems that in the case when unconscious brain process is carried through and the button is pressed in the end, there is no need to invoke a fundamental mental (non-causal) power for exercising the decision (and, subsequently, an action) to explain the pressing of the button, but it is not so. Invoking only neurophysiological (physico-chemical) processes is not enough, even in this case, because, as experiment shows, subjects can exercise *not-pressing* the button as well and under the same circumstances (until 200 ms before the action), for which we have to invoke an explanation beside neurophysiological (physico-chemical) processes; so we have to say that, even when button is pressed, that an agent exercised his fundamental mental (non-causal) power as a decision to *press* the button, this decision letting the neurophysiological (physico-chemical) process to go through. There is no redundancy between invoking fundamental mental (non-causal) power for exercising the decision (and, subsequently, an action) and neurophysiological (physico-chemical) explanation of the decision and action of pressing the button.

Now we shall consider the agent-causal option. Seen through the lens of agent-causation, Shulze-Kraft et al.’s findings suggest that the research subject can be constructed as the agent and as a substance – because he can nondeterministically exert his (agential) power to decide over which action he will do. If the unconscious brain process leads to an action he wants to do, an agent exerts his agential power as non-interference on the already going-on process and allows the unconscious brain process to finish its course, becoming conscious and terminating in action. If the unconscious brain process leads to an action that an agent does not want to do, an agent as a substance exerts his (agential) power and intervenes by substantially causing the terminating the brain process and not doing an action that would issue from that (which was in the onset unconscious) brain process. An agent can do both of these actions as a substance, and causally speaking here, whether omitting an action or allowing the action, both are within his power; so, an agent is causing these outcomes entirely on his own and only an agent is the cause of them. Since it seems from the experiment that both actions are available (both to press and not to press the button) to the experimental subject, under the same antecedent conditions, it seems also that neither is (fully) caused by prior events or other things, so experimental subject as a *substance* (on his own, at that moment) causes one of these events to happen (pressing or not pressing the button).

These interpretations allow us to say the following: if the prevailing commonsense view on freedom of the will is incompatibilist and libertarian, we should not revise it; we do not need revisionism in this direction. Revisionism that should be undertaken should go into opposite direction: those who have pre-theoretic compatibilist or deterministic intuitions or commonsense, should revise them to an incompatibilist libertarian view.

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THE INTER-RELATIONS BETWEEN ENTREPRENEURIAL ORIENTATION COMPONENTS AND THEIR IMPACT ON THE PERFORMANCE OF CROATIAN SMALL AND MEDIUM ENTERPRISES

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ABSTRACT

Association of entrepreneurial orientation with performance, viewed as both a unidimensional and multidimensional concept, has been widely researched, especially in the small and medium enterprises context. However, there is a gap in the literature related to how the components of entrepreneurial orientation are inter-related and how their intricacies drive small firm performance. Rather than looking into configurations between entrepreneurial orientation and various external factors, this article investigates the different configurations within the entrepreneurial orientation components and how they affect performance. This article builds on the work by Putniņš, T.J. and Sauka, A. “Why does entrepreneurial orientation affect company performance?” who used financial economics theory to explore the direct relationship between risk-taking and performance. They used innovativeness as a moderator and proactiveness as mediators of the relationship between risk-taking and performance. This article uses a configurational approach to investigate the effect of individual roles of each of entrepreneurial orientation’s dimensions and their interactions on small firm performance. Using survey data from 202 Croatian small and medium-sized firms, results reveal that entrepreneurial orientation and all of its three components are positively associated with small firm performance. Relationships between innovativeness and proactiveness with small firm performance are significant when controlling for risk-taking; therefore, they do not obtain this relationship through their association with risk-taking. Proactiveness does not have an indirect, positive relationship with small firm performance via risk-taking as a mediator. Innovativeness is a moderator that further strengthens the positive relationship between risk-taking and performance.

KEY WORDS

risk-taking, innovativeness, proactiveness, performance, Croatia

CLASSIFICATION

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INTRODUCTION

Entrepreneurial orientation (EO) as an academic concept and its association with firm performance has been intensely researched over the last decades [2-7]. Many researchers follow the conceptual framework laid down by [8] and [9] stating that EO covarying dimensions are critical for EO to exist, thus one strain of the literature is focused on observing EO as a unidimensional concept and examining various inter-relations with firm performance [10-12]. On the other hand, the other strain of academics [13-18] follow [4] conceptual framework who relaxed the assumption of covariance among EO dimensions and investigated entrepreneurially oriented firm as a context-dependent. Therefore, these academics viewed EO as a more complex concept and examined the relationships between EO dimensions and firm performance in various contextual settings [19-26].

Although the relationship between EO and performance has been widely studied all across the globe, researchers cannot still state with certainty that the relationship mentioned above is completely understood. Many authors found that the relationship has positive connotations [5, 6, 27]; however, many authors have not found the relationship positive [28-30]. Moreover, many authors even looked in more nuanced aspects of the relationship and determined that the EO – performance relationship is more complex and even non-linear [10, 18, 31-36, 43].

As stated earlier, EO as a concept has been looked upon as either a unidimensional or a multidimensional concept. Studies that adopted the multidimensional concept of EO explored the effects of certain EO dimensions [4, 5, 38], independent effects of each EO dimension [34, 39], unique effects in certain industries [16, 40, 41], and non-linear relations with performance [33, 34, 42, 43]. Moreover, many studies have highlighted that EO (including EO dimensions) – performance relationship is context-specific and that the relationship needs to be observed in interaction with various contextual factors [23, 31, 42, 44-46].

However, not many studies have explored how EO dimensions interact while related to firm performance. As far as authors' knowledge, only [1] have performed such an investigation where they determined on the sample of 1020 Estonian, Latvian and Lithuanian small and medium-sized enterprises (SMEs) that “all three components positively contribute to performance, but in different ways. Risk-taking has a direct positive relationship with performance, the relationship between risk-taking and performance is conditional on the level of innovativeness, and that proactiveness contributes to performance through its positive effect on the level of risk-taking” [1; p.713]. Therefore, this study aims to replicate the model developed by (1) within a small developed economy context, such as Croatia, and thus provide further validation to their findings. This research aims to investigate the inter-relations between each EO dimension and determine their effect on small firm performance. To be more precise, the research effort will be focused on identifying which EO dimensions are direct drivers of small firm performance and which EO dimensions have a moderating or mediating relationship with small firm performance. The research approach follows [1; p.712] a configurational approach that looks for “a configurational model internally within the dimensions of EO rather than between EO and external factors.”

This study starts with the literature review related to the concept of EO, its dimensions, and their relationship with small firm performance, where four hypotheses were developed based on examining their direct, mediating, and moderating effect. Afterward, the research method was discussed, followed by hypotheses testing and discussion of the results based on the data obtained from small and medium-sized enterprises in Croatia. The article concludes with the theoretical implications, implications for management, limitations, and implications for future research.

LITERATURE REVIEW AND HYPOTHESES

Entrepreneurial orientation (EO) has been a focus in academic research for decades, and the literature on investigating EO is growing rapidly. Many researchers and studies covered EO and its implications on various aspects of performance [6, 47-51] and within various contexts [24, 52, 53]. However, despite such a growing number of publications related to exploring the EO phenomenon, there are still academics [1, 54, 55] who believe that research around EO should return to a more conceptual discussion to understand the concept itself and its implications better.

Therefore, even though the EO has been widely covered in the forms of thorough reviews of the EO literature [7, 18, 55-58], examining the effects of various moderators and mediators [59-65], investigating effects of different contingencies [12, 66-68], and even observing different contextual circumstances [69-72] that govern the relationship between EO and firm performance, however, literature is very limited on studies related to investigating the interactions between the EO dimensions [1, 38, 73].

Therefore, this study aims to fill in this gap in the literature by replicating the [1] approach of examining interrelations between the EO dimensions and investigating if and how each of EO dimensions could have a mediating or moderating effect on the relationship between another dimension and firm performance. To be more precise, as per [1] proposition), risk-taking affects the firm performance directly and positively, innovativeness has a moderating influence on the relationship between risk-taking and firm performance, while proactiveness has an indirect (mediating) positive effect on firm performance.

Risk-taking is one of the central themes in the literature on entrepreneurship [74-76], especially when trying to explain entrepreneurial strategies and entrepreneurial mindset [77]. In the context of EO and following [79; p.923] definition, risk-taking refers to “the degree to which managers are willing to make large and risky resource commitments – i.e., those which have a reasonable chance of costly failures”. Moreover, risk-taking can be explained by [78; p.152] definition, stating that “risk-taking refers to a firm’s willingness to seize a venture opportunity even though it does not know whether the venture will be successful and to act boldly without knowing the consequences”. Following [1] hypothesis development approach, the relationship between risk-taking and firm performance can be explained through the tradeoff between risk and return, which is a fundamental principle in the financial economics theory. The basic assumption is that for entrepreneurs to take on more risk, i.e. more risky/uncertain actions/strategies/ventures, would require higher compensation (better performance) than for those actions/strategies/ventures that are viewed as being less risky/uncertain. Therefore, the following hypothesis is proposed:

H₁: *Risk-taking has a direct positive relationship with firm performance.*

Similar to the previously provided explanation for the development of hypothesis H₁, [1] consider that comparable mechanism is adequate for explaining the development of the second hypothesis H₂, where the relationship between venture-level strategy and firm performance should also be viewed through its association with risk/uncertainty. More precisely, since risk-taking should have a direct and positive effect on firm performance, the other two components of EO (firm strategy), innovativeness and proactiveness, should not have a direct, but rather an indirect effect on firm performance, i.e., they should affect firm performance via their association with risk-taking. However, such clarification is contingent on two assumptions: (a) the firm can self-determine the level of their EO, and (b) there is market competition among entrepreneurs. Thus, the following hypothesis is proposed:

H₂: *Proactiveness and innovativeness that have a relationship with firm performance obtain this relationship through their association with risk-taking.*

Proactiveness, as a dimension of EO, can be viewed as a first-mover advantage originating from anticipating and pursuing new opportunities and by participating in emerging markets [4] as shaping the environment opposite to reacting to the environment by introducing new products, technologies, or administrative processes [79], or as firms desire to be pioneers in their respective industries [6]. Therefore, following the provided definition, intuitively, proactive behavior involves certain levels of risk-taking. Stated differently, proactive leaders act on more or less complete or accurate information, meaning they are willing to act on certain calculated risk levels incorporated in their decision-making and strategy formulating process. Therefore, a certain level of risk will be required for a firm to develop new market opportunities proactively. Such proactive actions/strategies will increase firm performance; thus, proactiveness affects firm performance via risk-taking. In their research, several authors [34, 78, 80, 81] argue that firms first proactively identify new opportunities, followed by innovative and risk-taking behaviors to seize these opportunities. Therefore, the following hypothesis is proposed:

H₃: *Proactiveness has an indirect, positive relationship with firm performance via risk-taking as a mediator.*

Lumpkin and Dess [4, 78] view innovativeness as the firm's tendency to embrace new technologies or practices which could lead to new and creative ideas, novelty, and experimentation to bring new opportunities, novel solutions, new technologies, and products or services. [79] reflect that innovativeness can come in different forms, such as technological innovation manifested in R&D and engineering, product-market innovativeness manifested in new market niches, product design, advertising, and promotion. Therefore, since innovativeness represents a 'process' of creating something new, it entails a certain amount of risk-taking, which should bring value to the firm in increased performance. Many authors have found empirical evidence that innovativeness positively affects firm performance [82-85]. Authors in [1] argue that the resource-based view (RBV) of the firm provides theoretical reasoning why innovativeness could be a moderator to the risk-taking – firm performance relationship. Due to the limited resources, the firm could be pressured to engage in innovative risk-taking actions/strategies to satisfy demands of both innovative initiatives and risky endeavors, since as per RBV, "risk-taking is a highly resource-absorbing orientation because it involves committing large volumes of resources to endeavors with uncertain outcomes" [1; p.719]. Therefore, the following hypothesis is proposed:

H₄: *The positive relationship between risk-taking and firm performance is strengthened by innovativeness.*

RESEARCH METHOD

SAMPLE

Database of the Croatian Financial Agency (Fina) has been used to obtain the list of the observed companies. According to the European Union definition of small and medium-sized enterprises, a random sample of companies has been pulled out of Fina's database. The data sample consisted of 2 000 randomly selected small and medium-sized enterprises contacted in December 2019 and January 2020, From the data sample, 202 firms correctly replied to the email questionnaire, constituting a response rate of 10,1 %. The questionnaire was sent to firm owners or firm's top management email addresses, where 73 % of the respondents were either firm owners or directors, while 27 % were managers.

Moreover, almost 80 % had more than 7 years of working experience with the firm. Of 202 firms that replied to the email questionnaire, 145 were small (71,78 %), while 57 were medium-sized firms (28,22 %). Considering the industry, 66 firms operate in the manufacturing sector (32,67 %), while 136 firms operate in the service sector (67,32 %).

VARIABLES, MEASURES, AND ANALYSIS

Performance as a multidimensional concept has been measured via a modified instrument developed by [86] based on a 7-point Likert-type scale questions concerning indicators related to sales growth rate, operating profit, profit to sales ratio, market share, market development, and new product development. The performance score has a mean of 3,74, a standard deviation of 1,42, a range of 6,86, and Cronbach's α value of ,86.

EO was measured using 7-point Likert-type scale questions assessing innovativeness, proactiveness, and risk-taking [9]. The entrepreneurial orientation score has a mean of 4,33, a standard deviation of 1,21, a range of 5,78, and a Cronbach's α value of 0,77. Innovativeness score has a mean of 4,59, a standard deviation of 1,51, and a Cronbach's α value of 0,83, proactiveness score has a mean of 4,64, a standard deviation of 1,41, and a Cronbach's α value of 0,79., while the risk-taking score has a mean of 3,78, a standard deviation of 1,46, and a Cronbach's α value of 0,84.

Firm size and industry (sector) were used as controls to provide further robustness to our results. Firm size was measured according to the European Union definition of small and medium-sized enterprises, where micro firms are classified as the ones with less than 10 employees, small firms with 10-49 employees, and medium-sized firms with 50-250 employees. Regarding the industry or sector in which the firm operates, classification has been done whether the firm's main line of business was manufacturing or service.

The sequence of regression analysis that iteratively arrived at the model that best fit the data was used to test the interrelations between dimensions of entrepreneurial orientation and determine their direct and indirect effects on performance. All variables have been mean-centered to improve the interpretability of results, where Durbin-Watson statistic, maximum Cook's distance, and variance inflation factors (VIF) were well below critical values. A non-response analysis and common method bias analysis have been performed, and it can be confirmed that it is unlikely to be a severe concern in this study.

RESULTS

As shown in Table 1, the correlation between entrepreneurial orientation and performance is 0,357, while each of the dimensions of entrepreneurial orientation has a positive correlation with performance. The correlation coefficient between innovativeness and performance is 0,407, risk-taking and performance are 0,171, while proactiveness and performance are 0,408, [1] in their article refer to the work of [11] based on a meta-analysis on 51 studies showed that overall correlation between entrepreneurial orientation and performance is 0,24. On the other hand, all three dimensions of entrepreneurial orientation are positively correlated, where their correlations ranged from 0,48 to 0,65. Moreover, all three dimensions were positively correlated with an entrepreneurial orientation where their correlations range from 0,75 to 0,82.

Table 1. Means, SDs, and correlations.

	Mean	SD	1	2	3	4	5	6	7
1. Firm size	2,00	0,75	1,00						
2. Industry	1,67	0,47	0,103	1,00					
3. EO	4,29	1,04	0,044	0,090	1,00				
4. Innovativeness	4,59	1,50	0,085	0,054	0,776**	1,00			
5. Risk-taking	3,78	1,46	0,009	0,074	0,759**	0,486**	1,00		
6. Proactiveness	4,64	1,40	0,073	0,026	0,823**	0,656**	0,480**	1,00	
7. Performance	4,81	1,14	0,108	0,003	0,357**	0,407**	0,171*	0,408**	1,00

*significant with $p < 0,05$

**significant with $p < 0,01$ (2-tailed)

Tables 2 and 3 present the relationships between firm performance and EO dimensions.

Model 1 shows a statistically significant positive direct effect of entrepreneurial orientation on performance ($\beta = 0,385, p < 0,01$), controlling for firm size and industry. **Model 2** provides the separate effect of each EO's dimensions on performance while controlling for the other dimensions of entrepreneurial orientation, where innovativeness ($\beta = 0,203, p < 0,01$) and proactiveness ($\beta = 0,218, p < 0,01$) have a statistically significant positive direct effect on performance, while risk-taking does not. However, when we remove innovativeness and proactiveness from the model and only observe the relationship between risk-taking and performance as in model 6, results reveal a statistically significant positive direct effect of risk-taking ($\beta = 0,132, p < 0,05$) on performance. Therefore, we can state there is enough evidence to support hypothesis H₁.

Same as in **model 6**, when not controlling for risk-taking, both innovativeness ($\beta = 0,30, p < 0,01$) and proactiveness ($\beta = 0,325, p < 0,01$) have a statistically significant positive and unconditional effect on performance, as observed in **models 5 and 7**. Furthermore, **model 2** showed that relationships between innovativeness and proactiveness with performance are significant when controlling for risk-taking; we can conclude there is not enough evidence to support hypothesis H₂.

Mediating relationship between proactiveness, as a dimension of entrepreneurial orientation, and performance was tested by the same approach used by [1] and advocated by [87]. In the first step, **model 7** provides us with the value of the total effect (coefficient c), which is 0,325. In the second step, **model 9** gives us the value of coefficient a, 0,499. In the third step, the value of the coefficient b is calculated, which is -0,025. Based on the obtained coefficients, we can determine the proportion of indirect effect or mediation channel ($a \times b = -0,012$) in the total effect ($c = 0,325$), where the mediation channel accounts for 3,8 % of the total effect of proactiveness on performance ($(a \times b) / c$) and is statistically non-significant. Calculated both as per the bootstrap method (0 is included in the interval between LLCI and ULCI) and as per the Sobel test (t-statistic of -0,44, standard error of 0,02, and p-value of 0,6598). Therefore, we can conclude there is not enough evidence to support hypothesis H₃, meaning that proactiveness does not have an indirect, positive relationship with performance via risk-taking as a mediator.

Moderating relationships between dimensions of entrepreneurial orientation were tested via moderated linear regression analysis, an approach used by [6], where model 3 and model 4 build on model 2 by adding two-way and three-way interactions of innovativeness and proactiveness with risk-taking. **Model 3** explains for additional 4,2 % of the variation in performance ($p < 0,01$), while model 4 explains for another 0,02 % of the variation ($p < 0,01$). The results show statistically significant positive effect of the interaction between innovativeness and risk-taking with performance in both model 3 ($\beta = 0,157, p < 0,01$), and in **Model 4** ($\beta = 0,196, p < 0,01$). There is no evidence of moderating the relationship between proactiveness and risk-taking with performance, nor the three-way interaction effect between innovativeness, proactiveness, and risk-taking on performance. Therefore, the conclusion is there is enough evidence to support hypothesis H₄. To further explore the moderating effect of innovativeness on the relationship between risk-taking and performance, figure 1 plots the relationship between risk-taking and performance for three levels of innovativeness – low, average, and high, where low level is defined as one standard deviation below the mean, average as the mean, while the high level is defined as one standard deviation above the mean level of innovativeness.

Slopes in Figure 1 provide additional support for accepting hypothesis H₄, showing that higher levels of risk-taking and innovativeness are rewarded with higher performance.

Table 2. Relationships between firm performance and EO dimensions (Models 1-5).

Model	Performance				
	1	2	3	4	5
Direct effects					
EO	0,385*** (0,72)				
Innovativeness		0,203*** (0,066)	-0,401** (0,195)	-0,427** (0,198)	0,303*** (0,049)
Risk-taking		-0,070 (,058)	-0,301* (0,178)	-0,495 (0,306)	
Proactiveness		0,218*** (0,070)	0,638*** (0,197)	0,610*** (0,200)	
Moderation effects					
Risk*Innov			0,157*** (0,048)	0,196*** (0,070)	
Risk*Proactive			-0,107** (0,049)	-0,071 (0,068)	
Risk*Innov*Proactive				-0,007 (0,009)	
Controls					
Size	0,228 (0,168)	0,166 (0,162)	0,102 (0,160)	0,098 (0,160)	0,183 (0,165)
Industry (sector)	0,048 (0,162)	0,013 (0,155)	-0,006 (0,153)	-0,008 (0,153)	0,027 (0,158)
R-squared	0,369***	0,460***	0,503***	0,505***	0,414***
Adj. R-squared	0,136***	0,211***	0,253***	0,255***	0,171***

*significant with $p < 0,1$

**significant with $p < 0,05$

***significant with $p < 0,01$

Table 3. Relationships between firm performance and EO dimensions, for Models 6-10 (continued on p.389).

Model	6 Performance	7 Performance	8 Risk-taking	9 Risk-taking	10 Risk-taking
Direct effects					
EO					
Innovativeness			0,471*** (0,060)		0,290*** (0,078)
Risk-taking	0,132** (0,054)				
Proactiveness		0,325*** (0,052)		0,499*** (0,065)	0,296*** (0,083)
Moderation effects					
Risk*Innov					
Risk*Proactive					
Risk*Innov*Proactive					
Controls					
Size	0,269 (0,177)	0,199 (0,165)	-0,089 (0,203)	-0,064 (0,203)	-0,105 (0,197)

Table 3. Relationships between firm performance and EO dimensions, for Models 6-10 (continuation from p.388).

Model	6 Performance	7 Performance	8 Risk-taking	9 Risk-taking	10 Risk-taking
Industry (sector)	-0,003 (0,170)	-0,001 (0,158)	-0,139 (0,194)	-0,184 (0,195)	-0,146 (0,189)
R-squared	0,201**	0,415***	0,489***	0,484***	0,534***
Adj. R-squared	0,040**	0,172***	0,239***	0,235***	0,285***

*significant with $p < 0,1$

**significant with $p < 0,05$

***significant with $p < 0,01$

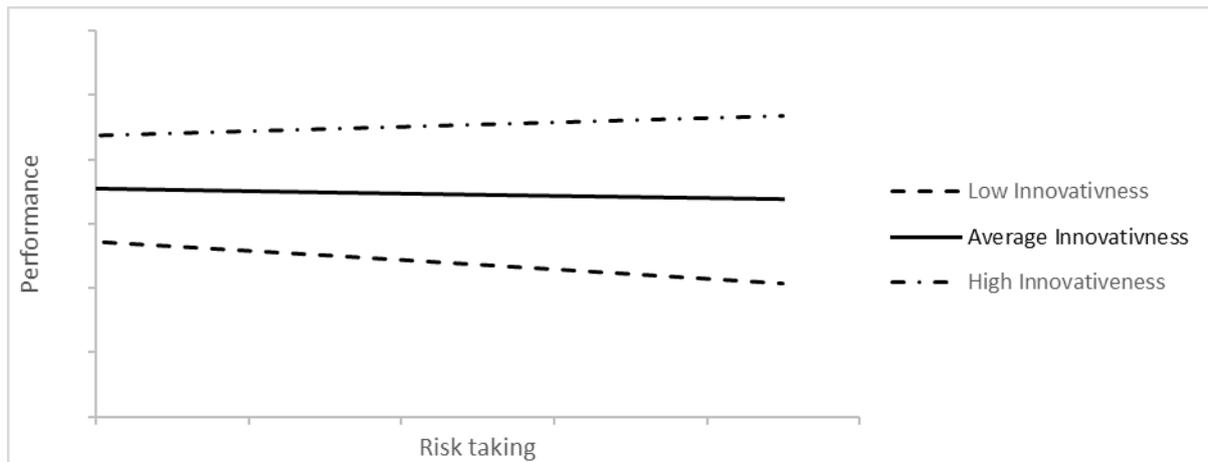


Figure 1. Risk-taking – performance relationship at different levels of innovativeness.

DISCUSSION

The relationship between EO and firm performance has been widely researched; however, a gap in the literature has been identified concerning how the inter-relatedness of EO dimensions drives firm performance. Since this study aimed to investigate different configurations within the EO dimensions, this study tried to replicate the research of [1] who used financial economics theory to explore the direct relationship between risk-taking and performance, where they used innovativeness as a moderator and proactiveness as a mediator of the relationship mentioned above. Using the data obtained from 202 Croatian small and medium-sized firms, results reveal that EO, viewed as a unidimensional concept, and its all three dimensions, have a positive direct effect on small firm performance. Relationships between innovativeness and proactiveness with small firm performance are significant when controlling for risk-taking; therefore, they do not obtain this relationship through their association with risk-taking. Moreover, the three-way interaction effect between innovativeness, proactiveness, and risk-taking on firm performance is not supported. Proactiveness does not have an indirect, positive relationship with small firm performance via risk-taking as a mediator. The positive relationship between risk-taking and firm performance is strengthened by innovativeness as a moderator.

Therefore, it can be concluded that the empirical results obtained in the context of Croatia do not fully confirm the results obtained by [1]. To be more precise, although the direct effect of risk-taking on performance and moderating role of innovativeness on the risk-taking – firm performance relationship has been supported, however, mediating role of proactiveness and that innovativeness and proactiveness obtain a relationship with firm performance through risk-taking have not. Therefore, this research has not proved that each EO dimension

positively affects firm performance but for different reasons, as stipulated by [1] which suggests that further validations of their model are required.

RESEARCH IMPLICATIONS

This study further validated EO as a construct since EO was viewed both as a unidimensional and multidimensional construct. All three dimensions of EO demonstrated a positive and direct relationship with firm performance. Moreover, this study confirmed that risk-taking is rewarded since higher levels of risk-taking initiatives/strategies increase the firm's performance. Furthermore, this study also confirmed that those risk-taking initiatives/strategies associated with higher levels of innovativeness yield higher performance than those risk-taking initiatives/strategies associated with lower levels of innovativeness.

Apart from observing the relationships above, it would be useful in future research to explore relationships between inter-relatedness of EO dimensions with other elements of strategy and determine how these relationships affect firm performance. Is the nature of these relationships characterized by direct, moderating, or mediating effects. Since the relationships between proactiveness and innovativeness and firm performance were conceptualized that they obtain such a relationship through their association with risk-taking, and were based on the assumptions that the firm possesses the ability to self-determine the level of its EO and that there is a market competition among entrepreneurs, future research should focus on exploring various contextual factors which could influence these relationships. Moreover, future research could investigate other factors that could potentially moderate and mediate the risk-taking – firm performance relationship. Although most of the academic research is focused on investigating various effects EO has on firm performance; however EO could also be related to other outcomes, not just performance; therefore, future research could examine the underlying notions between EO and other variables, which could provide further clarification of EO's role within the entrepreneurship process. Also, since many studies have confirmed the non-linear relationship between EO and firm performance, future studies could look into the non-linear effects between EO and firm performance dimensions.

This research study has certain limitations. Like any other academic article, this section will provide a brief overview of the main limitations that the reader needs to bear in mind while reading this article. Since this study focused only on Croatian SMEs, a sample of 202 small and medium-sized firms could be considered a relatively small sample size, especially when considering the response rate of 10 %. Moreover, since the research context was grounded in a small, developed economy such as Croatia, future research should be done in the wider regional context investigating the effects in other countries of Southeast Europe so that multicounty analysis could increase the validity of the currently obtained results and further test if context-specific aspects influence the observed relationships. Another limitation is concerned with the information gathering process since the unit of analysis was a single firm. The online questionnaire was filled out by only one firm representative making the results highly susceptible to the subjectivity of the respondents. Thus, future research should try to gather information from other sources within a firm and preferably use objective secondary data, such as financial and management reports, to triangulate the data. Furthermore, this study used [9] scale for determining EO within the firm. Future research could use other scales to measure EO to validate the results further and maybe offer some additional interesting insights.

CONCLUSION

This research has been conducted on 2 000 Croatian SMEs and analyzed 202 small and medium-sized firms. Results revealed a positive relationship between EO, observed both as a

uni-dimensional and multidimensional concept, and firm performance. More specifically, innovativeness, proactiveness, and risk-taking positively affect firm performance. Results also reveal that relationships between innovativeness and proactiveness with performance are significant when controlling for risk-taking. Therefore, it can be concluded that proactiveness and innovativeness do not relate to firm performance through their association with risk-taking.

Furthermore, it has been determined that proactiveness does not have an indirect, positive relationship with performance via risk-taking as a mediator or moderator. There is no three-way interaction effect between innovativeness, proactiveness, and risk-taking on performance. However, results confirm the positive moderating effect of innovativeness on the risk-taking – firm performance relationship. Stated differently, the positive relationship between risk-taking and performance is strengthened by innovativeness.

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PROVIDING AUTHENTICATION AND PRIVACY FOR UNIVERSITY CERTIFICATES USING SMART CONTRACTS IN BLOCKCHAIN TECHNOLOGY

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ABSTRACT

Traditional ways of distributing and verifying academic certificates are not efficient. Certificates are distributed as hard copy. Verifying the integrity of the certificate is a time and resource consuming process. As a result, forged certificates have become common. It is very difficult to differentiate between a real and a forged certificate. Through our system, we intend to make the certificate generation, distribution, and verification process seamless. Any student can enter his or her personal details, academic coursework details, and the university code, and thus submit a certificate request to the university. University admins can verify the certificate requests, and approve or reject the requests as per their policy. Any student or third party could verify the integrity of the certificate by entering the details of the certificate under scrutiny into the system. Data required to verify the integrity of the certificate will be stored on a blockchain. All verification data will be stored on the blockchain, so it will be tamper proof. This eliminates or limits the case of forged certificates to a large extend.

KEY WORDS

blockchain, smart contract, decentralised app

CLASSIFICATION

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INTRODUCTION

Digital technology plays a vital role across the globe. Nowadays the majority of things are converting from offline to online. Privacy and authentication are also an important factor. Transition from offline to online makes any process highly efficient. It is environmentally friendly. Digital assets are long lasting, portable and easy to store. Digital assets are also secure and private.

Since the emergence of blockchain, digital assets could now be decentralised. This means that users can now store their data online, forever, without worrying about any one failure point taking down the entire data and services. Blockchain has changed the way the internet functions. User data could now be distributed across multiple participating nodes, yet completely secure and private. This ensures that digital assets are persistent.

This transition from offline to online has opened up many opportunities to make processes more secure and efficient. One among them is digital academic certificates. Today most of the universities distribute academic certificates as a hard copy. They collect the data, generate the certificate, print it and manually distribute it to all the students. Once distributed, it is hard to verify the integrity of the certificate. It is due to this reason that cases of forged certificates have risen. Employers are finding it time consuming and resource intensive to verify the validity of a candidate.

This article focuses on a blockchain based approach to solve the above-mentioned issues. The system generates the certificate and stores the data required to verify the integrity of the certificate on blockchain. This provides zero knowledge proof. So no private data is made public, yet the validity of the certificate is public. This provides an effortless mechanism for the employers to verify the integrity of any certificates generated through the system.

BLOCKCHAIN

Blockchain has emerged as a trending technology in recent years. It entered the market as an infrastructure for crypto currency. Today, with the help of smart contracts, blockchain can be used for storing and distributing data throughout the blockchain network. The data written to the blockchain are immutable. New blocks are created for any update, the previous data logs will be still available. This ensures that data on blockchain cannot be tampered. Since blockchain has a distributed network, it avoids a single point of failure. Today, every industry is trying to transition their business process to blockchain. Increasing number of users of crypto currencies is an indicative factor of the growth of blockchain technology, Figure 1.

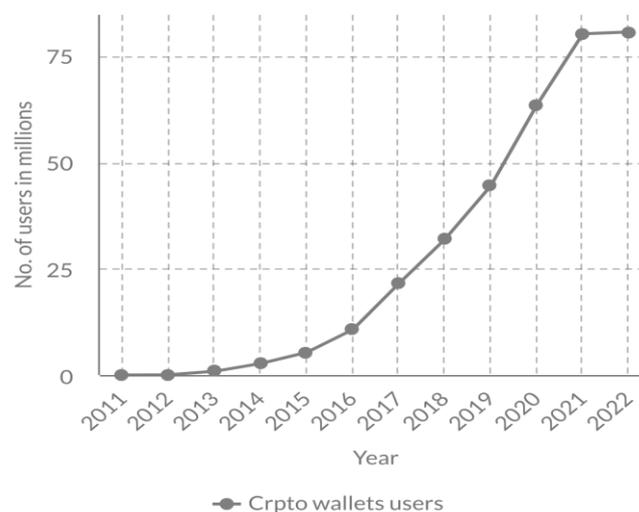


Figure 1. Number of crypto wallet users [1].

UNIVERSITY CERTIFICATES

Academic certificates are crucial for a graduate. These certificates convey their academic achievements and abilities. Employers depend on these certificates as one of the evaluating factors of a graduate. Currently, universities provide certificates as a hard copy. These are prone to damage over years or could be lost. Reapplying for a certificate is a cumbersome process. It is also hard to verify the integrity of the certificate. The cases of tampered or fake certificates still exist. The advancement in blockchain technology could be used to resolve this issue. Blockchain could give zero knowledge proof for the integrity of a certificate.

ETHEREUM

Ethereum is an open source blockchain technology. It supports smart contracts. Transactions on Ethereum are persistent and immutable. Ether is the native cryptocurrency of the Ethereum network. Users will have to pay a small gas fee for any transaction on Ethereum. The fee also depends on how much data has to be written to the contract. It is therefore ideal to store minimum data on the blockchain and achieve the desired outcome. The proposed system will only store the SHA256 hash of the certificate file.

Ethereum uses Proof of Work as a consensus mechanism. Proof of work requires a node to solve a complicated mathematical puzzle. Finding the solution of the puzzle should be hard, but validating the given solution should be easy. The puzzle should not be too hard that it makes it practically inefficient, nor too easy to allow DOS attack. Proof of Work has the following mathematical model.

An irreversible function f is defined for the entire network. For any transaction t , y is defined. A node is expected to find x such that,

$$f(x) = y. \quad (1)$$

where $x \rightarrow$ *Nonce* and $y \rightarrow$ *Required hash prefix*.

Now, consider 3 nodes that provide the answers as x_1 , x_2 and x_3 respectively. Any participating node can check which answer is correct by applying the function on the answers as follows:

$$f(x_1) = y_1, f(x_2) = y_2, f(x_3) = y_3.$$

Then they compare y_1 , y_2 and y_3 with y . The corresponding value of x for which $f(x)$ matches y is selected as the answer and the node who generated x is rewarded. The approval of the solution has to be done by 51 % of the participating nodes. Finding the value of $f(x)$ is a rather effortless process. So evaluation of the provided answer is easy.

ETHEREUM VIRTUAL MACHINE

Ethereum Virtual Machine (EVM) is a software platform based on blockchain. EVM helps developers to deploy smart contract bytecode. It is a Turing complete machine. Every full node of Ethereum blockchain will have an EVM implementation that runs the smart contract. EVM is more like a state machine. It will have a current state, take input and transition to another state:

$$F(S, T) \rightarrow S'. \quad (2)$$

where S is an old state, T is a valid transaction, F is an Ethereum state transition function, and S' is the new state.

SMART CONTRACT

Smart contract is a revolutionary technology that allows developers to deploy programs to blockchain to be run on EVM. Smart contracts were introduced in blockchain 2.0. This led to the emergence of distributed apps. The proposed system will use smart contracts to read and write data to the blockchain and to provide data privacy and security.

SOLIDITY

Solidity is the programming language used to write smart contracts for Ethereum. The smart contract for the system logic will be written in Solidity. A solidity program will consist of compiler version declaration followed by imports and contract definitions. A contract will consist of state variables, modifiers and functions. State variables track the current state of the contract. The function helps the contract to modify the state variable, access the state variable data or perform other transactions. State variables are changed by transactions. Once the smart contract is written, it is compiled using Solidity compiler. The bytecode generated is deployed on the EVM. All interaction of the system with the blockchain will be through this smart contract.

The main motivation to build this system is the rising cases of forged certificates. Academic certificates are one of the deciding factors for employment and higher studies. According to the current system, it is easy to forge a certificate or edit an existing certificate. It is practically impossible to check the integrity of all the certificates by an employer. So the employer will have to depend on the moral ethics of the candidate to trust the integrity of the certificate presented. Using forged certificates, candidates manage to secure undeserving benefits. The proposed system provides a trustworthy portal to the employers for dependable student certificates. The system also makes the certificate generation and distribution process more efficient and error free. It automates the process of distributing the certificate to the students. This saves a lot of time and effort for the university. This article focuses on building a decentralised app that could generate student certificates. The generated certificate is stored and distributed to the students. Our system also provides a portal to verify the integrity of the certificate by comparing the hash stored on the blockchain against the hash of the certificate under test.

The rest of the article is structured as follows: section two contains details of literature survey, detailed methodology is explained in section three, results and discussions are explained in section four, and at last conclusions are drawn in section five.

LITERATURE SURVEY

Significant research has been done so far towards certificate generation and maintenance with and without blockchain technology. Some of such important and recent works were reviewed and mentioned as follows.

Blockchain is an emerging technology. It is finding its way into the digital world quickly. Today, all the sectors are trying to implement blockchain in their business process. One of the main reasons blockchain is emerging as a candidate solution to all real world problems is trust. Blockchain is highly trustable. Authors in [2] talk about how blockchain's immutable nature helps people develop trust in decentralised apps. This helps blockchain to be used in many crucial applications. In [2], the authors have developed a voting system using blockchain. Since this system is decentralised and distributed over blockchain, it is impossible to tamper the result. Hence, it makes the election process more trust-able, transparent and efficient.

Blockchain can be used in machine learning and IOT based applications as well [3]. This manages the trust element of the system. Another application of blockchain technology in IoT devices is studied in [4]. Here, the authors use blockchain for tamper proof authentication and authorization. The botnet detection system mentioned in [5] proves that blockchain solution could be integrated with a smart city network to derive the best possible system. Article [6] shows how blockchain could be used as a supporting service for IoT and Deep Learning applications to detect BotNet attacks.

Smart contract is the programmable part of the blockchain [7]. Smart contract lets developers implement custom logic, store it on the blockchain, and run it on Ethereum Virtual Machine. The authors in [7] talk about how smart contracts could be used to create a greater extent of trust between transacting parties. The emergence of smart contracts paved the way for contract automation, they are executed when certain conditions are met. Smart contracts ensure both the parties can depend on the successful completion of the contract transaction as per the condition in the contract.

All these features of blockchain could be used to successfully develop a system that could generate and distribute student certificates that are tamper proof. [8] shows how the potential of blockchain and smart contracts could be exploited for this application. Here [8], the authors have discussed the features of blockchain that helps universities to generate tamper proof and transparent student certificates.

In [9], the author has developed a decentralised app based on hyperledger. They have used chaincode to interact with the blockchain. They generate the certificate, encrypt it, and store it on IPFS. The hash of the certificate and the link to the certificate file stored on IPFS is stored on the transaction written to the hyperledger. Storing files on IPFS is one of the efficient ways to avoid single point of failure [10]. IPFS is a protocol used to distribute multimedia files across the nodes in the network. The main objective of [10] is to let the students request for the certificate, the University to approve the certificate and the employer to verify the certificate. Article [11] focuses mainly on automating the certificate generation process. It also uses a hyperledger system to store transaction details about certificate generation. It provides a way to transfer the ownership of the certificate to another institute, in case of certificate transfer.

Another concern of certificate forgery is regarding certificates provided for online courses [12]. Online course completion certificates could be forged easily. The author of [12] has proposed a way to address this issue using blockchain. They have also included a module to transfer the credits so obtained from online courses into other academic courses. All these certificate generation, validation and credit transfer are counterfeit proof. Meaning, nobody could generate a fake certificate and transfer non earned credits to other courses.

One of the economical yet tamper proof ways to generate certificates is to use a centralised database for certificate storage and store only the hash of the certificate on the blockchain [13]. This way, it is easy to find the hash of a particular certificate from the blockchain and compare it with the certificate under test to check its integrity. Using a centralised database might introduce a single point of failure, but it could be resolved by using a cloud storage that stores different copies of your database on many servers. This approach is more economical as writing to blockchain is a costly transaction.

Belurgikar et al. propose a blockchain system for identity management [14]. Through this system, students' profiles are stored on blockchain. The access to these profile data is protected. Also since it is on blockchain, the identity management process is transparent. Table 1 summarises literature survey, while Table 2 provides additional data from utilised literature sources.

METHODOLOGY

The system mainly consists of 3 modules. One module for the students to request for the transcript, one for the admins to verify and approve certificate requests and one for any 3rd party to verify the integrity of the certificate. There are 2 logical modules – the smart contract module and the web app module that interacts with the smart contract. Logical modules differentiate and divide the logical part of the system. This approach helps to build the system in a modular approach, which will be highly flexible and easy to scale up.

Table 1. Summaries of related articles.

Ref.	Objective	Proposal	Drawbacks
[8]	Certificate generation and distribution system using blockchain for verification.	Used smart contracts to store certificate details on blockchain.	Centralised database.
[9]	Tamper proof certificate management.	Used hyperledger for blockchain needs, IPFS for certificate storage and elliptic curve encryption for certificate encryption.	Chances of disappearing certificates from IPFS if no node has pinned it.
[10]	Secure certificate validation system.	Used smart contracts, remix online IDE, and IPFS to generate and store certificates.	Client users will require an Ethereum account and meta mask extension to run the software.
[11]	A secure system to transfer academic certificates from one university to another.	Uses hyperledger to transfer and verify certificates.	The system cannot generate the certificate nor guarantee the availability of the certificate.
[13]	Multisignature blockchain based certificate generation and storage.	Used Bitcoin transactions to store the certificate hash in blockchain.	Centralised database, no smart contract or chaincode.
[15]	Blockchain based app to distribute and validate certificates.	Used Unicoi to store certificate hash on blockchain for verification.	Uses a private/custom Unicoi network, availability of the certificate is not guaranteed.
[16]	Automated system to generate and verify certificates.	GUI based certificate designing, centralised database to store and verify certificates	Completely depend on the issuing authority for certificate availability and verification. Certificate manipulation is possible.
[17]	Certificate digitization and verification using blockchain.	Convert the physical certificate to digital certificate, store its hash on blockchain.	No guarantee of the availability of the certificate.
[18]	Certificate verification using smart cards.	Generate a UID for certificates, encrypt it and store it on a smart card. Use this UID for verification.	Depend on the availability and integrity of the university for certificate verification.
[19]	Store certificate details on a QR code to save space.	Generate the QR code for the certificate and encrypt it.	Depend on a centralised service for availability and verification of the certificate.

Table 2. Analyzing parameters implemented in related articles.

Reference	Document hash on blockchain	Generate document	Document verification	Decentralised document storage	Encryption	Centralised document storage
[8]	✓	✓	✓	X	X	✓
[9]	✓	✓	✓	✓	✓	X
[10]	✓	✓	✓	✓	X	X
[11]	✓	X	✓	X	X	✓
[13]	✓	✓	✓	X	X	✓
[15]	✓	✓	✓	X	X	✓
[16]	X	✓	✓	X	X	✓
[17]	✓	✓	✓	X	X	✓
[18]	X	X	✓	X	✓	✓
[19]	X	✓	✓	X	✓	X

SMART CONTRACT MODULE

Smart contracts are the backbone of this system's security. It interacts with the blockchain to read and write data related to the system. Here, the smart contract stores the hash of the certificate as a mapping, mapped from certificate id to certificate hash. It also stores the details of admins and the owner of the contract. Only the owner is allowed to add new admins. Only the admins can approve certificate requests. Owner is also an admin.

Moreover, it has 4 functions, `add_hash`, `get_hash`, `add_admin` and `remove_admin`. `add_hash` takes in 2 arguments, the certificate ID and its hash. Only admins can call this function. The smart contract also prevents overriding existing certificate hash. `get_hash` takes in 1 argument, the `certificate_ID`. If the hash of the given certificate exists, it returns the hash, else it returns null. `get_hash` is a public function that can be called by anybody. `add_admin` and `remove_admin` take in the address of the admin to be added to the list of admins or removed from the list of admins, respectively. These functions can only be called by the owner of the contract. The one who deploys the contract becomes the owner of the contract.

add_hash logic:

1. Input `certificate_id`, `certificate_hash`, `sender_address`.
2. Check if the sender is an admin.
3. If the sender is not an admin, revert the transaction.
4. Else, check if the `certificate_id` already exists.
5. If it already exists, then revert the transaction.
6. Else, add the hash to the mapping as below.

certificate_hash(certificate_id) → certificate_hash

get_hash logic:

1. Input certificate_id.
2. Fetch certificate_id from certificate_hash mapping.
3. Return fetched certificate_hash if it exists.
4. Else return an empty string.

The identity of the person interacting with the contract is authenticated using the private key of the user's Ethereum account.

There will be a contract helper program running on the backend web app server. This program establishes communication between the web app and the deployed contract. All requests to the contract from the webapp happens through this helper program.

WEB APP

Web App manages the front end interaction, centralised database handling, and the overall user experience of the system. Web app consists of 3 modules. Through these modules, users can request for certificates, generate certificates and verify the certificate.

Request Certificate Module

This module collects data from the students with the help of a HTML form. The data includes their personal details and academic course works. Then it commits these data to the centralised database. It will mark the certificate as yet to be approved in the database. This field helps differentiate uncertified certificates from certified certificates.

The database is private and cannot be accessed without authentication. So the system maintains user privacy. This database is common to the entire system. Any module within the system can access this database. Certificate generation module uses the data from this database to generate the certificate.

Approve Certificate Module

This module could only be accessed by university admins. They can open this module, view the certificate requests made, and approve the certificate requests if it is a valid request. When the admin logs in, the system collects the list of yet to be approved certificate requests from the database and displays them in the home screen. Admins can choose any certificate for verification and approval. Figures 2-4 depict described relations.

Verify Certificate Module

The integrity of the certificate is verified through this module. This module takes in the certificate(c') under test and its certificate ID. It calculates the hash(d') of c' and compares it with the hash present on the blockchain(d). If both the hash matches, it shows that the certificate is valid. If the hash does not match, it shows that the certificate is invalid, Figures 5-6.

$SHA256(c') \rightarrow h'$
 $hexdigest(h') \rightarrow d'$
If $d' = d$, then
 "The certificate is valid."
else
 "The certificate is invalid."

where $c \rightarrow$ Actual certificates, $c' \rightarrow$ Certificate under test, $h \rightarrow$ hash of actual certificates, $h' \rightarrow$ hash of certificate under test, $d \rightarrow$ hexdigest of h , $d' \rightarrow$ hexdigest of h' .

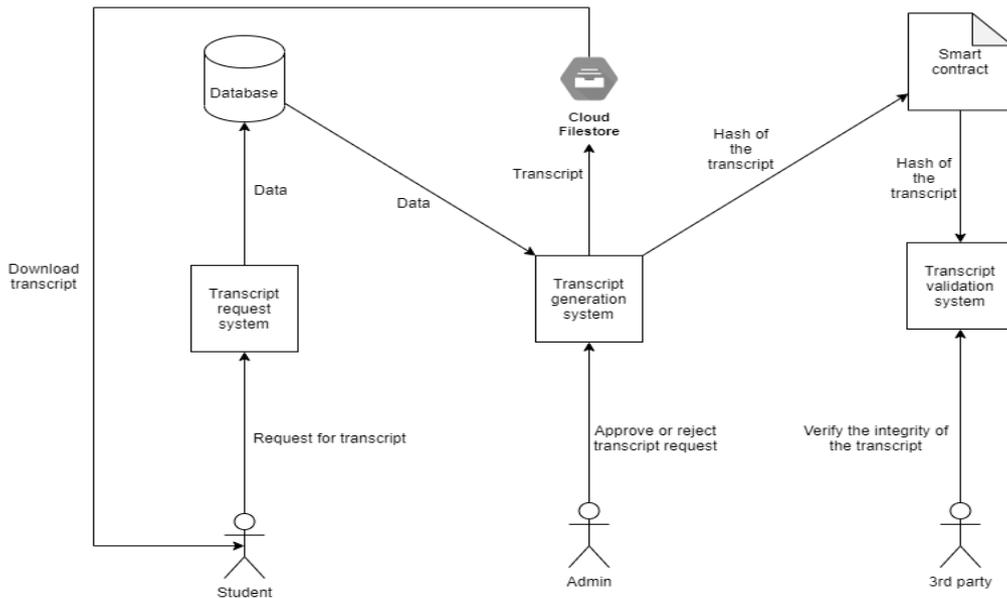


Figure 2. Interaction between different modules.

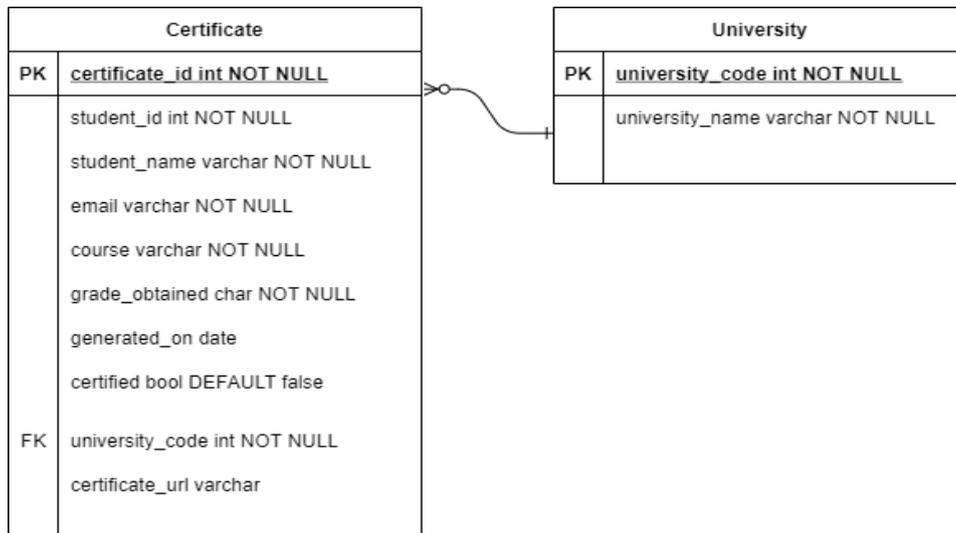


Figure 3. Database schema.

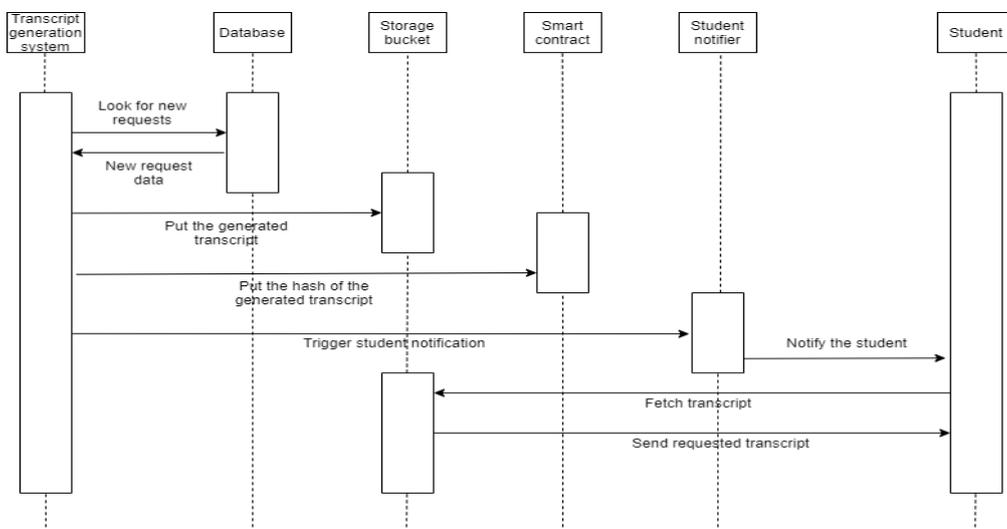


Figure 4. Certificate generation system sequence diagram.

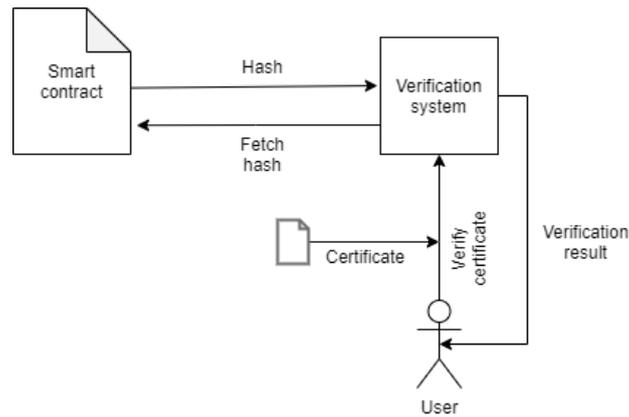


Figure 5. Hash Verification flow diagram.

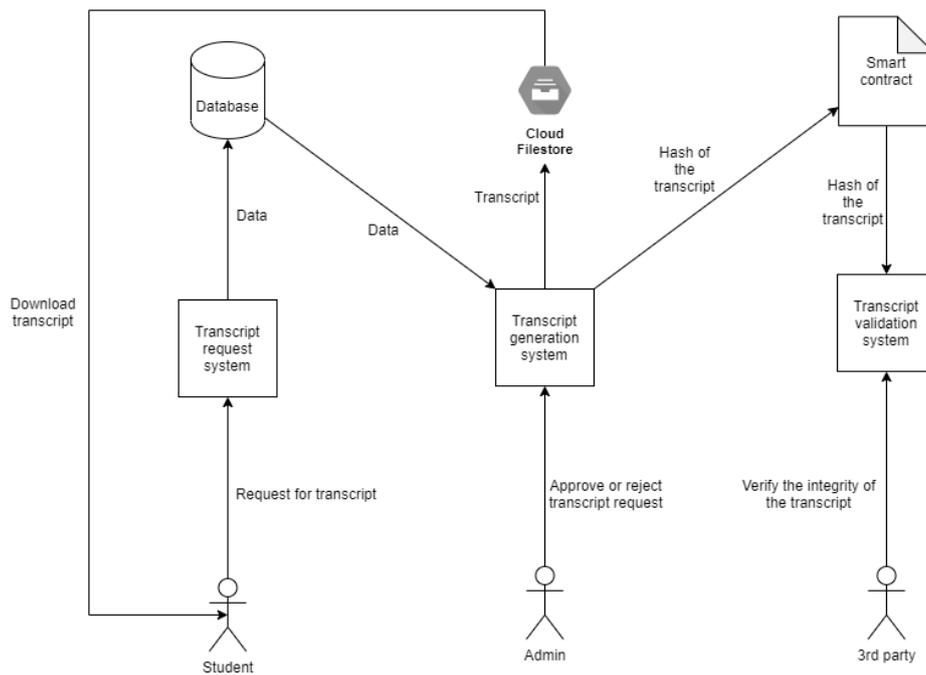


Figure 6. Interaction between different modules.

RESULTS

The end product of our system is a web app that can generate, distribute and verify certificates. The app can be deployed on any university network. Once deployed, students can start applying for certificates, admins can start approving certificate applications and employers can start verifying certificates. As students are filling out their certificate details, the chance of human error is less. Admins can log in, verify the details and approve the certificate. This procedure takes less time compared to manual processes.

The landing page of the app is shown in Figure 7. From there users can navigate to different pages as per their role.

A student can navigate to the request certificate page. Certificate request page consists of a form. Student has to fill out this form to provide his personal and academic details. Once he/she has filled the form, he/she can request for the certificate and wait for the approval by the university admins. The request certificate form is shown in Figure 8.

When the admins approve the certificate request, the student gets an email notification. The email will also contain the link to download the generated certificate from the storage bucket.

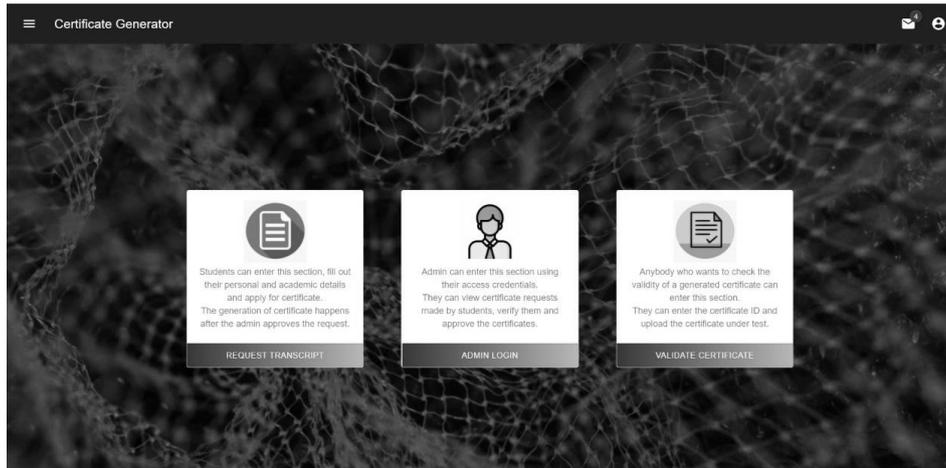


Figure 7. Home screen.

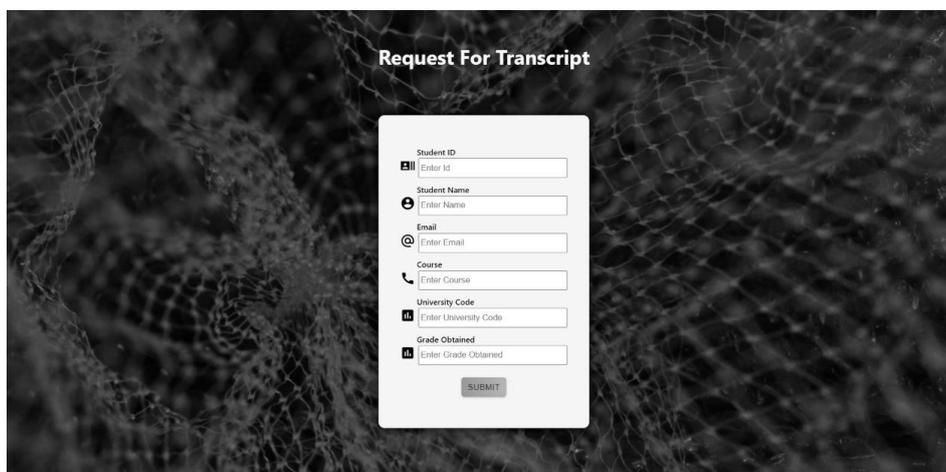


Figure 8. Request certificate page.

An admin can navigate to the admin login page from the landing page. Admins will have to enter their login credentials to access the admin page. Once the admins have logged in, they can view the certificate requests made and approve the requests accordingly. Admin page is shown in Figure 9.

When the certificate is approved, the generated certificate is stored in the Firebase storage bucket. The storage bucket is shown in Figure 10.

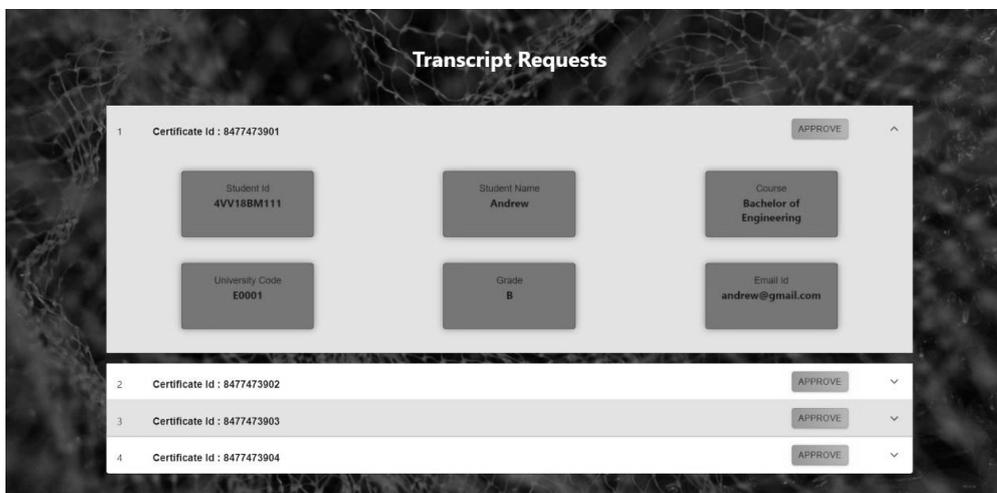
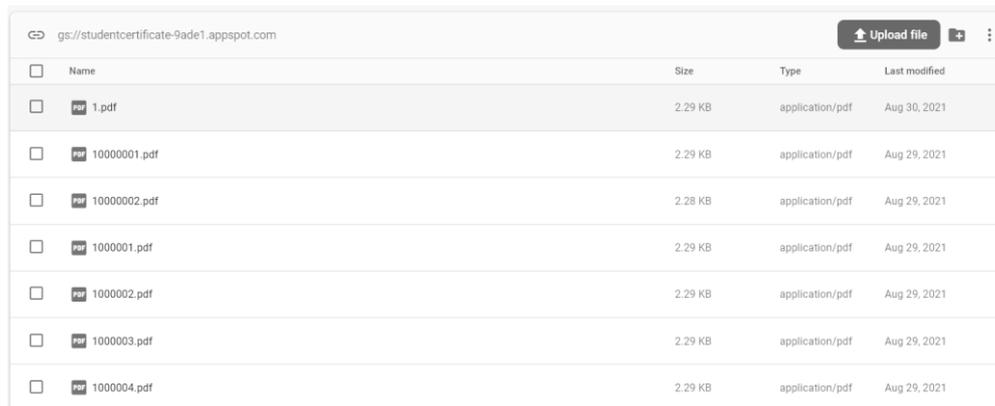


Figure 9. Certificate approval page.



Name	Size	Type	Last modified
1.pdf	2.29 KB	application/pdf	Aug 30, 2021
1000001.pdf	2.29 KB	application/pdf	Aug 29, 2021
1000002.pdf	2.28 KB	application/pdf	Aug 29, 2021
1000001.pdf	2.29 KB	application/pdf	Aug 29, 2021
1000002.pdf	2.29 KB	application/pdf	Aug 29, 2021
1000003.pdf	2.29 KB	application/pdf	Aug 29, 2021
1000004.pdf	2.29 KB	application/pdf	Aug 29, 2021

Figure 10. Firebase storage.

Anybody who wants to verify the validity of the certificate can go to the validation page from the landing page. Validation page consists of a form that takes in certificate ID and PDF certificate under test and informs the user if the certificate is valid or not. Validation page is shown in Figure 11.

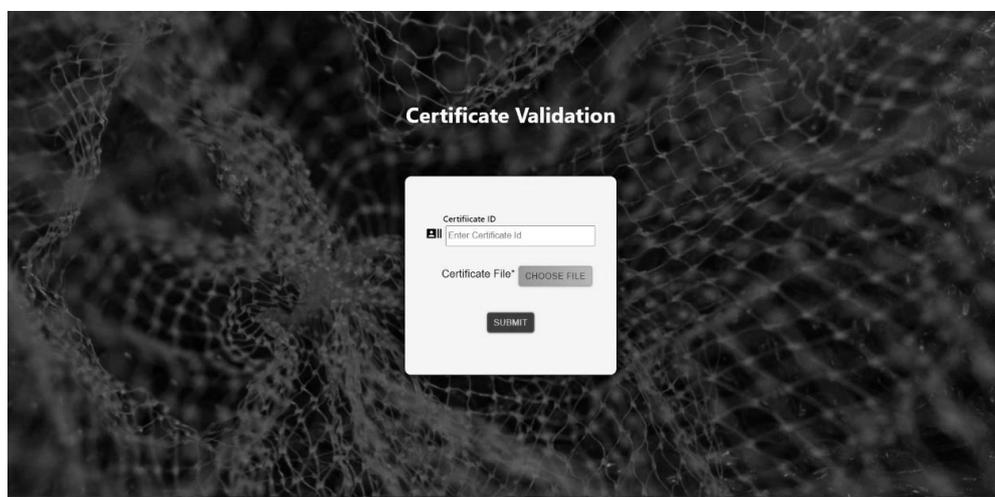


Figure 11. Validation page.

The hash of the certificate is stored on the blockchain. The transaction details of storing a hash on the blockchain is shown in Figure 12.

Blockchain provides a decentralised database to store data. As blockchain is decentralised and involves a lot of individual parties who are spending their resources to mine the transaction, they will be charging clients who perform the transaction to compensate for the resources they spent. This charge is called gas fee. This gas fee could get high quickly. The gas fee depends on the gas spent for a transaction and the price of the gas at the time of transaction. On Ethereum mainnet, the gas fee is paid in ETH. Developers are required to pay attention to the data they store on blockchain to reduce the gas fee and make their system more cost efficient. This is one of the main concerns of decentralised applications.

Data chunks of different sizes are stored on the blockchain to study to dependence of cost of transaction on data size. The result of the analysis is shown in Figure 13. Our analysis shows that as the size of the data stored on the blockchain increases, the gas fee also increases. So, it is deemed necessary to find out a cost efficient amount of data to be stored on the blockchain such that the certificates are easy to verify and the gas fee is feasible, yet impossible to tamper the certificate. SHA256 hash of the certificate is found to be an ideal metadata to check the integrity of the certificate. SHA256 makes it impossible to modify the certificate, because a simple modification in the certificate will create a hash mismatch with the hash of

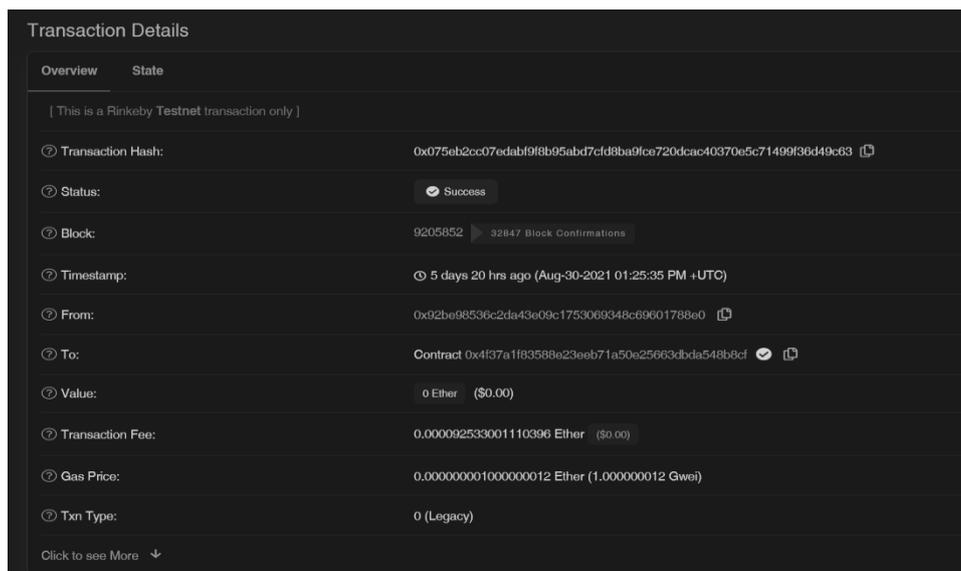


Figure 12. Transaction receipt.

the original certificate. By using SHA256 only 64 characters hexdigest of the hash is stored on the blockchain, which is cost efficient compared to storing the entire meta data of the certificate. It also speeds up the transaction process. This analysis is conducted on Ethereum Rinkeby test network as depicted in Figure 13.

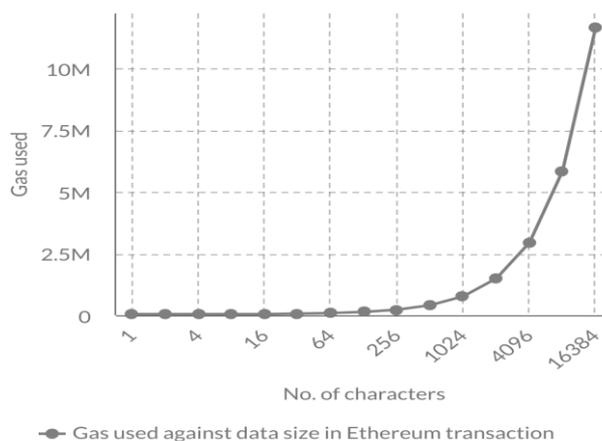


Figure 13. Transaction fee comparison.

CONCLUSION

The article mainly focuses on a system that can generate, distribute and validate academic certificates with the help of blockchain. The entire process is seamless. It saves a lot of effort and resources for the university. It also provides a tamper proof platform to verify the integrity of the certificate. The security of the system is maintained by Ethereum blockchain. In other words, to compromise our system, the attackers will have to compromise 51 % of the Ethereum nodes. It is practically infeasible. The end product is a certificate management system that is secure, tamper proof and highly dependable. Our system will make it nearly impossible to create forged certificates.

At present, our system has defined an admin role for the university. As future enhancement, more roles can be included. This enables the university to pass the certificates through different levels of approval. The certificate flows through the hierarchy of admins of the university before it is issued to the student. A decentralised storage can also be added to the

system. This ensures that the certificates are still available even if the university database goes down. Another improvement would be to automate and generate certificates in batches using the result database of the university. This enables generation of multiple certificates simultaneously without requiring individual approvals.

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EXAMINING THE IMPACT OF VIRTUAL EXPERIENTIAL MARKETING ON E-STORE IMAGE AND E-STORE LOYALTY

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ABSTRACT

As a result of the changes in lifestyles, consumption habits, and consumer expectations in recent years, individuals prefer to buy experiences instead of just purchasing products and services. The basics of the economy accept consumption as an experience process and experiential marketing is gradually increasing its importance in our lives. The focus of experiential marketing is the idea that there is a hedonistic and experiential value surrounding the product and service, and even consumption itself, as well as the functional and utilitarian value that emerges with the purchase of a product or service. Today, with the widespread use of the internet and the development of information technologies, virtual experiential marketing has emerged. In this context, the aim of the research is to examine the effect of virtual experiential marketing on e-store image and e-store loyalty. Within the scope of the research, data were collected from 531 people using the online survey technique. Confirmatory Factor Analysis and Path Analysis were applied to the data with Partial Least Squares Structural Equation Modelling. According to the Confirmatory Factor Analysis results, the scale was found to be valid and reliable. According to the path analysis results, it was concluded that all of the virtual experiential marketing dimensions have a significant effect on the e-store image and that these dimensions positively and significantly affect the e-store loyalty through the e-store image. It was determined that e-shop image has an effect on e-shop loyalty.

KEY WORDS

virtual experiential marketing, e-store image, e-store loyalty, path analysis, pls-sem

CLASSIFICATION

JEL: M30, M31

INTRODUCTION

The experience economy, which gave priority to creating experience in economic activities in the 1990s, brought experiential marketing to the fore. Therefore, this situation has added excitement and fun to the annoying practices of traditional marketing and the winds of change have started [1]. Experiential marketing is a marketing concept that aims to create loyal customers by tapping into customer emotions and gives a positive feel to the products and services offered by the company. In this approach, the company creates a product or service by touching the senses, hearts and minds of customers [2]. Customer satisfaction occurs when products enable customers to have a memorable experience in a positive way, and satisfied customers continue to use the same product or service, turning into loyal customers and telling their experiences to others.

Gilmore and Pine [3] define experiential marketing as memorable events or experiences that engage the senses and engage the consumer individually by giving the consumer the necessary information to make a decision. Gentile, Spillerand and Noci [4] stated that customer experience results from a series of interactions that cause a reaction between a customer and a product, a company, or part of its organization. This experimentation is purely personal and expresses the participation of the client at diverse levels (rational, emotional, sensory, physical and spiritual).

The widespread use of the internet and the increasing competition among retailers, together with the time constraints in traditional shopping, the shopping environment and the decrease in perceived values, have led to the use of virtual experiential marketing practices [5]. Virtual experiential marketing encompasses a variety of applications such as chat rooms, interactive displays, virtual communities, blogs, online games to create an enriched experience through visual and auditory cues to create an immersive experience. Virtual experiential marketing is based on interfaces that act as intermediaries for real-world experiences, as opposed to a physical experience that directly affects the senses [6]. Therefore, an electronic virtual environment can interact with consumers, offer them unique experiences, arouse their emotional response, and ultimately enable businesses to gain competitive advantage and create customer loyalty [7].

Schmitt [8], after making some observations or participating in certain events, determined that there are certain stimuli that trigger consumers' motivation to make a purchase and proposed the concept of strategic experiential modules. These experiences (modules) include sensory experiences perceived by the five senses (perceiving), emotional experiences (feeling), creative cognitive experience (thinking), physical experiences, behavior and lifestyle (acting), and reference groups or cultural experiences to which one belongs (attribution). The goal is to create five distinct experiences of how consumers perceive, feel, think, act and relate.

In order to gain competitive advantage, create customer satisfaction and loyalty, businesses need to create a consumer experience rather than just offering products or services. When the atmosphere of the website appeals to the consumer's senses, emotions, thoughts, behaviors and relational experiences, positive attitudes towards the business, its products and services will develop. As a result, these positive attitudes will lead to e-shop image and e-shop loyalty. When the domestic and foreign literature is examined, generally, in studies, consumer experiences have been comprehensively examined in traditional offline environments, and while customer satisfaction, loyalty and purchase intentions are more discussed, no study has been found that deals with store image. In this context, the aim of this study is to reveal the effect of virtual experiential marketing and its sub-elements, Sensory, Emotional, Intellectual, Behavioral and Relational marketing, on e-store image and e-store loyalty. For this reason, it is thought that this study will contribute by filling the gap in the literature.

REVIEW OF LITERATURE

VIRTUAL EXPERIENTIAL MARKETING WITH E-STORE IMAGE AND E-STORE LOYALTY

Virtual experiential marketing, involves the marketing of a product or service through an experience on the internet. It covers the Internet and together with all the channels included it, as well as every types technology that offers an environmental experience enriched with visual and audio tools and produces a spiral experience. Customer experiences, which form the basis of the experiential marketing framework, consist of modules of perception, feeling, thinking, acting and relating. Businesses in order to succeed, must target all of these experiences at the same time and apply them appropriately to each other [8]. Hence an experience in order to achieve this goals; should include personal attention, novelty, surprise, learning and participation [9]. A positive virtual experience implemented by businesses should create e-store image and e-customer loyalty in customers. Hu, Ho and Hsieh [10] stated that creating an image through experiential marketing practices can affect consumer loyalty. In other words, the store image tool plays a role as a variable in creating customer loyalty through experiential marketing. In this direction, the following hypotheses have been created:

H₁: Virtual experiential marketing has an impact on e-store image.

H₂: Virtual experiential marketing has an impact on e-store loyalty.

SENSORY EXPERIENCE

It is the application of marketing strategies by addressing the senses of sight, taste, touch, hearing and smell to for create sensory experiences [11]. In the absence of a physical experience, sensory experience plays an important role in differentiating products and services, motivating customers, and adding values such as aesthetics / excitement to products [8]. The goal here is to create a sensory experience through image and sound [7]. The as attached a experience is to the senses, the so effective and memorable it will be [3]. Yoo, Park and MacInnis in a study conducted by [12], they revealed that sensory experiences such as store characteristics, product diversity and store atmosphere cause negative or positive emotions. Zaltman [13] argues that an experience, sensory or emotional, has a greater influence in shaping consumer preferences (creating image and loyalty) than the qualities of a product or service. In this extent, the following hypotheses have been created:

H_{1a}: Sensory experience has an impact on the e-store image.

H_{2a}: Sensory experience has an impact on e-store loyalty.

EMOTIONAL EXPERIENCE

Emotions are define as a situation to which a person feels good, elated, happy or satisfied in a situation [14]. Emotions, tend to drive consumers to make positive evaluations about a new stimulant, discover new alternatives and take risks. Therefore, the fact that a consumer achieved or realized achieved a hedonic experience will affect their loyalty to visiting a website or business. But when the consumer's experience does not meet their expectations, they may prefer to visit another site for better service [7]. In online retail, visual (color, tone, graphic, layout, design, etc.) and auditory cues, albeit to a limited extent, should be able to evoke emotional responses and convey information to consumers [15]. Stimulus-organism-response (SOR) model, a sign of Atmospheric at the consumer (i.e. in the organism), in order to provide a desired response, which leads to an emotional reaction to a stimulus when it may provides the targeted effect of the atmosphere (more explore and interact, and the desire to communicate with others, a sense of satisfaction) highlights [16]. Pine and Gilmore [3] argue

that the best relationships with costumers are sensory or emotional by its nature. Shaw [17] stated that at least 50 % of customer experience is related to emotions. At the same time, Shaw [17] stated that there is a strong relationship between the feelings of customers and their loyalty [18]. Hsu [19] and Chao and Kuo [20] stated that the emotions that experiential marketing creates for consumers increase consumers impression related to the business image. In their study, Atasoy and Marshap [21] concluded that emotional experiences are effective in creating customer loyalty and increasing the existing level of loyalty. Based on this information, the following hypotheses have been created:

H_{1b}: Emotional experience has an impact on the e-store image.

H_{2b}: Emotional experience has an impact on the e-store loyalty.

INTELLECTUAL EXPERIENCE

Intellectual (cognitive) experience includes experiences that lead customers to think about a particular topic and motivate them to lean on the this topic. It is aimed that customers will re-evaluate for the products or services offered by experiencing the problem solving experience. In this experience, communication is establish intend to inform more consumers [8]. The intellectual element of the experience is to encourage consumers to think in detail and creatively in order to re-evaluate products. In this way, it is aimed to bring innovative ideas to life [22]. A study conducted by Köse and Özer Cizer [23] found a positive relationship between intellectual experience with customer loyalty. Hypotheses established in the light of this information are as follows:

H_{1c}: Intellectual experience has an impact on the e-store image.

H_{2c}: Intellectual experience has an impact on the e-store loyalty.

BEHAVIORAL EXPERIENCE

Day [24] expressed behavioral experience through indirect actions (i.e., consumer loyalty) such as repeated purchases, a customer's value to the brand, and word-of-mouth communication. Behavioral experience enriches customers ' lives by targeting their physical experiences, showing alternative ways of doing things, alternative lifestyles, and interactions. Rational approaches to behavior change (i.e. theories of reasoned action) are just one of many behavior change options. Changes in lifestyles and behaviors are often more motivating, inspiring and emotional and are often motivated by role models (such as movie stars or athletes). This experience differs according to the social identities, cultural characteristics, lifestyles and demographic characteristics of the customers [8]. Köse and Özer Cizer [23] found a positive relationship between behavioral experience and customer loyalty in their study. Therefore, the hypotheses formed are as follows:

H_{1d}: Behavioral experience has an impact on the e-store image.

H_{2d}: Behavioral experience has an impact on the e-store loyalty.

RELATIONAL EXPERIENCE

Relational experience refers to the association of the product or service purchased by the customers with the social class, status or group the consumer belongs to or wants to be [8]. A community allows its members to share specific interests with each other, usually in the consumption context of a product or service [25] and focuses on achieving both personal and shared goals. Whether it's the group to you belong to or the group you want to belong to, often this situation encourages loyalty [26]. In relational experience, it is aimed to create a sense of belonging related to sensory, emotional, intellectual and behavioral experiences [27]. In this way, that entertains the senses and interacts with the consumer, creates positive attitudes,

evokes emotional reactions, facilitates the enjoyment of the shopping experience and creates a sense of belonging to a community, a website will create a positive attitude. In their study, Seock and Norton [28] found that websites that consumers rated among their favorites scored high in the “fun to visit” feature. In their study, Faiz and Kaplan [29] concluded that the meaningful and positive effect of relational experience on e-loyalty is supported by testing with customers who experience online book purchases. In this context, the following hypotheses have been created:

H_{1e}: Relational experience has an impact on the e-store image.

H_{2e}: Relational experience has an impact on e-store loyalty.

E-STORE IMAGE AND E-STORE LOYALTY

E-store image can be defined as the complexity of a consumer’s perceptions of a store on different (conspicuous) attributes [30]. Product variety, quality, price, atmosphere, staff, ease of shopping, brand, transportation, etc. elements form the image of the store [31, 32]. In recent years, online shopping has become one of the most popular forms of out-of-store retailing. While the number of websites is increasing rapidly, e-commerce marketing managers have faced serious competition. Therefore, creating an e-shop image has been one of the priorities [33]. In particular, the value of the website in terms of image is important in creating customer satisfaction and loyalty.

E-store image leads to many factors that will provide profitability to the retailer, such as e-customer satisfaction and e-customer loyalty. E-store image characteristics have a direct significant impact on e-loyalty [34, 35]. In general, the attitudes that result from a store image directly contribute to building loyalty. Therefore, designing an experience that includes clues to arouse positive attitudes goes beyond satisfaction and directly affects loyalty. The image of the store and the orientation of the store to customer relations is one of the most important ways to gain loyal customers. Factors such as store image, customer relations, positive impression, satisfaction, trust and commitment have a strong and positive effect on store loyalty [36].

It can be said that store image directly affects store satisfaction and indirectly affects loyalty [37]. Yoo and Chang [31] stated that the elements that make up the store image are the most important features that define store loyalty. Chang and Tu [34], Koo [35], Yun and Good [38] found in their studies that store image directly contributes to building loyalty. Based on this information, the following hypothesis can be formed:

H₃: E-store image has an impact on e-store loyalty.

RESEARCH METHOD

SAMPLE OF THE RESEARCH

The study group of the research consists of 531 people over the age of 18 who shop online. The data used in the study were collected by online survey method on 1-30 August 2021. The survey link was shared via social media and mobile communication applications and the participants were asked to fill it out. Data analysis was carried out on a total of 531 valid questionnaires that responded positively to the call.

DATA COLLECTION TOOL

In the study, a five-point Likert type measurement tool consisting of 38 statements was used. Among the statements in the scale, those related to virtual experiential marketing are from the study of Köleoğlu and Çolakoğlu [39]; Statements about e-store image and e-store loyalty are taken from Öztürk’s [40] study. The naming of the factors was also taken from the same scales as they were. In addition, there are ten more expressions in the measurement tool that

measure the demographic and online shopping characteristics of the participants. In the study, online survey method was preferred due to time, cost and pandemic conditions.

STATISTICAL TECHNIQUES USED

In the study, firstly, Confirmatory Factor Analysis with PLS-SEM was performed and the validity and reliability of the scale used in the research was examined. Then, the research model was tested with Path Analysis via PLS-SEM.

Although it is recommended to perform analysis on small samples (between 30-100) in the PLS-SEM method, it is also known that there is no definite rule regarding the number of samples [41]. However, when the sample size is 250 or more and there are the correct number of indicative variables (ie four or more variables), the results of the PLS-SEM with other structural equation models (CB-SEM: AMOS, Lisrel etc.) used to measure each construct almost the same accuracy [42]. Therefore, the PLS-SEM method was preferred in testing the research model in this study.

The data gathered from the participants are analyzed using SPSS program and SMARTPLS.

POPULATION AND SAMPLE

The demographics of the consumers in the research are given in Table 1 below.

According to Table 1, 56,3 % of the participants are women and 43,7 % are men. Considering the age distribution, the highest participation is between the ages of 18-26 with 78 %; the least participation is 0,8 %, with participants aged 54 and above. Considering the distribution of educational status, the highest participation is Undergraduate with 34,3 %; the least participation is in Postgraduate with 4,1 %. Considering the occupational distribution, the highest participation is students with 42,2 %; the least participation is in the tradesmen/traders with 3 %. Considering the monthly average family income, the highest participation rate is 71 % in those with an income of 3000 ₺ or less; the least participation is in people with an income of 6001-7500 ₺ with 2,4 %. Finally, 20 % of the participants are married and 80 % are single.

Again, according to Table 1, 15,1 % of the participants shop online once a week, 41,2 % once a month, 24,7 % every three months and 19 % every six months. Looking at the monthly online shopping amount, it is seen that 78,9 % of the participants spend 500 ₺ or less. It is seen that the most used online shopping site is Trendyol with 64,6 % and 77 % of the participants use the mobile application of the online shopping site.

SCALES: RELIABILITY AND VALIDITY

With PLS-SEM, the research model was tested with Confirmatory Factor Analysis and the factors' AVE, CR, rho_A, Cronbach Alpha and discriminant validity were examined. CR scores of 0,7 and above; If AVE scores are above 0,5 and all CR scores are greater than AVE scores, it can be stated that the scale provides convergent and convergent validity [43]. A scores between 0,60-0,79 for the Cronbach α coefficient, which is accepted as a measure of internal consistency, indicates that the scale is "quite reliable", and a scores between 0,80-1,00 indicates that the scale is "highly reliable" [44]. If the rho_A (Data Consistency Coefficient) is 0,70 and above, it can be said that the factor items are reliable [42]. The validity and reliability coefficients for the factors and the whole scores are as in Table 2.

Since the factor load value of the 13th item (ESI13) of the E-Store Image factor in the scale given in Table 2 is very low, it was excluded from the analysis and the validity and reliability coefficients were calculated accordingly.

Table 1. Demographics of the Participants.

Gender	Frequency	Percent	Profession/Sector	Frequency	Percent
Female	299	56,3	Public sector	41	7,7
Male	232	43,7	Private sector	77	14,5
Age	Frequency	Percent	Self-employment	70	13,2
18-26	414	78	Artisan/Merchant	16	3
27-35	58	10,9	Student	224	42,2
36-44	35	6,6	Other	103	19,4
45-53	20	3,8	Ave. Income per Month	Frequency	Percent
54 and above	4	0,8	3000 ₺ and below	377	71
Education Level	Frequency	Percent	3001-4500 ₺	81	15,3
Elementary and below	56	10,5	4501-6000 ₺	44	8,3
High school	168	31,6	6001-7500 ₺	13	2,4
Vocational school	103	19,4	7501 ₺ and above	16	3
Bachelor degree	182	34,3	Shopping Site	Frequency	Percent
Postgraduate	22	4,1	Gittigidiyor	18	3,4
Online Shop. Freq.	Frequency	Percent	Hepsiburada	55	10,4
Weekly	80	15,1	n11	11	2,1
Monthly	219	41,2	Sahibinden	16	3,0
Quarterly	131	24,7	Morhipo	7	1,3
Once in a six month	101	19	Cimri	7	1,3
Monthly Online Shop. Amount	Frequency	Percent	Akakçe	2	0,4
500 ₺ and under	419	78,9	Trendyol	343	64,6
501-750 ₺	77	14,5	Amazon	12	2,3
751-1000 ₺	22	4,1	Diğer	60	11,3
1001 ₺ and above	13	2,4	Mobile Shopping App.	Frequency	Percent
Marital Status	Frequency	Percent	Yes	409	77
Married	106	20	No	122	23
Single	425	80			
Total	531	100	Total	531	100

As seen in Table 2, the CR scores of all factors in the scale were 0,7 and above; It is seen that AVE values are 0,5 and above, and finally, all CR scores are greater than AVE scores. Accordingly, it can be said that the scale provides convergent and convergent validity.

Again, according to Table 2, the Cronbach α coefficient of all factors is 0,6 and above. In other words, the Sensory Experience factor is highly reliable, while the remaining six factors are highly reliable. In addition, the Cronbach α coefficient of the entire scale was found to be 0,951. Again, except for the Sensory Experience factor, the rest of the rho_A coefficient is above 0,7. Accordingly, all factors and the entire scale have high reliability. Therefore, it is seen that the scale used in the research is also reliable.

For discriminant validity, the Fornell-Larcker criterion coefficients proposed by Fornell and Larcker [45] were first examined. Findings related to the relevant statistics are as in Table 3.

Table 2. Findings Related to the Scale.

Factors	Items	Loadings	Cronb. α	rho_A	CR	AVE
Sensory Experience	SE1	0,783	0,647	0,684	0,759	0,519
	SE2	0,801				
	SE3	0,554				
Emotional Experience	EE1	0,592	0,825	0,844	0,878	0,594
	EE2	0,824				
	EE3	0,746				
	EE4	0,841				
	EE5	0,821				
Intellectual Experience	IE1	0,839	0,799	0,804	0,882	0,713
	IE2	0,853				
	IE3	0,841				
Behavioral Experience	BE1	0,751	0,810	0,814	0,875	0,638
	BE2	0,836				
	BE3	0,808				
	BE4	0,796				
Relational Experience	RE1	0,826	0,771	0,798	0,866	0,684
	RE2	0,876				
	RE3	0,776				
E-Store Image	ESİ1	0,691	0,917	0,919	0,930	0,525
	ESİ2	0,752				
	ESİ3	0,701				
	ESİ4	0,740				
	ESİ5	0,764				
	ESİ6	0,762				
	ESİ7	0,739				
	ESİ8	0,762				
	ESİ9	0,664				
	ESİ10	0,677				
	ESİ11	0,663				
	ESİ12	0,751				
	ESİ13	0,392				
E-Store Loyalty	ESL1	0,624	0,877	0,885	0,930	0,578
	ESL2	0,781				
	ESL3	0,782				
	ESL4	0,734				
	ESL5	0,772				
	ESL6	0,795				
	ESL7	0,817				

Table 3. Fornell & Larcker Criterion Coefficients.

	Behavioral Experience	Emotional Experience	Sensory Experience	Intellectual Experience	Relational Experience	E-Store Image	E-Store Loyalty
Behavioral Experience	0,799*						
Emotional Experience	0,491	0,711*					
Sensory Experience	0,491	0,528	0,720*				
Intellectual Experience	0,593	0,551	0,525	0,844*			
Relational Experience	0,609	0,357	0,424	0,475	0,827*		
E-Store Image	0,632	0,649	0,545	0,627	0,581	0,724*	
E-Store Loyalty	0,528	0,538	0,391	0,475	0,441	0,628	0,760*

*the square root of the AVE values are included in the diagonal elements

In the Fornell and Larcker criteria, the square roots of the AVE scores should be higher than the correlation coefficients between the factors [45]. According to the findings in Table 3, it is seen that all factors meet the Fornell and Larcker criteria.

Also in the study, Henseler, Christian and Sarstedt [46] Heterotrait-Monotrait ratio coefficients were also examined. Findings related to the relevant statistics are as in Table 4.

Table 4. Heterotrait-Monotrait Ratio Coefficients.

	Behavioral Experience	Emotional Experience	Sensory Experience	Intellectual Experience	Relational Experience	E-Store Image	E-Store Loyalty
Behavioral Experience							
Emotional Experience	0,603						
Sensory Experience	0,704	0,726					
Intellectual Experience	0,735	0,679	0,746				
Relational Experience	0,764	0,437	0,641	0,595			
E-Store Image	0,726	0,740	0,723	0,727	0,673		
E-Store Loyalty	0,625	0,620	0,539	0,560	0,535	0,691	

Heterotrait-Monotrait ratio is the ratio of the correlation mean of the factor in the model to the geometric mean of the correlation coefficient of the same factor, and the ratio is expected to be less than 0,85 [46]. According to the findings in Table 4, the coefficients of all factors are below 0,85. Therefore, it is seen that the scale also provides the criterion coefficient of the Heterotrait-Monotrait ratio.

According to the result of Confirmatory Factor Analysis, the coefficients related to the validity and reliability of the scale were revealed and according to the findings obtained, it was seen that the scale used in the study was valid and reliable. After the validity and reliability of the scale, the model was tested with Path Analysis.

STRUCTURAL MODEL AND TESTING HYPOTHESES

The research model is given in Figure 1.

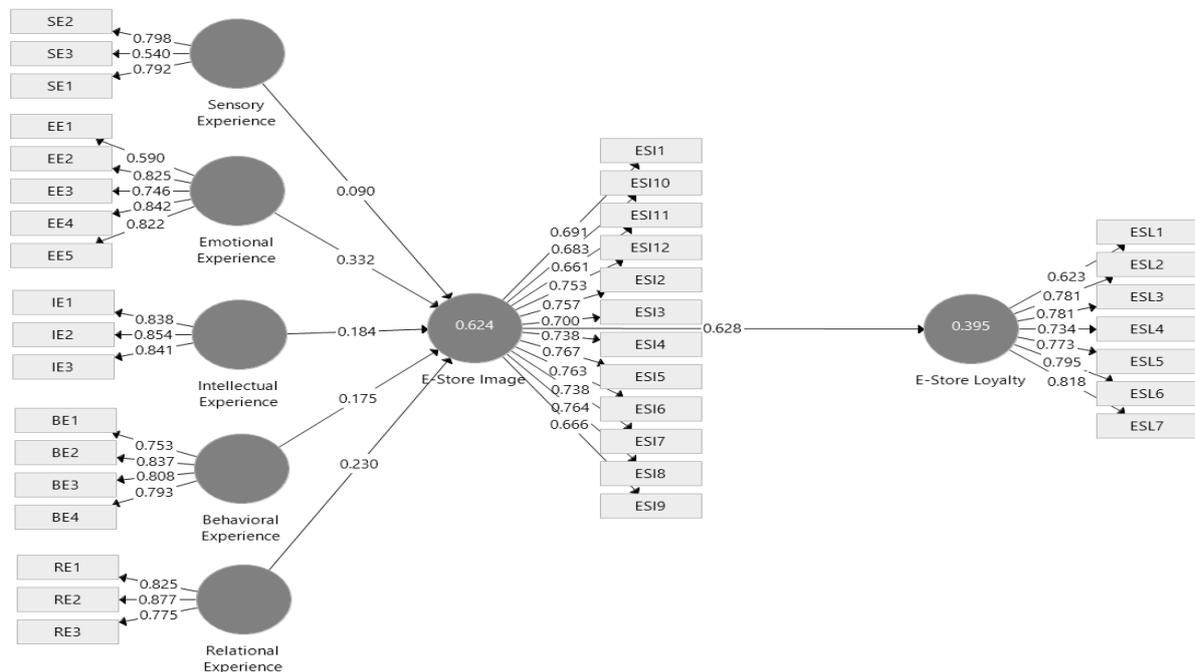


Figure 1. Path Diagram of the Research Model.

As a result of testing the research model given in Figure 1 with PLS-SEM, E-Store Image is explained by 9 %, Emotional Experience by approximately 33 %, Intellectual Experience by approximately 18 %, Behavioral Experience by approximately 18 %, and Relational Experience by approximately 23 %. In other words, Virtual Experiential Marketing sub-factors affect the E-Store Image by 62 % in total. The E-Store Image factor, which is affected by Virtual Experiential Marketing factors, also explains the E-Store Loyalty factor by approximately 39 %. A 5000-unit bootstrap was applied to test the significance of the path coefficients in the model. Accordingly, the significance of the path coefficients in the model is given in Table 5.

Table 5. Significance of Path Coefficients.

Paths	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (O/STDEV)	P Values
H_{1a}: Sensory Experience → E-Store Image	0,090	0,093	0,039	2,323	0,021
H_{1b}: Emotional Experience → E-Store Image	0,332	0,328	0,045	7,418	0,000
H_{1c}: Intellectual Experience → E-Store Image	0,184	0,186	0,043	4,330	0,000
H_{1d}: Behavioral Experience → E-Store Image	0,175	0,174	0,049	3,574	0,000
H_{1e}: Relational Experience → E-Store Image	0,230	0,231	0,042	5,427	0,000
H₃: E-Store Image → E-Store Loyalty	0,628	0,629	0,033	18,907	0,000

For path coefficients to be significant in PLS-SEM, t values must be greater than 1,96. Since the t scores of all roads in Table 5 are greater than 1,96, all paths established in the model are significant. Accordingly, H3 and H1 and H1s' below hypotheses were accepted.

Indirect effects can be seen in PLS-SEM. Accordingly, Table 6 showing the indirect effects of Virtual Experiential Marketing sub-factors on E-Store Image over E-Store Loyalty is as follows.

Table 6. Significance of Path Coefficients.

Paths	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics ((O/STDEV))	P Values
H_{2a}: Sensory Experience → E-Store Image → E-Store Loyalty	0,057	0,059	0,024	2,320	0,021
H_{2b}: Emotional Experience → E-Store Image → E-Store Loyalty	0,208	0,206	0,031	6,796	0,000
H_{2c}: Relational Experience → E-Store Image → E-Store Loyalty	0,144	0,145	0,028	5,140	0,000
H_{2d}: Behavioral Experience → E-Store Image → E-Store Loyalty	0,110	0,110	0,032	3,456	0,001
H_{2e}: Intellectual Experience → E-Store Image → E-Store Loyalty	0,116	0,117	0,026	4,372	0,000

According to the findings in Table 6, all the ways showing the indirect effect are significant ($p < 0,05$). Accordingly, Sensory Experience affects e-Store Loyalty indirectly by approximately 6 % positively. Emotional experience indirectly affects E-Store Loyalty positively by approximately 21 %. Relational Experience indirectly affects E-Store Loyalty by approximately 14 % positively. Behavioral Experience indirectly affects E-Store Loyalty by 11 % positively. Finally, Intellectual Experience affects E-Store Loyalty indirectly by approximately 12 % positively. As a result, it is seen that Virtual Experiential Marketing sub-factors have positive and indirect effects on E-Store Loyalty. With this result, the hypotheses H2 and its sub-hypotheses were also accepted.

Three different fit indices, SRMR, NFI and χ^2 values, are used to test the significance of the model established in PLS-SEM [42]. It should be $SRMR < 0,08$ and $NFI > 0,90$. In this context, $SRMR = 0,070$, one of the goodness-of-fit scores of the research model; $NFI = 0,922$ and $\chi^2 = 3240,743$. According to these scores, it can be said that the model fits well. Therefore, the model established by the researchers can be said to be statistically significant and valid.

R^2 (Coefficient of Determination), f^2 (Effect Size Coefficient) and Q^2 (Predictive Fit Value) values are used for the structural analysis of the model in SMARTPLS. The fitness values of the research model are given in Table 7, Table 8 and Table 9 below, respectively.

The results showing the coefficients of certainty in the analysis of the research model are shown in Table 7.

For R^2 values, 0,19 is weak, 0,33 is moderate, and 0,67 is significant [48]. According to Table 7, two variables are explained at a moderate level.

Table 7. Coefficient of Determination.

Dependent Variables	R²	Adjusted R²
E-Store Image	0,628	0,625
E-Store Loyalty	0,393	0,391

The f^2 value, indicative of the effect size, indicates the level of explanation of the endogenous variable for each exogenous variable, and 0,02-0,14 is considered low, 0,15-0,34 moderate, 0,35 and above high [49]. The effect size coefficients obtained as a result of the analysis are given in Table 8.

Table 8. Effect Size Coefficients.

Variables	E-Store Loyalty	E-Store Image
Behavioral Experience		0,043
Emotional Experience		0,164
Sensory Experience		0,016
Intellectual Experience		0,046
Relational Experience		0,089
E-Store Image	0,646	
E-Store Loyalty		

According to Table 8, the effect level of Emotional Experience on the E-Store Image is moderate, while those of other factors are low. The effect of the E-Store Image on E-Store Loyalty is high. Finally, Table 9 shows the predictive fitness of Stone-Geisser's Q^2 .

Table 9. Stone-Geisser's Q^2 Coefficients.

Total	SSO	SSE	$Q^2 = 1-SSE/SSO$
Behavioral Experience	2124,000	768,729	0,638
E-Store Loyalty	3717,000	1509,438	0,594
E-Store Image	6372,000	2992,990	0,530
Emotional Experience	2655,000	1079,195	0,594
Intellectual Experience	1593,000	456,7123	0,713
Relational Experience	1593,000	503,635	0,684
Sensory Experience	1593,000	767,7431	0,518

The Q^2 fitness value is a criterion that shows how well the values observed by the model and its parameter estimates are reconstructed [48]. $Q^2 > 0$ indicates that the model provides predictive fit, while $Q^2 < 0$ indicates that it does not. According to Table 9, the Q^2 value of all variables in the model is positive. In this context, it is seen that all variables in the model provide predictive fitness.

DISCUSSION, CONCLUSION, AND SUGGESTIONS

Today, consumption provides customers with more meaningful or valuable experiences rather than the features and functions of goods and services. In other words, the consumption experience itself is richer in value compared to the good or service. Consumers who want to enjoy the experiential aspects of their shopping are motivated by the shopping process, relative to the purpose or results of the shopping. That is why creating experiences is a good way to connect with customers. Therefore, as a result of the experiences of individuals, their image and loyalty towards the store will increase. In this context, in this study, the effect of virtual experiential marketing on e-store image and e-store loyalty is discussed. In addition, the second aim of the study is to compare the virtual experiential marketing elements, e-store image and e-store loyalty variables according to the demographic and online shopping characteristics of consumers. In line with the analyzes made within the scope of the research, the following results were obtained:

According to the results of the analysis made to determine the effect of virtual experiential marketing on the e-store image; it has been determined that virtual experiential marketing dimensions (sensory, emotional, intellectual, behavioral and relational experiential) have a significant effect on the e-store image. Therefore, the hypotheses H_{1a}, H_{1b}, H_{1c}, H_{1d} and H_{1e} were accepted. Hsu [19] and Chao and Kuo [20] stated that the emotions created by experiential marketing for consumers increase consumers' impression of the company image. This result is in agreement with the results of the study. Another finding obtained from the research is that virtual experiential marketing has a positive and significant effect on e-store loyalty through the e-store image. There are studies showing parallelism with this finding. Thomas [47] and Hu et al. [10], it has been determined that the store image has a mediating effect in creating customer loyalty with experiential marketing practices. Finally, it was concluded that e-shop image has an effect on e-shop loyalty. Thus, hypothesis H₃ was also accepted. In the studies conducted by Chang and Tu [34], Koo [35], Yun and Good [38], it was determined that the image of the store can have a direct and significant effect on loyalty. This result is similar to the findings of the present study.

In the light of these findings, it can be said that with the development and progress of information technology, consumption will become more realistic with techniques such as simulation and virtual reality. For this reason, customers should be encouraged to buy by analyzing them through experiential marketing practices over the internet. In addition, managers should try to improve experiential marketing in the virtual world and increase e-image and e-loyalty through experiential marketing practices in the virtual environment.

LIMITATIONS

The most important limitation of the study is the use of quantitative analysis techniques. Since experiential marketing practices are personal, it is important to construct them from a qualitative point of view in order to obtain more descriptive results. In future studies, it will be possible to reach different results in the analyzes to be made with qualitative research techniques. Secondly, the fact that the data were collected in August, and most of the people were on vacation this month, may have affected the quality and quantity of people reached. Therefore, in this case, it may have affected the results. Therefore, the results cannot be generalized.

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COMPETENCIES OF UNIVERSITY TEACHERS AND CHANGES FOR WORKING IN THE KNOWLEDGE SOCIETY

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ABSTRACT

In a post-industrial society, knowledge has replaced capital as the main source of economic development in developed and developing countries. Due to the fact that universities have traditionally been places of research and “knowledge production”, it has become necessary to analyze higher education systems in order to rationalize them and stimulate their maximum efficiency. Universities are required to contribute to the building of a knowledge-based society. At the same time, demands placed on the academic profession are also increasing, as it is expected to improve the quality of teaching, pursue research projects, and deal with managerial and administrative tasks, regardless of the already existing scientific research and teaching workload. Hence, apart from the traditional activities such as research and teaching, competencies of university teachers now also include the ability to do institutional work, cooperation with other institutions, administrative and managerial activities, use of new knowledge in solving social problems, and contribution to the development of civil society and democracy. European education policies particularly emphasize the importance of strengthening the quality of teaching and establishing connections between research and the learning and teaching process in higher education. In Croatia, however, the official system of professional advancement continues to reward research and publication of scientific papers at the expense of teaching competencies, although administrative and guidance roles are gaining more importance as of late. This article aims to examine the attitudes of university teachers towards the competencies needed to work at a university and to establish whether they accept the new roles related to institutional contribution. For the needs of this research, a questionnaire was constructed, whose reliability was determined based on the obtained data and measured using Cronbach’s Alpha coefficient $\alpha=0,882$. The research was based on a quantitative and qualitative methodology which included an analysis of the relevant literature and an inquiry into teachers’ attitudes. SPSS Statistics software package was used for the descriptive and factor analysis of data, and the results showed that the respondents believe research and teaching competencies to be more important than the ones related to the institutional contribution, i.e. those of administrative and managerial character.

KEY WORDS

administrative, guidance and management competencies, psycho-pedagogical competencies, research competencies, university teachers

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INTRODUCTION

Due to the pressure and requirements of both national and international education and economic policies, growing expectations of the society and major changes in the student population, universities all over the world have started to change and question their role, core values and organizational structure [1-7]. The 20th century was marked by a tremendous expansion of higher education. Whereas in the early 20th century elite universities were enrolled only by privileged young people prepared for academic study, nowadays there is a massive student population for whom university education is a chance for improving their own prospects in the labour market, but who lack the corresponding prior knowledge and motivation and are not academically oriented and committed to learning [1, 4, 8]. In economically developed countries, the percentage of students enrolled in higher education institutions has increased from less than 5 % in 1950s to over 50 % in the first decade of the 21st century [1, 3, 4, 9]. In Croatia, in 1991, 39,8 % of the graduated secondary school students enrolled a higher education programme, while by 2004 that percentage has increased to 64,7 % [10]. The increase in student population is also brought about by social benefits of higher education, which are manifested on an individual level through better chances of employment and improvement of quality of life, while on the level of the society they are reflected in the contribution of higher education to progress and growth of national economy and a decrease in the unemployment rate [10]. After Croatia joined the Bologna process, the percentage of enrolled students has increased even further. According to the data provided by the Croatian Bureau of Statistics, 48 540 first-year students were enrolled in the academic year 2005/2006, while in the academic year 2016/2017 the number of enrolled students reached 61 226, which is approximately 26 % more than ten years earlier (Croatian Bureau of Statistics, Students enrolled in higher education institutions in 2005/2006 and 2016/2017).

In the modern-day, post-industrial society, the mission and the role of universities is also affected by a constant expansion of international cooperation between higher education institutions and by technology transfer, along with a continuous mobility of students and teachers and a rapid obsolescence of knowledge [3, 11]. Universities are subject to processes of globalization and are required to meet the needs of globally-oriented societies based on knowledge and market economy. This is why they are forced to compete for financial resources and submit to occasional evaluation and accreditation processes for the purpose of determining justifiability of the way they spend either public or private funds [11, 12]. Jónasson [2] believes there are three predominant university traditions: German (Humboldt's model), French (Napoleon's model) and British (Newman's model), and wonders whether either one of them meets the expectations of modern-day society. The first model advocates integration of research and teaching for the purpose of creating and expanding knowledge and for the purpose of personal development of individuals through science [13]. The second model favours a division into scientific-humanistic and professionally-oriented universities which should provide high-quality academic, i.e. professional education [2]. The third model promotes a broad general education of socially sensitive and ethically upright members of a civilized society, capable of free and critical thinking [14]. Modern higher education should meet all the aforementioned requirements because the model of new, institutionalized society after the Second World War is focused on increased democratization, preservation of human rights, development of science and development planning [1]. A particularly important purpose of modern-day university education is to help students adapt to rapid social and technological changes [8].

The 20th century was characterised by significant differences in the enrolment policies at European universities, the duration and structure of study programmes, the versatility of obtained diplomas, the conditions of employment of teaching staff, and academic freedom [4].

The expansion of higher education depended on conditions of economic and social development in each country, and was organised either as a dual system of higher education divided into universities and polytechnics as in Croatia, or united into a single university system in which some study programmes are more research-oriented, while others are more professionally-oriented. The introduction of the Bologna process (1999) and the creation of the European Higher Education Area (EHEA) for the purpose of achieving synergy in education and research established numerous principles of international cooperation and academic exchange, and outlined the direction in which modern universities should develop [4, 6]. All signatories have committed to adapting their national education systems to the agreed principles by, for example, facilitating mobility of students and higher education staff, allowing international recognition of diplomas, preparing students for a future life of active citizens in democratic societies, supporting their personal development, as well as granting a broad access to higher education and ensuring a competitive and high-quality development of European higher education which would be open to other countries around the world. After the first meeting held in Bologna, education ministers of EU member states met every two or three years in one of European cities to check the implementation of guidelines of the Bologna process, which define priorities and set development goals and standards. By publishing communiqués and recommendations, education ministers continued to support the achievement of the said goals. As some of the extremely important priorities, the ministers have repeatedly emphasized synergy of teaching and research in higher education and mutual contribution of higher education and research to the economic and cultural development of the European society [15, 16]; they agreed it was essential to recognize and support quality teaching in higher education, and to provide opportunities for enhancing academics' teaching competencies [17-19]. Along with other guidelines of the Bologna process, the European Commission has repeatedly emphasised the need for a continuous professional development of teachers.

PEDAGOGICAL AND PSYCHOLOGICAL COMPETENCIES OF UNIVERSITY TEACHERS

In times of rapid and fundamental changes, efficiency, effectiveness and ensurance of high-quality teaching represent a great challenge for higher education institutions. Quality of higher education, recognized and advocated at a political and organizational level, plays a crucial role in implementing innovations and transformations in a society, not only in terms of achievements and reputation of university research, but also in terms of excellence in teaching and learning, as an increasingly important aspect of universities' role [20, 21]. Faced with ever-growing demands, universities are developing educational policies and practices, which will be able to recognize the complexity of the academic context and are using targeted interventions to ensure proper preparation for those teachers who are willing to face the new circumstances. Higher education institutions are responsible for ensuring that their academic staff is well prepared for teaching, while university teachers are responsible for ensuring the best pedagogical and didactic practice and for meeting the expectations of students and the society. As a part of institutional policies and a common response to society's expectations, management of higher education institutions requires teachers to undergo continuous training in teaching. Teaching competence is seen as a complex and valuable aspect of quality of higher education, which cannot be based solely on the knowledge acquired during one's academic career and/or on emulation of more experienced colleagues. Therefore, universities have started developing strategies for improvement of pedagogical, psychological and methodical competencies of teachers in order to modernize and enhance the learning and teaching process, and to encourage change of the concept of teaching and professionalization of teaching in general [22-25].

On an international level, numerous universities have established Centers for teaching and learning excellence and Faculty development, or shorter, Teaching and Learning Centres. The aim of these centres, widely present in the North European and American context, is to organize, prepare and implement pedagogical and psychological training programmes for university teaching staff, whose purpose is to improve their teaching competencies [4, 26]. The activities involve shorter (10 ECTS) or longer (30 to 70 ECTS) training programmes, courses, seminars, workshops, round tables, *peer to peer* monitoring and evaluation of teaching activities, preparation of digital didactic materials, etc. [22, 23, 26, 27]. In some countries, pedagogical and psychological training is a necessary requirement for employment at a university, while in others it depends on teachers' voluntary decision, regardless of whether it is taken into account for career advancement or not. Nonetheless, everyone is recommended to undergo training courses and other pedagogical, psychological and didactic activities both at the beginning of their careers and throughout their working life. In most countries, the organization of such courses is centralized and governed by a competent institution at a national level, while in others it is entrusted to the centres formed at faculties or departments of a given university [22, 23, 26, 27]. In the Republic of Croatia, despite international requirements defined by the European Higher Education Area, there is no systematic teacher training for university teachers, nor is participation in pedagogical-psychological and didactic-methodical training programmes a requirement for employment at a university, except at the University of Osijek. Most universities in the Republic of Croatia have established Centres for Lifelong Learning, which organize various training programmes for improvement of teaching competencies in higher education, while the only university which introduced a six-month programme for improvement of teaching competencies in higher education, intended for associate employees, is the University of Rijeka.

Contrary to the aforementioned situation, over the past few decades this trend has gained momentum in numerous countries around the world, not only through the formal organization of pedagogical and psychological training programmes, but also through numerous research studies analyzing the effects of such programmes on the strengthening of high-quality, efficient university teaching [4, 22-24, 26, 28-31]. The previously conducted research studies have identified two main approaches to teaching: the teacher-centred approach and the student-centered approach, as well as two main concepts of teaching: teaching as knowledge transfer and teaching as organization of active learning for students. The majority of those research studies examined whether and to what extent do training programmes in psychology and pedagogy affect the improvement of the quality of teaching, the change in approach and/or the concept of teaching, and an increase in students' achievements. Teaching in higher education is a rather complex phenomenon, which is why some research studies have shown that pedagogical and psychological training is conducive to adoption of the student-centered approach and to modernization and dynamization of the teaching concept [22, 24, 28, 31]. Other researchers [32] either found no differences in the teaching concept adopted by teachers who attended such courses and those who did not, or they established [33] that the interviewed respondents failed to introduce any innovations in their teaching after the completion of their training programmes due to insufficient support in the workplace. Finally, some authors believe that further research needs to be conducted into the influence of pedagogical and psychological training programmes on professionalization of teaching [25, 31].

The second widely used method for improving the efficiency of teaching is evaluation of teaching, whereby each newly hired assistant is assigned a mentor who monitors his/her research and teaching and periodically reports the findings to the faculty council. Teaching can be mutually monitored and evaluated by two or more teachers who take turns in the peer-to-peer role. Another widespread method is the assessment of inaugural lecture given by the

candidate during the initial appointment into a scientific-teaching grade, which is conducted by an officially formed committee consisting of three members appointed into the same or higher title than the candidate. In Croatia, evaluation of the inaugural lecture and a positive student evaluation are formally taken into account for appointment into higher grades. It is precisely the student evaluation of teaching at the end of each semester or each academic year that raises most controversies in the eyes of researchers and teachers alike [34]. Student evaluation of teaching is one of the aspects of the modern university life which is much debated, and numerous research studies show that this type of evaluation is used as an indicator of the quality of teaching in almost all higher education institutions around the globe [34-39]. Initially, students' evaluation of teaching was intended for informational purposes, as feedback to teachers on how to improve the elements of teaching that students were unsatisfied with. Since the 1970s, the data obtained via student evaluations have been increasingly used for making decisions on the advancement of the teaching staff, although it has not been proved that such evaluations encompass the teacher's ability to encourage learning, i.e. there is no evidence of the links between the evaluation and students' achievements, nor of the effectiveness of the evaluation as a tool for the improvement of teaching [38]. Previously conducted research studies have highlighted numerous unacceptable elements of this type of evaluation of effectiveness of teaching which affect its validity. One of the most frequently raised issues is the connection between teachers' personal characteristics (race, gender, cultural preferences) and their teaching competence, attitude towards their teaching style, student bias in assessment of teachers depending on the level of difficulty of the course in question, teachers' grading leniency, or mistakes caused by the use of survey instruments which have not been tested for validity and reliability, i.e. by a misinterpretation of the obtained data [35, 38]. After a thorough analysis of numerous research studies on students' evaluation of teaching, Spooren, Brockx and Mortelmans [34] claim that its usefulness and validity are still questionable and that its results should not be used as the only indicator of effective teaching.

SCIENTIFIC AND RESEARCH COMPETENCIES OF UNIVERSITY TEACHERS

Most communiqués of European ministers of education emphasize that all levels of higher education need to be based on modern scientific research and its development, and promote innovation and creativity in a society. Quality of research has become the main competitive focus of universities competing for limited funding and relative prestige [40]. Although scientific and research competencies cannot be treated as new competencies in the academic profession, relevant research studies suggest that the changes in the broad area of scientific research activity require acquisition of new competencies for this segment of academic activity. One of the special categories of (new) competencies is associated with the new demands in the context of scientific and research work and complementary competencies – “Modernization of scientific and research techniques and procedures also requires new competencies.” ... “Science changes rather quickly, there are always new developments which one needs to keep abreast of on a daily basis. This also requires new scientific and research competencies” ... “...in order to be a good scientist, one needs to acknowledge new developments, especially in science and research. New developments mean new competencies.” [41; p.153].

Further supporting this claim is a document published about ten years ago entitled *Skills and competencies needed in the research field: Objectives 2020* (according to Ulrich and Dash [42]). This document contributed significantly to the structuring and systematization of scientific and research competencies by means of a comparative study of opinions of researchers from eight research-intensive countries. In this research, the debate on research competencies is centered around a series of crucial questions about the main trends and changes affecting research

institutions and organizations, and about the competencies which researchers will be required to possess in the years to come. Strong globalization pressures, increased openness of the research market, a strong tendency towards mobility of researchers, insistence on increased interdisciplinarity and cooperation between different research teams, and political investments in research and innovation are only some of the factors influencing changes in scientific and research policies. Based on the data from approximately 80 interviews, research skills in this international research study have been grouped into: a) scientific competencies, b) team management and project management skills, and c) personal qualities. The first group of skills includes familiarity with the scientific area, ability to formulate research questions, ability to apply existing knowledge, ability to learn, ability to work in an interdisciplinary environment, and ability to analyze and understand sophisticated IT tools. The second group of skills includes ability to work in a team, communication and language skills, ability to manage a team or a project, awareness of the importance of research and its influence on the community. Personal characteristics and interpersonal skills include creativity, open-mindedness, motivation, adaptability and self-assessment skills. From the aforementioned document, Ulrich and Dash [42] identified the following as the most important new competencies in researchers: well-developed capacity for analysis, including the ability to use sophisticated IT tools; ability to work and cooperate in interdisciplinary environments; ability to develop research networks; language and communication skills; business culture and management skills; awareness of the importance of research and ability to assess its influence on the community. The study provides useful information, poses interesting questions and is thought-provoking, but it also has its shortcomings, the principal among which are the insufficiently developed research methodology and the study of research competencies from the perspective of commercial and technological scientists in research-intensive countries [42-44]. New research competencies necessary for success also involve scientific openness. European Union document entitled *Providing researchers with the skills and competencies they need to practise Open Science* [45] mentions four groups of competencies required for practicing open science. Apart from the professional research skills, researchers also need to have open-access publishing skills and techniques, technical and legal skills for open data management, and science popularization skills.

Perceptions of quality and norms for assessment of important competencies in researchers can develop and change in a short period of time because science changes too quickly, making it impossible to compose long-term lists of necessary competencies. Even though every analysis includes the scientific competence, the manners in which it is assessed change in accordance with technological advances. Instead of subjective opinions about someone's scientific excellence, substantiated criteria such as scientific productivity and citations in relevant journals and databases, such as the Web of Science, Scopus, Google Scholar etc., are increasingly used [46]. Such data can be analyzed in different ways in order to get an objective overview of scientific productivity and level of interest for one's research. In his analysis of characteristics of a good scientist-researcher, Sumpter [46] also mentions the influence of one's research outside the academic community, i.e. on the society and economy, governance and guidance of a research team, and personal characteristics such as objectivity, curiosity, ability to identify important research topics, communication skills, ability to cope with failure, commitment to work, and integrity. Integrity is mentioned last because Sumpter [46] often finds it to be questionable, which he supports with his own experience about non-ethical behaviour of university teachers in reviewing numerous scientific articles. He has, for example, noticed bias in the interpretation of research findings, exaggeration, especially in titles and abstracts of scientific articles, figures which either distort the data or fail to fully present them, failure to quote relevant articles written by other scientists, excessive quotation of one's own work, disregard for restrictions and conflicts of interest in research, etc.

According to Stull and Ciappio [47], some of the key qualities of successful scientific researchers include passion for one's area of expertise, resilience, focus on the details while maintaining the vision, creative thinking, determination, professionalism, self-motivation, ability to work in a team, ability to communicate effectively, and openness to new ideas. Apart from the ability to work in a team, Stefanadis [48] mentions diligence, open-mindedness, knowledgeable, resourcefulness, precision in the presentation of data, and critical thinking. Due to an increase in the volume of international team research, especially in health research, Parker and Kingori [49] have studied the factors which scientists and other research participants identify as important for a successful research cooperation. The respondents have listed eight factors they see as essential in judging the merits of active participation in research: opportunities for active involvement in cutting-edge, interesting science; effective leadership; competence of potential partners in and commitment to good scientific practice; capacity building; respect for the needs, interests and agendas of partners; opportunities for discussion and disagreement; trust and confidence; and, justice and fairness in collaboration. Apart from these, they also emphasize capacity building, which is understood as the potential for opportunities to increase scientific competence and expertise of both experienced and younger scientists.

Langfeldt et al. [50] offer a novel framework to study and understand research quality across three key dimensions: quality notions that originate in research fields (Field-type) and in research policy spaces (Space-type), those stemming from the existing studies on "good research", and those which stem from different sites where notions of research quality emerge, are contested and institutionalised (scientific journals, conferences, knowledge communities and similar). Each of these elements contributes to the development of criteria and indicators which define a good research and affect research practice. Notions of research quality originating in specialized knowledge communities require research to be original, reliable, relevant to the field, useful for further knowledge production, reproducible, scientifically based and to use effective methods and reliable and valid instruments. Such research quality notions are enforced predominantly through peer judgement and peer review practices, which are used at multiple selection points, including recruitment and promotion of research staff, publishing in scientific journals, conference participation, and access to national or international resources. Another source of research quality criteria are the published scientific articles on the topic, which often distinguish between elements for assessment of quantitative and qualitative research. Literature dealing with the quality of quantitative research often identifies the following as crucial quality criteria: originality, credibility, reliability and scientific value or social benefits of research [50-52], i.e. rigour, validity, reliability, transferability and possibility of generalization [53, 54]. According to Cameron [54], another criterion for assessment of qualitative research is credibility, defined as congruence with reality; transferability, defined as applicability to other situations and contexts; dependability, i.e. detailed insight into the employed methods and instruments; and objectivity in the interpretation of data obtained from informants. Brinkmann [55] identifies two basic criteria for the assessment of qualitative research: validity, as the potential to improve reality, and objectivity in the interpretation and description of the object of the study. According to this author, a good qualitative researcher has to follow high ethical standards and be rather sensitive to beliefs and feelings of respondents, as well as to abide by scientific rules of research, while university professors have the responsibility of being role-models and shape the ethical conduct of young researchers who will bring about changes through best practices based on scientific evidence.

Within the hierarchical organization of universities, advancement in one's academic career mostly depends on published articles, while the quality, quantity and presence of scientific

articles in relevant databases also serves as an indicator of success for the purpose of obtaining financial support for research on a local, national or international level. Writing and publishing high-quality scientific articles is believed to be a university professor's basic skill, but to have one's work recognized for its quality requires additional skills, particularly those related to the selection of a relevant journal or publisher.

ADMINISTRATIVE AND MANAGERIAL COMPETENCIES OF UNIVERSITY TEACHERS

Changes which higher education has been facing over the last few decades have resulted in an increasing importance of managerial, i.e. leadership or governance competencies in university teachers. The need for good governance has increased for several reasons, primarily because higher education institutions, as beneficiaries of public or private funding, need to effectively adapt to the growing and changing demands of society and labour market. They are given greater autonomy, which in turn requires ability and responsibility in managing human and financial resources, modernization of the existing study programmes and development of new ones, and quality assurance of teaching and research [56-58]. Responsible and transparent management is necessary at the level of universities, faculties, departments and other organizational units [59].

Numerous authors draw attention to the use of different terminology for governance and leadership functions in higher education institutions [6, 58-66]. Governance refers to the organization of governing bodies, distribution of responsibilities, standards of conduct of members of the management, procedures and rules related to financial and developmental decision-making for the purpose of achieving strategic goals [67]. Management comprises planning, organizing, directing and controlling activities of staff members aimed at the achievement of a series of goals of a higher education institution. According to a research study conducted by Potgieter and Coetzee [68], a manager needs to be a good financial expert, strategic planner, manager of diversity and conflict, successful communicator, quality controller, change implementer, coordinator and representative of senior management bodies, whose role should be based on supervision and control of delegated operative tasks. Academic leadership encourages and motivates members of the academic community to achieve the strategic vision of a university through collaboration, interaction and conversation, and responds productively to the current changes in education and society [61, 67, 69]. Some authors [56, 70] see institutional leadership, management and administration as components of governance.

For the majority of university professors, assuming governance roles and responsibilities is not a priority [61, 71], even though a leader is a person "who holds superior power which enables him/her to influence, lead and control people around" [69; p.93]. They are appointed from a collective, among reputable teachers and researchers with outstanding achievements based on research and academic recognition, but their managerial skills are questionable. Over the past ten years, management, i.e. leadership competencies have been researched from different perspectives. These competencies are the research topic of doctoral dissertations [72-74] and scientific articles on possible abuse of position within faculty structures [75; p.160], on the needs and perception of effective academic management and the discrepancy between institutional expectations and actual competencies of academic leaders [76], on the importance of acquiring leadership competencies within university study programmes [77], on the lack of women in senior management positions [78, 79], and on the importance of a personal vision of education and running an institution by an effective leader [80]. Particularly frequent are research studies on characteristics and skills necessary for an effective leadership and management of higher education institutions. Based on the examined research studies, Potgieter and Coetzee [68] concluded that the heads of higher education are

often poorly prepared for their managerial role and that they need training to develop specific competencies in order to perform their function effectively. The authors have divided the management competencies in five different dimensions: planning and organization, leadership, control, specific aspects of human resources and personal characteristics. Their findings could serve as a potential basis for the development of training programmes for leaders in higher education environments. Ott and Mathews [81], who have explored the importance of effective administrative management and improved cooperation between the faculty management and administrators, claim that the conditions for a more effective shared governance arise from the balance between the following five elements: trust, shared sense of purpose, clear understanding of the issues at hand, adaptability and productivity.

Basing their conclusions on numerous research studies, Turk and Ledić [6] claim that there are two opposing viewpoints about characteristics of a higher education leader. According to them, on the one hand there is the traditional attitude, typical of a hierarchical system, where the leader is usually an experienced individual, “a person who builds and establishes relationships, who is a good communicator and who possesses a high level of social intelligence, who represents his/her institution, team or themselves in public, who bases his/her work on high ethical and professional principles and promotes the culture of quality in every aspect of his/her work” [6; p.61, according to Wisniewski, 2011]. On the other hand, however, they cite authors such as Dávila Quintana, Mora Ruiz and Vila Lladosa [82], according to whom leaders should possess the basic skills of social intelligence, immanent to every person, which are often innate or based on the upbringing in the immediate family, school or broader community, but can also be partially learned or acquired. “Therefore it is possible for a young person at the beginning of his/her academic career to build credibility and authority of a leader, thanks to his/her (innate) abilities” [6; p.61, 82]. Kaminskiene and Gedminiene [69] have examined the relevant literature on leadership in higher education in order to determine which topics are explored by research studies about educational leadership and what are the perspectives of an innovative leader in higher education. They have emphasized that there is no unique answer to the question how to become a good leader and that the opinion according to which leadership traits such as charisma and social intelligence are innate still prevails. Other authors, however, believe that leadership skills can be learned, identifying the following as characteristics of a good leader: ability to guide and experience with guidance, ability to adapt to changes, openness in the exchange of information and ideas, a clear vision of development, allowing colleagues to participate in the decision-making process, providing support and opportunities for development, professional autonomy and recognition of achievements of other members of the collective, and personal characteristics such as credibility, reliability, selflessness, flexibility and fairness. Leadership style is determined by specific skills and behaviours, and among a number of different leadership styles used in higher education, the most frequently mentioned ones are the transactional and transformational leadership styles [69, 83-86]. A transactional leader enforces rules, sets clear expectations, monitors the performance, rewards success and punishes failure, leaving little room for creativity. A transformational leader encourages members of an institution to have great expectations, motivates them to achieve personal goals by offering assistance in their achievement, and strongly supports innovativeness and creativity. Even though these two leadership styles differ significantly, numerous authors insist that both are necessary in each education institution. Turk and Ledić conclude that “leadership competencies in higher education equally apply to all stages of an academic career, however, they need to be developed in accordance with the environment and the activities to which they refer” [6; pp.61-62].

RESEARCH METHODOLOGY

The attitudes of university teachers were analyzed by means of a descriptive and causal non-experimental method of pedagogical research [87], along with surveying, assessment of attitudes and analysis of pedagogical documentation.

Sample of respondents

Table 1. Sample structure with regard to title and scientific area.

Title	F	%	Scientific area	F	%
Lecturer	11	6	Natural sciences	7	3,8
Senior lecturer	20	10,9	Technical sciences	10	5,4
Teaching assistant	24	13	Biomedicine and health	4	2,2
Postdoctoral researcher	6	3,3	Biotechnical sciences	2	1,1
Assistant professor	62	33,7	Social sciences	86	46,7
Associate professor	35	19	Humanities	54	29,4
Full professor	26	14,1	Artistic area	3	1,6
			Interdisciplinary area of sciences	13	7,1
			Interdisciplinary area of the arts	5	2,7
Total	184	100	Total	184	100

Table 2. Sample structure with regard to years of service and county.

Years of service	F	%	County	F	%
1 to 5	15	8,2	Istria	63	34,2
6 to 10	23	12,5	Primorje-Gorski Kotar	5	2,7
11 to 15	50	27,2	Zadar	2	1,1
16 to 20	34	18,5	City of Zagreb	21	11,4
21 and more	60	32,6	Split-Dalmatia	63	34,2
No answer	2	1	Osijek-Baranja	7	3,8
			Koprivnica-Križevci	11	6,0
			Varaždin	9	5,0
			No answer	3	1,6
Total	184	100	Total	184	100

As many as 184 university professors from various counties of the Republic of Croatia participated in the research. Most of them were from the Istria and Split-Dalmatia County (34,2 %). As can be seen in Tables 1 and 2 the sample is very dispersive (scattered) and includes respondents having scientific and teaching titles from the scientific, artistic and interdisciplinary areas of science and arts. According to their title, most of the sample respondents were assistant professors (33,7 %), while according to the scientific area, most of them belonged to social sciences (46,7 %). When it comes to years of service, most of the respondents (32,6 %) have more than 21 years of service. The research was conducted via an online questionnaire which could be responded from the beginning of January to the end of July 2020.

Research instrument

Due to the lack of an already existing instrument that would fit the needs of this research, the authors have prepared a questionnaire entitled *Pedagogical, psychological and other competencies of university teachers* suitable for the higher education context in the Republic of Croatia. It was constructed especially for this purpose, but is based on similar research conducted in Croatia and abroad. (Examples of consulted research studies [6, 88].

The respondents were asked to indicate the extent to which they agree or disagree with each statement by using the Likert-type five-point scale: “I do not agree at all”, “I do not agree”, “I cannot evaluate”, “I agree”, “I completely agree”, i.e. “not at all”, “a little bit”, “I cannot evaluate”, “a lot”, “very much”. The constructed instrument was checked for satisfactory metric characteristics. Sensitivity was tested by means of measures of dispersion, construct validity was tested by means of factor analysis, and reliability was tested by means of the internal consistency method – Cronbach’s alpha $\alpha = 0,882$. To determine the dimensionality of the investigated constructs, factor analysis of principal components was used. Kaiser-Guttman’s criterion was used for determining the number of significant factors, while the factorial structure has been defined either as single-factorial or multi-factorial according to the number of extracted factors with the characteristic root higher than 1.

Results and discussion

Table 3. Results of the factor analysis of the *Pedagogical, psychological and didactic competencies* scale and the descriptive analysis of the items of the scale.

Pedagogical-didactic and social competencies of university teachers	Factor*		Arithmetic mean	Standard deviation
	1	2		
Defining clear goals and outcomes in the learning and teaching process	0,962		4,342	0,773
Use of different teaching methods in accordance with the learning outcomes	0,906		4,342	0,759
Planning and delivering a class	0,836		4,413	0,711
Use of different procedures for assessment and grading of students’ achievements in accordance with learning outcomes	0,793		4,141	0,797
Understanding and use of theories on which the learning and teaching process is based	0,736		4,065	0,878
Adaptation of the teaching process for students with special needs	0,419		4,005	0,890
Use of e-learning and its integration into the teaching process	0,385		3,913	0,982
Teaching students to become socially responsible and active citizens		0,880	4,266	0,802
Knowledge of the principles of negotiation and conflict resolution		0,816	3,923	0,902
Use of research findings in teaching		0,775	4,059	0,850
Creating an environment that will stimulate students to learn		0,718	4,521	0,660
Familiarity with ethical principles in teaching and research		0,646	4,244	0,829
Use of active learning techniques in the teaching process		0,563	4,462	0,738

*to facilitate the interpretation of data, only those factorial saturations whose absolute value is greater than 0,3 are shown

The conducted factor analysis has shown that *Pedagogical-didactic and social competencies of university teachers* are a multi-dimensional construct. Two factors with the characteristic root greater than 1 have been extracted, which account for 61,564 % of the scale variance. Considering the size of the coefficient in the pattern matrix shown in Table 3, the first factor was named *Pedagogical-didactic competencies* (items 1 to 7), while the second was named *Social competencies* (items 8 to 13). On the basis of the aforementioned factor analysis, two eponymous sub-scales have been constructed.

The results of item analysis (Table 3) for each item of the *Pedagogical-didactic competencies* subscale show that the lowest mean value ($M = 3,91$) and the highest standard dispersion of results ($SD = 0,982$) were obtained for the item *Use of e-learning and its integration in the teaching process*. The highest mean value ($M = 4,41$) and the lowest standard dispersion of results ($SD = 0,71$) can be observed for the item *Planning and delivery of a class*.

The results of item analysis for each item of the *Social competencies* subscale showed the lowest mean value ($M = 3,92$) and the highest standard dispersion of results ($SD = 0,90$) for the item *Knowledge of the principles of negotiation and conflict resolution*. The highest mean value ($M = 4,52$) and the lowest standard deviation ($SD = 0,66$) were obtained for the item *Creating an environment that will stimulate students to learn*.

On the basis of the conducted analysis, it can be concluded that the respondents find all the listed pedagogical-didactic and social competencies to be either important or very important in their work with students. Apart from the traditional importance attributed to the planning and delivery of a class, the obtained highest average values indicate that students are increasingly becoming equal partners in the education process who are expected to learn actively and acquire knowledge autonomously, while the role of a teacher is to set up a high-quality learning environment and organize didactic activities. The interviewed teachers demonstrate awareness of the importance of an innovative and dynamic approach to student-centered teaching, in which the teacher is primarily concerned with students' acquisition of skills or concept development and attainment of a higher level of learning outcomes. Furthermore, the results show that the respondents consider students as adults and responsible persons who autonomously form relationships with others, and that there is no need for teachers to be familiar with the principles of negotiation and conflict resolution. Slightly surprising is the low mean value obtained for the item *Use of e-learning in the teaching process*, considering the current emphasis on on-line teaching, especially during the pandemic caused by the SARS-CoV-2 virus.

The conducted factor analysis has shown that *Scientific and research competencies of university teachers* are a multi-dimensional construct. Two factors with the characteristic root greater than 1 have been extracted, accounting for 61,015 % of the scale variance. Considering the size of the coefficient in the pattern matrix shown in Table 4, the first factor was named *Collaboration and management in scientific research* (items 1 to 6), while the second one was named *Methodological research literacy* (items 7 to 10). Based on the aforementioned factor analysis, two eponymous subscales have been constructed.

According to the results of item analysis (Table 4) for each item of the *Cooperation in research* subscale, the lowest average mean ($M = 3,71$) and the highest standard deviation ($SD = 0,96$) can be observed for the item *Familiarity with programme/project management*. The highest arithmetic mean ($M = 4,15$) and the lowest standard deviation ($SD = 0,76$) were obtained for the item *Conducting reviews in one's own scientific area*.

The results of the item analysis (Table 4) for each item of the *Methodological research literacy* subscale shows that the lowest median value ($M = 4,08$) and the highest standard

Table 4. Results of the factor analysis for the *Scientific and research competencies* scale and descriptive statistics of the items of the scale.

Scientific and research competencies of university teachers	Factor*		Arithmetic mean	Standard deviation
	1	2		
Awareness of project funding opportunities in one's area of research interest	0,824		3,739	0,950
Familiarity with programme/project management (writing, application and management of programmes/projects)	0,801		3,706	0,964
Building and maintenance of (international) research networks	0,787		4,021	0,874
Supervision and counseling of junior colleagues engaged in scientific research	0,783		4,168	0,855
Work in an interdisciplinary environment	0,666		4,119	0,840
Conducting reviews in one's own scientific area	0,584		4,146	0,764
Application of basic principles of scientific writing and publishing		-0,868	4,369	0,712
Use of effective strategies for critical appraisal and analysis of scientific literature		-0,804	4,320	0,701
Use of effective strategies for searching scientific and professional literature		-0,780	4,315	0,752
Use of research methodology and statistical processing of data		-0,693	4,087	0,942

*to facilitate the interpretation of data, only those factorial saturations whose absolute value is greater than 0,3 are shown

dispersion of results ($SD = 0,94$) were obtained for the item *Use of research methodology and statistical processing of data*. The highest mean value ($M = 4,37$) was obtained for the item *Application of basic principles of scientific writing and publishing*, while the lowest standard deviation ($SD = 0,70$) was obtained for the item *Use of effective strategies for critical appraisal and analysis of scientific literature*.

Relatively high mean values attributed to most of the items indicate that the respondents consider all the listed scientific and research competencies to be important for working at a university. While placing less importance on administrative skills, such as preparing the artwork for the implementation of a scientific project and technical skills of statistical processing of data, which can be entrusted to the experts in the field, the respondents attribute more importance to competencies such as familiarity with scientific writing and publishing, conducting reviews and use of effective strategies for searching scientific and professional literature. Research by Höhle and Teichler [9], conducted at an international level, indicates that research achievements are still seen as more important for appointment into higher grades than teaching achievements, and that there is an imbalance between teaching and scientific work. It also seems to indicate that more emphasis is placed on conducting socially relevant research. However, in order to ensure a systematic presence of universities in the economy, culture and society, and in accordance with the Rome Ministerial Communiqué [20], teaching needs to be granted the same status as research. Also, standards and guidelines for quality assurance in the European Higher Education Area [89] emphasize that the quality of higher education is the result of a well-balanced relationship between learning, research and innovation. While scientific research guarantees a university's prestige, teaching strengthens its public image, which is why both are crucial for the academic community and should be equally valorized.

Table 5. Results of the factor analysis of the *Leadership competencies and contribution to the institution* scale and descriptive statistics of the items of the scale.

Leadership competencies and contribution to the institution	Factor*		Arithmetic mean	Standard deviation
	1	2		
Familiarity with the principles of strategic planning	,924		4,010	,855
Introduction of innovations and changes in the work of the institution / department / chair	,877		4,157	,857
Management of financial resources of the institution / department / chair	,774		3,902	,893
Defining ethical values of the institution / department / chair	,756		4,288	,835
Connecting with the social and economic community	,660		4,157	,783
Performing managerial duties	,416		3,641	,970
Editing and publishing of scientific journals		,939	3,864	,891
Organization of scientific and professional conferences		,937	3,956	,841
Familiarity with the local / regional cultural heritage		,410	3,929	,887

*to facilitate the interpretation of data, only those factorial saturations whose absolute value is greater than 0,3 are shown

The conducted factor analysis has shown that *Leadership competencies and contribution to the institution of university teachers* are a multi-dimensional construct, which is why two factors with the characteristic root greater than 1 have been extracted, accounting for 62,950 % of the scale variance. Considering the size of the coefficient in the pattern matrix shown in Table 5, the first factor was named *Management of an educational institution* (items 1 to 6), while the second factor was named *Business ethics and sustainable development* (items 7 to 9). On the basis of the aforementioned factor analysis, two eponymous subscales have been constructed.

According to the results of the item analysis (Table 5) for each item of the *Management of an educational institution* subscale, the lowest average mean ($M = 3,64$) and the highest standard dispersion of results ($SD = 0,97$) have been obtained for the item *Performing managerial duties*. The highest mean value ($M = 4,28$) was obtained for the item *Defining ethical values of the institution*, while the lowest standard deviation ($SD = 0,78$) was obtained for the item *Connecting with the social and economic community*.

Results of the item analysis for the *Business ethics and sustainable development* subscale show the lowest average mean value ($M = 3,86$) for the item *Editing and publishing of scientific journals*, while the highest mean value ($M = 3,95$) was obtained for the item *Organization of scientific and professional conferences*. Editing a scientific journal is a rather challenging task, especially when its survival depends on inclusion in international databases, which is very difficult to achieve.

Results presented in Table 5 show that a somewhat lower mean value was attributed to the majority of items in comparison to the pedagogical-psychological and research competencies,

which leads to the conclusion that the respondents believe successful engagement in research and teaching to be more important for a university career than the management of a faculty or a department, and editing or publishing of journals. The competencies which they find least attractive are management of financial resources of the institution and performance of managerial duties. This is understandable, because numerous research studies on academic leadership and management confirm that these are rather complicated and demanding functions, associated with a considerable amount of stress and a high level of burnout [61, 90, 91]. Furthermore, those employed in higher education mostly do not respond well to authoritative managers and leaders due to a deep-rooted need for collegiality, counseling and academic freedom [62].

The conducted factor analysis has shown that the *Acquisition and importance of pedagogical and psychological competencies of university teachers* is a multi-dimensional construct. Two factors with the characteristic root greater than 1 have been extracted, which account for 59,828 % of the scale variance. With regard to the size of the coefficient in the pattern matrix shown in Table 6, the first factor was named *Importance of pedagogical and psychological competencies* (items 1 to 5), while the second one was named *Acquisition of pedagogical and psychological competencies* (items 6 and 7). On the basis of the aforementioned factor analysis, two eponymus subscales have been constructed.

Table 6. Results of the factor analysis of the *Acquisition and importance of pedagogical and psychological competencies of university teachers* scale and the descriptive statistics of the items of the scale.

Acquisition and importance of pedagogical and psychological competencies of university teachers	Factor*		Arithmetic mean	Standard deviation
	1	2		
Pedagogical and psychological education is necessary for maintaining a high level of quality of university teaching.	-0,853		4,173	1,009
Formal acquisition of pedagogical and psychological competencies is an unnecessary waste of time.	0,833		1,739	,968
Upon employment at the university, teachers who do not have pedagogical and psychological training should be required to complete formal courses in the field.	-0,730		3,771	1,211
In my opinion, pedagogical and psychological competencies are not useful for professional advancement.	0,703		1,728	1,102
A thorough subject-matter knowledge is sufficient for a high-quality university teaching.	0,605		2,255	1,147
Pedagogical and psychological competencies can be acquired after employment.		0,879	3,635	1,082
University teachers acquire pedagogical and psychological competencies with many years of practical experience.		0,414	3,369	1,063

*to facilitate the interpretation of data, only those factorial saturations whose absolute value is greater than 0,3 are shown

According to the results of the item analysis (Table 6) for each item of the *Importance of pedagogical and psychological competencies* subscale, the lowest mean value ($M = 1,73$) was obtained for the item *Formal acquisition of pedagogical and psychological competencies is an unnecessary waste of time* and ($M = 1,72$) for the item *In my opinion, pedagogical and psychological competencies are not useful for professional advancement*. The highest arithmetic mean was obtained for the item *Pedagogical and psychological education is necessary for maintaining a high level of quality of university teaching* ($M = 4,73$). The conducted analysis shows that the respondents believe formal acquisition of pedagogical and psychological competencies to be necessary not only for appointment into higher grades, but also for a high-quality university teaching. In response to the demands of the education policy to improve the quality of university-level teaching, the issue of mandatory pedagogical courses for university teachers is being considered or debated in several European countries (e.g. Finland, Norway, Sweden), although it still has not been determined for whom it should be mandatory [31]. Most of the analysed research studies seem to suggest that pedagogical and psychological training is necessary for early-career university teachers [22, 24, 28, 31].

The item *A thorough subject-matter knowledge is sufficient for a high-quality university teaching* obtained a low mean value ($M = 2,25$) and high standard deviation ($SD = 1,147$), which means that the respondents are not unanimous in their support of such a thesis, although there are still those who agree with it. At a time when pedagogical training courses have an increasingly important role in the professionalization of higher education teaching, a thorough knowledge of the subject matter is certainly not sufficient for high-quality teaching.

The results of the item analysis (Table 6) for each item of the *Acquisition of pedagogical and psychological competencies* subscale show that relatively low arithmetic means ($M = 3,36$) have been observed for the item *University teachers acquire pedagogical and psychological competencies with many years of practical experience* and for the item ($M = 3,63$) *Pedagogical and psychological competencies can be acquired after employment*. High standard deviations ($SD = 1,06$ and $SD = 1,08$) were obtained for both items. These results indicate a high level of respondents' awareness of the small impact of professional experience on the improvement of pedagogical and psychological competencies. The fact that experience alone does not guarantee more effective teaching is confirmed by Marsh [92] who, in his 13-year-long longitudinal research, reached the conclusion that the majority of teachers who received relatively low grades at the beginning of the research study were awarded the same grades at the end of the research, while those who initially received relatively high grades maintained them throughout the course of the research.

The conducted factor analysis has shown that the *Manners of acquiring pedagogical and psychological competencies of university teachers* are a multi-dimensional construct, which is why two factors with the characteristic root greater than 1 have been extracted, accounting for 51,981 % of the scale variance. Considering the size of the coefficient in the pattern matrix shown in Table 7, the first factor was named *Formal acquisition of pedagogical and psychological competencies* (items 1 to 5), while the second one was named *Non-formal acquisition of pedagogical and psychological competencies* (items 6 and 7). On the basis of the aforementioned factor analysis, two eponymous subscales have been constructed.

The results of the item analysis (Table 7) for each item of the *Formal acquisition of pedagogical and psychological competencies* subscale show that the lowest average mean value ($M = 2,55$) and a high standard dispersion of results ($SD = 1,26$) were obtained for the item *through post-graduate education*. A low arithmetic mean value ($M = 2,79$) was obtained for the item *through the pedagogical-psychological set of courses, after employment at a*

Table 7. Results of the factor analysis for the *Manners of acquiring pedagogical and psychological competencies of university teachers* scale and the descriptive statistics of the items of the scale.

Manners of acquiring pedagogical and psychological competencies of university teachers	Factor*		Arithmetic mean	Standard deviation
	1	2		
at targeted seminars and professional training courses	0,681		3,722	1,113
through the pedagogical-psychological set of courses, after employment at a university	0,681		2,798	1,413
through on-line courses	0,631		2,837	1,274
through the pedagogical-psychological set of courses at the graduate study programme	0,614		3,260	1,353
through post-graduate education	0,598		2,559	1,266
by observing examples of good practice of colleagues from one's own or other university institutions		0,870	3,722	,988
through study visits to other university institutions		0,782	3,456	1,080

*to facilitate the interpretation of data, only those factorial saturations whose absolute value is greater than 0,3 are shown

university, while the highest arithmetic mean value ($M = 3,72$) was obtained for the item *at targeted seminars and professional training courses*.

The results of the item analysis for the *Non-formal acquisition of pedagogical and psychological competencies* subscale shows that the respondents agree in their evaluation of the items *by observing examples of good practice of colleagues* ($M = 3,72$) and *through study visits to other university institutions* ($M = 3,45$) as manners of acquiring pedagogical and psychological competencies. On the basis of the obtained results, it can be concluded that the majority of respondents believe that observing the examples of good practice is more important for the development of teachers' competencies than formal pedagogical and psychological education.

The obtained results seem to indicate respondents' mistrust in the effectiveness of formal pedagogical and psychological training courses, which is consistent with the controversial results of most research studies in the field. Even though some research studies indicate that it is necessary to additionally verify the effectiveness of various pedagogical training programmes in order to confirm their ability to improve the quality of teaching [25, 31], the international movement for professionalization of higher education teaching advocates the introduction of compulsory pedagogical training programmes, at least at the beginning of one's career.

CONCLUSION

Higher education institutions are constantly under pressure to adapt quickly and efficiently to the growing and changing demands of the society and labour market. A greater emphasis on the quality of learning and teaching has been brought about by increased globalization, development of knowledge-based economy, international coordination of professional qualifications, acquisition and dissemination of new knowledge, as well as by the request that universities should take responsibility for solving various social problems and contribute to the development of democracy and civil society [4, 25]. Therefore, modern-day university teaching requires support for professionalization and formal evaluation of teachers' skills as necessary university strategies for modernization of the teaching and learning process. Professionalized teaching is able to meet students' needs and high academic standards more

efficiently, and is a condition for survival of higher education institutions. This is why a growing number of institutions provide shorter or longer training programmes, courses and/or workshops for pedagogical and psychological education of interested teachers. Teaching is still considered subordinate to research, to which greater importance is attached in appointment into higher grades, although this approach does not support the development of teaching competencies in higher education. However, education policies in the European Higher Education Area believe that the key to a successful university education lies in synergy between research and teaching, which need to be student-centered and accompanied by strengthening of the quality of teaching. Changes in higher education have resulted in changes in work environments, activities and demands placed on academic staff. These changes have led to a diversification of the existing and appearance of new jobs, resulting in the need to re-define traditional academic competencies and develop new ones. Production and dissemination of knowledge, i.e. research and teaching, are no longer the only activities in the profession. Traditional competencies required for working at a university are becoming ever more complex, with the addition of new ones related to organization, management and administrative activities in academic institutions, and to an institution's engagement in the provision of services to the community, so that universities might contribute to the development and improvement of the economic, cultural and civil life.

The respondents who participated in the survey conducted for the purpose of this article recognize the importance of research and pedagogical-psychological competencies, although Croatia still has not introduced appropriate forms of professional support for the development of those competencies, while the existing legal provisions on monitoring and evaluation of all types of activities of university teachers are changing slowly. Respondents believe that the least important competencies are the one related to academic leadership and governance, most likely because those are very complicated and challenging functions, associated with a considerable amount of stress and additional workload. The obtained results indicating respondents' doubts about the impact of formal pedagogical and psychological training on the improvement of quality of university teaching are contradictory, since respondents assign great importance to such training, but attach little importance to the existing formal manners of acquiring teaching competencies. Furthermore, although respondents do not believe that experience can significantly improve the quality of teaching, they assigned relatively high grades to observing examples of good practice, even higher than those assigned to the formal pedagogical and psychological training.

Unfortunately, this research confirms the findings of previous research studies [93, 94], according to which university teachers do not attach enough importance to formal acquisition of pedagogical and psychological competencies, which is not one of the requirements for appointment into higher grades. These findings foreshadow numerous challenges for the future development and transformation of the academic profession, both in Croatia and abroad. Furthermore, this research raises several other research questions and current topics, such as the competitiveness of researchers, (academic) freedoms of university staff, stronger emphasis on the research role of some universities, and the need for competency profiling of the teaching profession.

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PROGNOSTICATION OF UNSEEN OBJECTS USING ZERO-SHOT LEARNING WITH A COMPLETE CASE ANALYSIS

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ABSTRACT

Generally, for a machine learning model to perform well, the data instances on which the model is being trained have to be relevant to the use case. In the case of relevant samples not being available, Zero-shot learning can be used to perform classification tasks. Zero-shot learning is the process of solving a problem when there are no examples of that problem in the phase of training. It lets us classify target classes on which the deep learning model has not been trained.

In this article, Zero-shot learning is used to classify food dish classes through an object recognition model. First, the data is collected from Google Images and Kaggle. The image attributes are then extracted using a VGG16 model. The image attributes belonging to the training categories are then used to train a custom-built deep learning model. Various hyperparameters of the model are tuned and the results are analyzed in order to get the best possible performance. The image attributes extracted from the zero-shot learning categories are used to test the model after the training process is completed. The predictions are made by comparing the vectors of the target class with the training classes in the Word2Vec space. The metric used to evaluate the model is Top-5 accuracy which indicates whether the expected result is present in the predictions. A Top-5 accuracy of 92% is achieved by implementing zero-shot learning for the classification of unseen food dish images.

KEY WORDS

zero-shot learning, machine translation, unseen image classification

CLASSIFICATION

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INTRODUCTION

In this day and age, even as we are collecting a lot of data in various fields, there are some categories where it is difficult to collect relevant data. In these particular categories, the mechanism of zero-shot learning (ZSL) can be used to perform classification tasks for unknown object categories that have not been used for training the model. Traditional machine learning approaches mainly focus on predicting data of only the categories they have been trained on. ZSL instead focuses on classifying data of new and unseen categories. This approach can be used in various applications ranging from autonomous vehicles to healthcare use cases.

Unseen food dishes are classified and recognized through ZSL in this article. Nine training classes and four ZSL classes were considered in an attempt to classify the samples of ZSL classes using the Deep learning model trained on samples of training classes. In our case, the task of recognition of food dish classes is chosen to show how ZSL can be used to perform image classification on unseen objects. The VGG16 model [2] is used for extracting the image features of both training and ZSL class samples. Then, a new deep learning model is built to train the samples of the training classes.

The word embeddings are gathered by using the pre-trained Word2Vecs by Google. The result of this is a Word2Vec for the thirteen target categories that have been taken. After performing image feature extraction [1] and normalization, the Top-5 classes are predicted by comparing the vectors in the Word2Vec space. If the Top-5 predictions contain the actual label, then the model is said to have correctly classified the given image.

This article discusses the Literature Survey in Section 3. ZSL is discussed in Section 4. The problem scenario is defined in Section 5. Section 6 explores the methodology of ZSL. Section 7 discusses the case study undertaken. The article weighs up the performance of various optimizers in Section-8. Section-9 discusses the results and analyses the performance of the model in tuning the hyperparameters. The article is concluded in Section 10.

LITERATURE SURVEY

In [3], the authors proposed a novel strategy Zero-Short Learning three-fold. First, they defined new benchmarks by considering the unification of the evaluation protocols as well as the publicly available data splits to overcome the lack of agreed-upon ZSL benchmarks. Also, the Animals with Attributes 2 (AWA2) dataset, in terms of image features and the images themselves, is proposed by them. Secondly, a comparative study with a state-of-art algorithm is provided, and finally, the limitations are also given.

The authors in [4] presented a novel procedure named Generalized Zero-Short Learning, which combines unseen images and unseen semantic vectors while the training process is going on. They propose a low dimensional embedding of visual instance to fill the gap between visual features to a semantic domain similar to semantic data that quantifies the existence of an attribute of the presented instance. They also showed in the article the quantification of the impact of noisy semantic data by utilizing the visual oracle.

The authors in the article [5] provided an approach that is based on a more general framework that models the relationships between features, attributes, and classes as a two linear layers network. They contemplated that the weights of the top layer are not learned but are considered from the environment. They also provided learning bound on the generalization error of this kind of approach by casting them as domain adaptation methods.

A novel zero-shot classification approach is proposed by article [6] that automatically learns label embeddings from the input data in a semi-supervised learning framework. It considers

multi-class classification of all classes (observed and unseen) and tackles the target prediction problem directly without introducing intermediate prediction problems. It also can incorporate semantic label information from different sources when available.

Instead of reformulating ZSL as a conditioned visual classification problem, the authors of [7] develop algorithms targeting various ZSL settings: (i) train a deep neural network that directly generates visual features from the semantic attributes with an episode-based training scheme as a conventional setting, (ii) concatenate the learned highly discriminative classifiers for seen classes and the generated classifiers for unseen classes to classify visual features of all classes, and (iii) exploit unlabelled data to effectively calibrate the classifier generator using a novel learning method without forgetting the self-training mechanism – this process is guided by a robust generalized cross-entropy loss.

Article [8] provides a comprehensive survey on ZSL mechanisms. The authors presented the survey in several categories: (i) an overview of ZSL includes data utilized in model optimization and classification of learning settings, (ii) different semantic spaces adopted in existing ZSL works, (iii) categorize existing ZSL methods. Apart from this, the authors also highlighted different applications of ZSL and promising future research directions.

ZERO-SHORT LEARNING

Identifying an object among many other categories is becoming a popular application that can be used to expose new information in image data. By using ZSL, a target class is recognized and interpreted even when a similar object has not been seen or there is no information regarding the category it belongs to. ZSL methods are made to study various object classes, their features, and use the features learnt during image classification to help recognize unseen classes of data. It uses information from the training classes with labelled samples using the class attributes to perform recognition tasks. It is performed in the following way:

- training stage: the stage where information regarding the data is extracted,
- learning stage: the stage where the information captured categorizes various data samples which have not been previously seen.

The ZSL process is quite similar to how humans recognize objects. But there can be projects where data of thousands of classes may need to be labelled manually. Using the process of ZSL, it is feasible to classify many objects instead of performing recognition tasks on finite sets of objects. Traditional object classification tasks may struggle to provide good results when there is a lack of relevant data. In these types of situations, ZSL can potentially be used to implement many innovative applications.

While implementing ZSL, let us assume that we are training the model for C classes. The activation function used is the Softmax function. Since we are using it for a multi-class classification, the output will be the probabilities of every class, with the target class having the highest probability. We minimize the objective functions using Categorical Cross-Entropy Loss [9]. It is a good metric for differentiating between two discrete probability functions. Categorical Cross-Entropy Loss is defined as:

$$f(s)_i = e^{s_i} / \sum_j^C e^{s_j}, \quad (1)$$

which is the Softmax function.

where s represents the input vector, e^{s_i} is the standard exponential function for input vector, C is the number of classes in the multi-class classifier and e^{s_j} is the standard exponential function for output vector. The Categorical Cross-Entropy Loss:

$$CE = - \sum_i^C t_i \log(f(s)_i), \quad (2)$$

where $f(s)_i$ is the i -th scalar value in the model output, t_i is the corresponding target value and C is the number of scalar values in the model output.

The vector of the target class is compared with the vectors of training classes to obtain the predictions at the testing phase.

DESIGN OF THE PROBLEM

Consider a scenario where it is wished to classify species which live in places that humans cannot go to easily. It is almost impossible to collect the necessary image data of these animals. It would not be enough if you just collected similar pictures because it would not provide the diversity that the recognition task needs. So, the image data has to be quite unique. Adding to this difficult task of classifying various target categories, labelling of target categories can be trickier than it may seem. There are cases in which the labelling of object classes can only be done after the topic is really mastered or in the presence of a specialist. Under the guidance of a person who is experienced in the particular field, object classification tasks like the classification of endangered animals or plants are viewed as examples of giving labels to the data. Let us consider pandas, where some specific species of pandas are considered to be endangered or vulnerable, but an ordinary human will label all the pandas they observe as a panda instead of correctly naming its exact species which can only be done by an expert. Although there is truth in labelling it as just a panda, it does not help the neural network to recognize a particular species of panda. In such a situation, all the generalized labels are pretty much useless and there is the need of a specialist to label the particular species. As labelling the data instances manually can take a lot of time, ZSL can be used to perform classification tasks in such scenarios.

To perform object classification tasks with good accuracy in fine-grained object classification, it is needed to decide on a finite amount of target categories. It is important to gather as much image data for the target categories that have been decided. The training dataset must obviously have images captured at various positions in diverse habitats. Even though image data of a lot of object classes can be collected, there are often classes in which data is difficult to get hold of.

METHODOLOGY

While performing ZSL on image samples that have not been trained on may seem strange at first, it is possible to do so. The Training and Zero-shot classes are then separated. Simply put, how is it possible to recognize objects that the model has not seen before? The data should be depicted with sensible features. Thus, two data depictions are used. Class embedding and image embedding are the two data depictions that are required.

Image embedding [10] is used to read images and evaluate them locally or to upload them to a remote server. To calculate a feature vector for each image, deep learning models are used. This is done so in order to return another data table with additional image descriptors. This is learnt using a deep learning model and is called a feature vector. The deep learning model can either be a pre-trained convolutional network that already has a high accuracy rate or a new one can be built from scratch. For the image feature extraction process, a pre-trained deep learning model called VGG16 [2] is used.

Image embeddings can be obtained for all the instances of the dataset that are collected for training classes. But there is a lack of samples of images for the ZSL classes. It is impossible to obtain image embeddings for the ZSL classes. It is here where ZSL is different from the usual image classification problems. Now in this stage, there has to be an

alternative depiction of data linking both the ZSL and training classes. Image embedding should be learnt from the image dataset regardless of which class they belong to, whether it be training or Zero-shot. Therefore, labels of categories should be focused upon instead of concentrating on the image itself.

Both the class labels and image samples for the Training classes are available to us now. However, only the class labels for the Zero-shot classes are available as the image data has not been seen. This is shown in Figures 1 and 2. Here, it can be seen that image embedding is done only for the training classes and not for the ZSL classes, while class embedding is done for both training and ZSL classes.

MODEL ARCHITECTURE

As the final step is using the Word2Vec as a link to classify the target categories that have not been trained on, the last layer of the model that was custom-defined and untrainable is removed. The model then gives a vector output for each input image. The model contains various layers, and it is made sure that the input shape of the first layer of the model is of the same shape as the image attributes extracted using the VGG16 model.

A vector is then obtained that gives an indication of a coordinate in the Word2Vec space for every data instance. Then this vector output is mapped to the one which is placed closest by differentiating it with the thirteen category vectors available. From the VGG16 model, the last three layers were removed in order to map to the input shape of the custom sequential model which is as shown in Figure 3.

After tuning the hyperparameters [11] and getting to the best possible model performance, the trained model is tested on the image data of ZSL classes.

CLASSES	CLASS EMBEDDING	IMAGE EMBEDDING
TRAINING	Yes	Yes
ZSL	Yes	No

Figure 1. Whether class and image embeddings are performed for the classes.

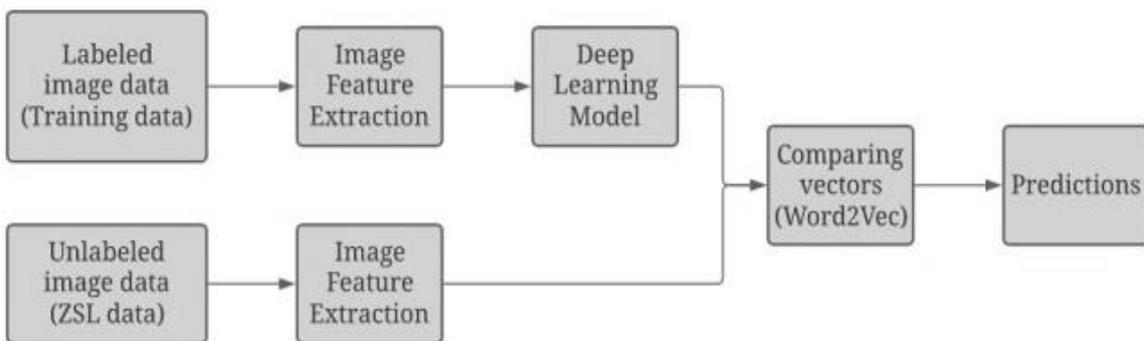


Figure 2. Flowchart describing the process of ZSL.

DATA COLLECTION

The first step is to collect the necessary images of both the training and testing classes. The image data of training classes is utilized for training the ZSL model, while that of the testing classes is utilized for assessing how the model performs.

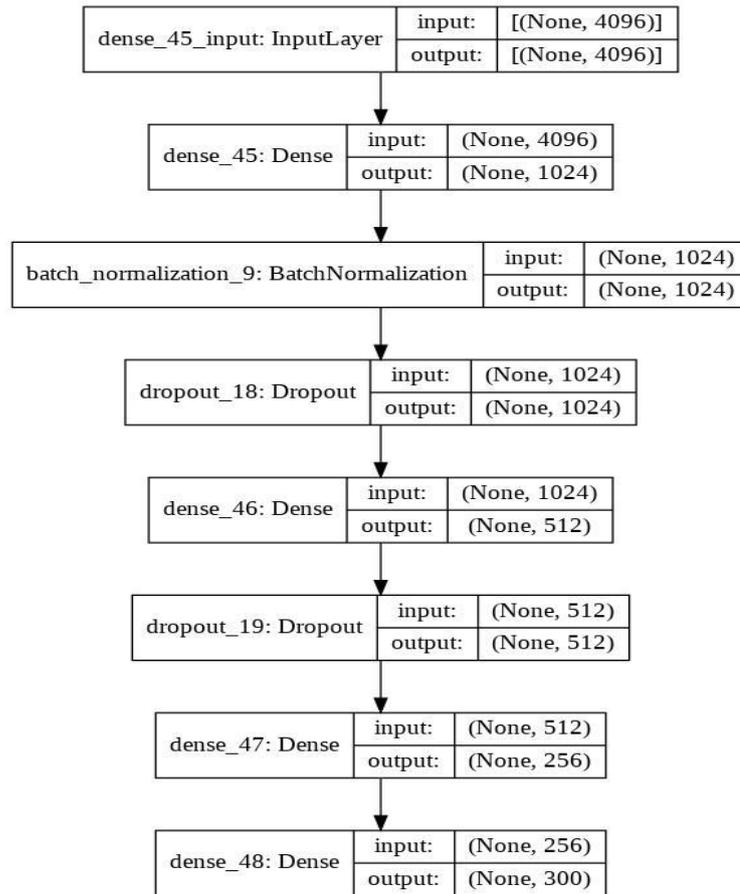


Figure 3. Architecture of the deep learning model.

The image data described above is collected from Google Images and Kaggle [23]. Thirteen classes were selected in total, out of which nine classes are chosen for the training phase and four classes are chosen as ZSL classes. Now, it is necessary to decide which classes out of the total thirteen are chosen to be ZSL and training classes. Various food dishes have been picked as classes for demonstrating the process of ZSL for classification of unseen objects.

TRAINING CLASSES FOR ZSL

Burger Caprese Salad Carrot Cake
 Butter Chicken Cup Cake Deviled Eggs
 Donut Greek Salad Paneer Butter Masala

Figure 4. Training classes for ZSL.

ZERO-SHOT CLASSES FOR ZSL

Caesar Salad Chocolate Cake
 Eggs Benedict Mixed Vegetable Curry

Figure 5. Zero-shot classes for ZSL.

IMAGE FEATURE EXTRACTION

From Google Images and Kaggle, the required food dish images are obtained for all the necessary classes. Extraction of the image attributes [1] is done using the VGG16 convolutional neural network [2] from the data collected.

WORD EMBEDDINGS

The word embeddings [12] of all the classes are gathered after the datasets have been formed and extracted the image features. Google's Word2Vec depiction is used for this process. This is a Word2Vec for all the 13 food dish target categories which have been considered.

Class embedding is the form of depiction of a particular category in a vectorized manner. It can be easily accessed for every object category aside from image embeddings. Vectors are placed near each other in the Word2Vec space if the two words tend to appear together in similar Google News documents.

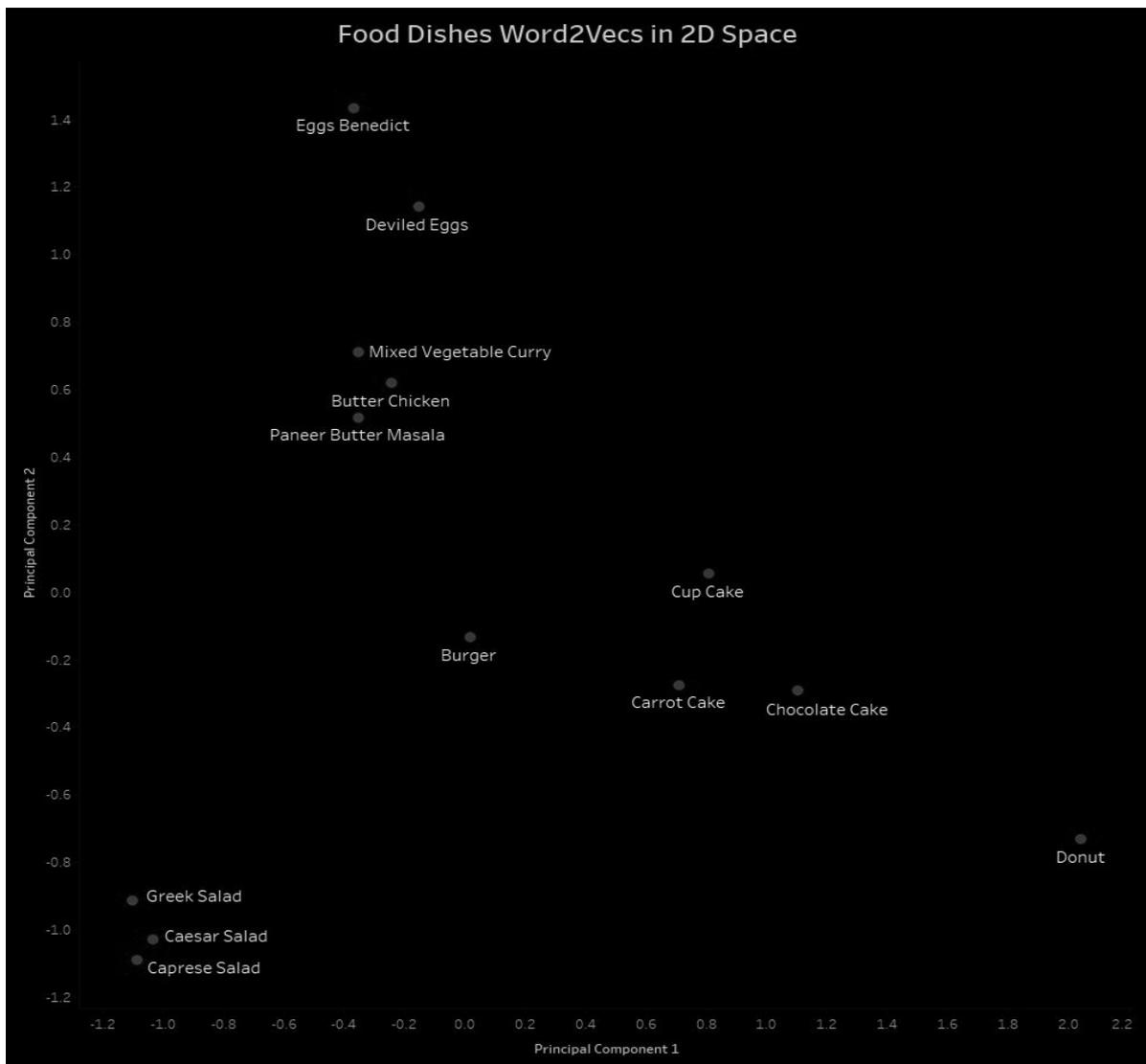


Figure 6. Word2Vec space containing the vectors of Training and ZSL classes.

From the Word2Vec space illustrated in Figure 6, it can be noticed that the vectors of food dishes related to cakes are placed near to each other. But they are placed far from the vectors of food dishes related with salads.

MODEL TRAINING

Here, the inputs are the image features extracted, and the corresponding outputs are the Word2Vecs. A fully-connected Keras model is created as a follow-up to the pre-trained convolutional model, which is used to extract the image features. The last layer of the model created has to be a custom layer. This layer should not be trainable. This indicates that the layer must not be changed by updating the gradients. The different kinds of layers used in this model are:

- dense layer: It is a deeply connected neural network layer. It is the most frequently used layer in deep neural networks. It receives input from all neurons of its previous layer [13],
- dropout layer: It is a method of reducing overfitting in neural networks by preventing the model from learning noise in the dataset [14],
- batch Normalization layer: It is a method that is used for training neural networks which standardize the inputs to a layer for each mini-batch [15].

The formula for implementing Batch Normalization is:

$$x^* = (x - E[x]) / \sqrt{\text{var}(x)}. \quad (3)$$

where x^* is the new value of a single component, $E[x]$ is its mean and $\text{var}(x)$ is its variance.

Batch Normalization can learn the identity function using:

$$x^{**} = \text{gamma} * x^* + \text{beta}. \quad (4)$$

where x^{**} is the final normalized value.

OPTIMIZERS

The process of updating the deep learning model according to the loss function's output by tying together the parameters and the loss function is performed by optimizers. Simply put, by futzing with the weights of the neurons, the deep learning model is updated to its best form. The model is trained using various optimizers in order to know which best fits the dataset. The accuracies obtained are shown in Table 1.

Table 1. Accuracies obtained upon using various optimizers.

Optimizer	Top-5 Accuracy	Top-3 Accuracy
Adagrad	0,92	0,78
Adam	0,91	0,76
SGD	0,90	0,76
Nadam	0,89	0,76
RMSprop	0,88	0,75

Here, it can be observed that the Adagrad optimizer [16] performs best on our training dataset with the best Top-5 and Top-3 accuracy. The Adam optimizer [17] comes a close second after Adagrad.

Adagrad (Adaptive Gradient Algorithm) is an algorithm that is used for gradient-based optimization. By incorporating knowledge of past observations, the learning rate is adapted to the parameters component-wise. It performs bigger updates for those parameters which are not frequent and smaller updates for those that are frequent. While using Adagrad, the learning rate need not be tuned manually, and its convergence is more reliable. Adagrad is also not sensitive to the size of the master step.

The formula used by Adagrad to update the parameters is [13]:

$$\theta_{t+1} = \theta_t - \frac{\alpha}{\sqrt{v_t + \epsilon}} \cdot \frac{\partial L}{\partial \theta_t} \quad (5)$$

where t is the time step, θ is the weight/parameter which we want to update, v_t denotes different learning rates for each weight at each iteration, α is a constant number and $\partial L / \partial \theta_t$ is the gradient of L , the loss function to minimise, with respect to θ .

RESULTS AND ANALYSIS

The accuracy scores of the deep learning model when it is tested on the image data of the four unseen food dish classes are shown in Figure 7. 92% accuracy for Top-5 predictions and 78% for Top-3 is attained after tuning the hyper parameters of the deep learning model.

```
ZERO SHOT LEARNING SCORE
-> Top-5 Accuracy: 0.92
-> Top-3 Accuracy: 0.78
```

Figure 7: The final ZSL scores obtained.

For testing the model, the data instances of ZSL classes will be used. These images have not been used for training the model. The deep learning model is evaluated by performing ZSL classification on the collected image data. The Word2Vec is compared for each image sample with the 13 vectors. The metric that is used is Euclidean distance [10]. Finally, the class which is closest to the target class in the Word2Vec space is predicted.

For example, an image of a Chocolate Cake is taken which is one of the zero-shot classes. The predictions of the model are shown in Figure 8 upon performing ZSL on the selected image.

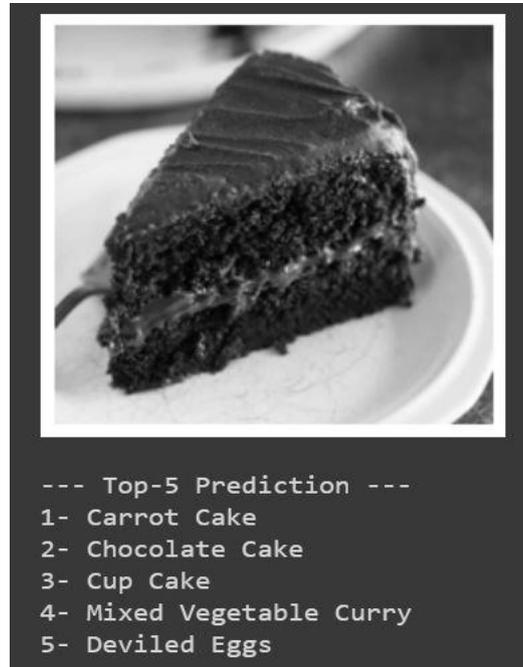


Figure 8. Top-5 Predictions when the target class is Chocolate Cake.

It can be seen that it predicts ‘Chocolate Cake’ at the second position while not having seen the image class during the training process. The metric that is being used to evaluate the model is Top-5 and Top-3 accuracy. It basically means whether the actual label for the unseen image is present in the Top-5 or -3 predictions. Top-5 accuracy is around 92 %. Since

this is a process of classifying images that have not been seen by the model before, the accuracy percentages are pretty decent.

The deep learning model knows only the positions of the classes in the Word2Vec space. Thus, it can be deduced that ZSL clearly works better than some random object recognition task.

A confusion matrix helps in visualizing the performance of a deep learning model. Figure 9 shows how many images the model predicted correctly for each class. The ‘Not in Top-5 preds’ row indicates the number of images the model predicted incorrectly for each class.

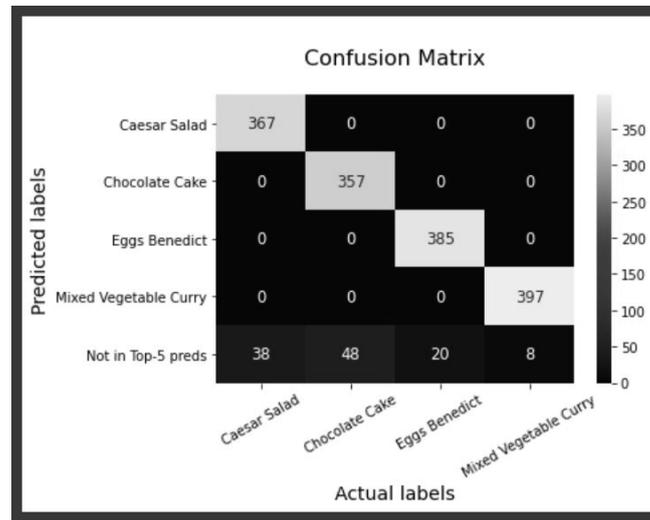


Figure 9. The confusion matrix of the Zero-Shot classes tested on the deep learning model.

EFFECT OF BATCH SIZE

The amount of data instances that are needed to be trained before updating the necessary hyperparameters is known as batch size. It iterates over the data and predicts classes. The predicted values are compared to the expected values and the loss is computed. The neural network is improved from this loss by moving down the error gradient.

The training accuracies and losses of different batch sizes such as 64, 128 and 256 [18] are compared. The training accuracy and loss of the deep learning model using various batch sizes are shown in Figures 10 and 11. The number of epochs (X-axis) denote the number of passes that the model has completed of the entire training dataset.

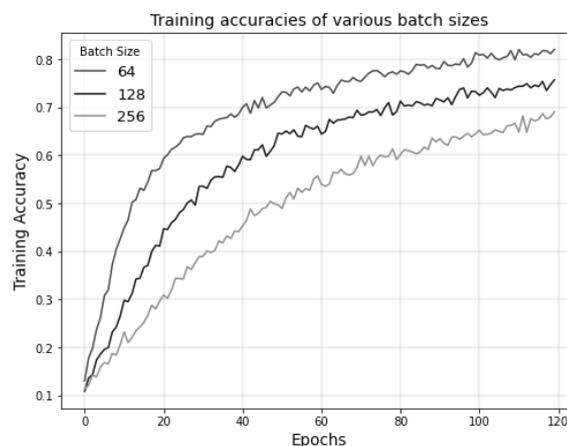


Figure 10. Comparing the training accuracies of the model when trained with different batch sizes.

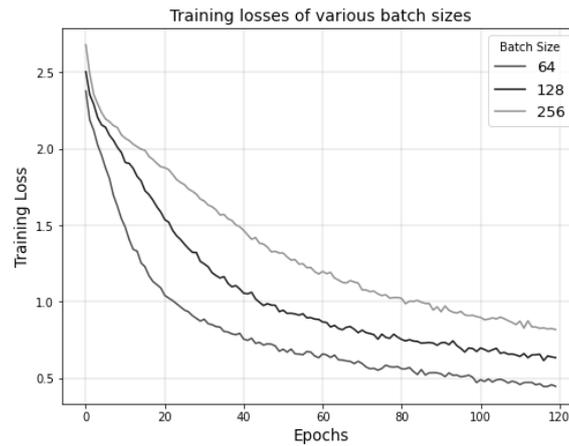


Figure 11: Comparing the training losses of the model when trained with different batch sizes.

From the figure one can analyse that low training accuracy is caused by high batch sizes. As the batch size increases, the training accuracy decreases and the training loss increases. This is due to the amount of data being trained as a batch is increased. A hypothesis on why this happens is that the training instances of a particular batch interfere with one another's gradient. Therefore, this leads to smaller gradients overall.

EFFECT OF LEARNING RATE

The hyperparameter that controls the amount of change in reaction to the loss every time the weights of neurons get updated is called the learning rate [11]. The process of selecting a learning rate can be difficult as the value may be too large, resulting in learning a sub-optimal set of weights too quickly, whereas a smaller value may end in the training process getting stuck. There are studies [19] that analyze the impact of varying learning rates over larger batch sizes. Thus, the learning rate is increased and it is checked if the training accuracy that has been lost are regained.

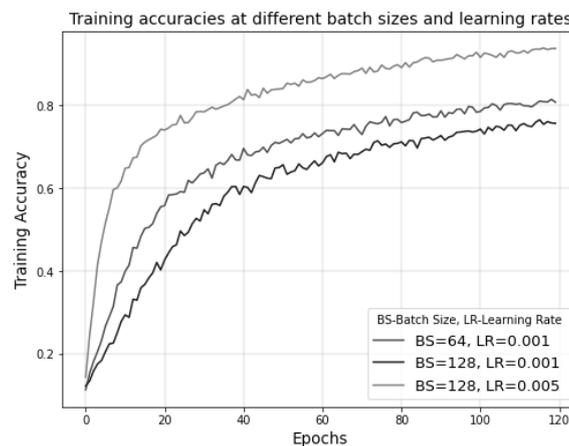


Figure 12. Comparing the training accuracies of the model at different batch sizes and learning rates.

The learning also affects such a way that the lost training accuracy is regained by increasing the learning rate. As the learning rate is increased, the training accuracy lost by increasing the batch size is regained as the model learns at a faster rate than the previous runs.

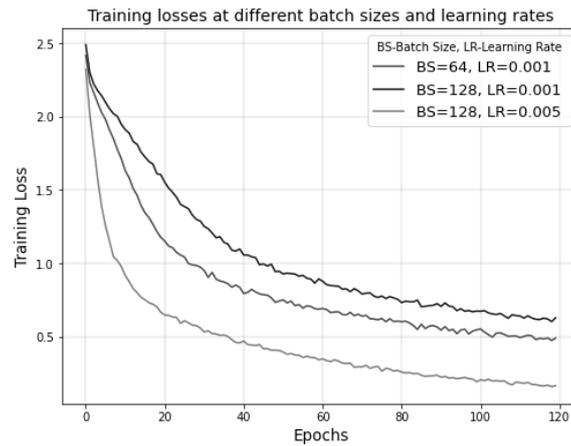


Figure 13. Comparing the training losses of the model at different batch sizes and learning rates.

IMPLEMENTING EARLY STOPPING

The process of monitoring the model’s performance for each epoch on a validation set during training and ending the training based on the validation set performance is called Early Stopping [20]. Early Stopping is implemented during training and it is checked whether there is an improvement in the Validation loss.

In Figure 14, it can be seen that the validation loss stops decreasing and starts to go back up. This shows that the model is overfitting the dataset. However, in Figure 15 implementing Early Stopping, the training is stopped as soon as the validation loss starts to increase, thereby preventing overfitting.

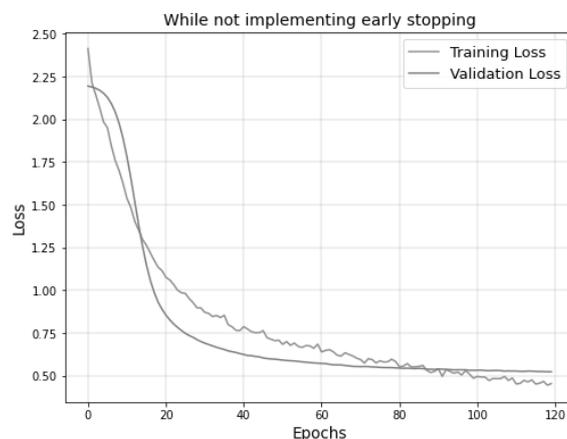


Figure 14. Comparison between training and validation losses of the model while not implementing early stopping.

REGULARIZATION LAYERS

To help the model in generalizing well, regularization layers are used that make some changes to the algorithm. Here, in the methodology for optimization, the following regularization layers are implemented: Dropout, Gaussian Noise and Gaussian Dropout.

Dropout [14] is partially learning the weights over many epochs. Dropout value of 0.5 leads to the highest possible regularization. The intention is to lessen the dropout loss in order to regularize the deep learning model. This is done using the following equation:

$$E_R = \frac{1}{2} (t - \sum_{i=1}^n p_i w_i I_i)^2 + \sum_{i=1}^n p_i (1 - p_i) w_i^2 I_i^2. \quad (6)$$

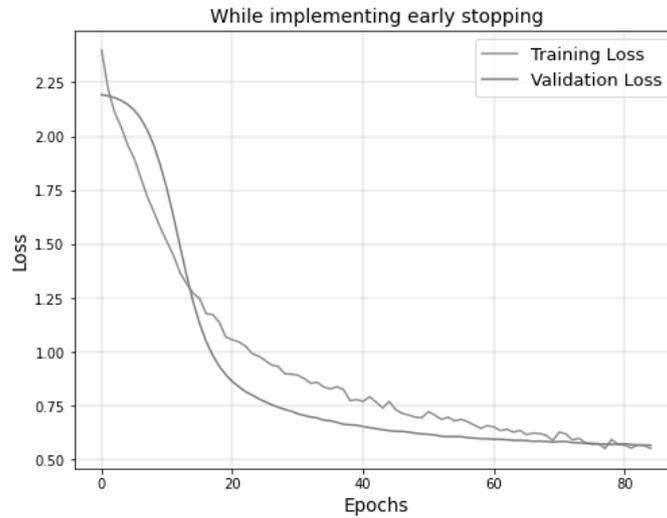


Figure 15: Comparison between training and validation losses of the model while implementing early stopping.

where w represents the weights, I represents the input vector, i is the activity in a particular unit.

Gaussian Dropout involves multiplying the weights with a variable. There are Gaussian Gates are put on each connection. The weights need not be scaled in Gaussian Dropout. The equation for Gaussian Dropout is shown below.

$$E[\sum \delta_i w_i I_i] = \sum w_i I_i \text{ if } \delta_i \sim N(1, \sigma_i). \tag{7}$$

where δ denotes a gating 0-1 Bernoulli variable, w the weights, I the input vectors, i the activity in a particular unit.

The layer of Gaussian Noise [21] is used to include noise in the model. This helps in reducing overfitting. It is particularly useful when dealing with inputs which are real valued. It performs the second best right after the Dropout layer when trained on the image data of the training classes.

The probability density function p of a Gaussian random variable z is given by:

$$p_G(z) = \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{(z-\mu)^2}{2\sigma^2}}, \tag{8}$$

where z represents the grey level, μ represents the mean grey value and σ is its standard deviation. The model is trained on the following regularization layers obtaining accuracies as shown in Table 2.

Table 2. Effect of different regularization layers on the model.

Regularization layer	Top-5 Accuracy	Top-3 Accuracy
Dropout	0,92	0,78
Gaussian Noise	0,91	0,76
Gaussian Dropout	0,88	0,72

As it can be observed that using the Dropout layer achieves the best results, with the Gaussian Noise layer coming a close second. Two Dropout layers are used with the first one having a rate of 0,8 and the second one having a rate of 0,5. The rate of the first layer is 0,8 because it is important to retain as much information when implementing Dropout layers at the input. If not done so, a lot of information might be lost and it might affect the training process.

CONCLUSION

A ZSL model is built in a way that uses the VGG16 model [2] to extract image attributes and then recognize daily life objects which the model has not seen. Nine training classes and four ZSL classes were considered in this article to classify the samples of ZSL classes on training the model with samples of training classes. The data is collected from scraping Google for images and from a Kaggle dataset. A deep learning model is then trained on the features extracted from the training class data collected. It is tested on ZSL class data and achieved a Top-5 accuracy of 92 %.

Images that have not been trained on are being classified, especially when the neural network is not aware of the ZSL classes, at scores that are quite decent. The only information given to the model is location of the word vectors of these classes in the Word2Vecs. The scores are not always high as it is more difficult to recognize target classes that belong to similar categories.

ZSL has great scope and is a popular topic in Deep Learning even though it is a relatively new idea. ZSL can be built upon and improved to make further systems like helper-based systems using ZSL for the visually impaired. The natural vegetation can be analysed in remote areas and rare animals can be classified in their own habitats. There have been a lot of developments recently in the field of robotics [22] and ZSL can be used to produce robots that can carry out functions of humans. This can be done as humans can recognize an object that the model has not been trained on before and might not have information regarding what the thing is.

Future work that we envisage carrying out is focused on adopting ZSL mechanisms in deep learning algorithms for the design and development of intelligent systems. We aim to test other N-shot approaches such as one-shot and few-shot learning, and compare their performance to ZSL. Another approach could be to combine other N-shot approaches with ZSL to achieve better predictions in practical situations such as autonomous vehicles. This takes the novelties of all such approaches and produces an overall positive result.

The code is available at <http://www.github.com/JatinArutla/Zero-Shot-Learning>.

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SMART INTERNET OF THINGS MODULAR MICRO-GROW ROOM ARCHITECTURE

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ABSTRACT

This article proposes the Internet of Things-based self-sustaining modular grow room architecture for optimising the seed germination and seedling development process. The architecture is scalable and flexible as it can be adapted to particular environments, scopes, requirements and plant types; it is modular as the host room can contain one or more smaller-scale grow rooms, each of them controlling their own micro-environment independently. One of the main goals of the research was to develop such a system that could be deployed efficiently, with minimal costs and energy footprint, which would enable its practical usage primarily in private self-sustainable households. The usage of widely available and inexpensive components, open source code, and free cloud services all enabled us to reach such a goal. Besides simple automation mostly described by existing solutions, the architecture proposed within this article offers remote control and data processing and visualisation, data trend tracking, smart optimisation, and actuator control, and event notifications.

KEY WORDS

grow room, IoT, self-sustainability, AI, smart agriculture

CLASSIFICATION

JEL: L86

INTRODUCTION

In recent years, agricultural sector has faced many challenges like urbanisation, climate change, resource limitation, food waste, but the major challenge it faces is meeting the food needs of a rapidly growing number of people. United Nations predict that there will be 9,6 billion people in the world in 2050 [1]. In order to provide food for the entire population it is important to merge modern information and communication technologies with agriculture to perform intelligent farming [2] and improve productivity. IoT is a technology that has great potential in this aspect and offers innovative solutions for agricultural sector modernisation.

The Internet of Things (IoT) was first mentioned in 1999 when MIT's Kevin Ashton stated that "adding RFIDs to everyday objects would create an Internet of Things" [3, 4]. The most comprehensive definition of IoT is given by IEEE IoT initiative [5] in their document with baseline definitions of IoT. They separate definitions for small systems which contain uniquely identifiable things and small sensors, and complex systems that interconnect millions of things with a capacity to deliver complex services. IoT for low complexity systems is defined as [5] "a network that connects uniquely identifiable 'things' to the Internet. The 'things' have sensing/actuation and potential programmability capabilities. Through the exploitation of unique identification and sensing, information about the 'thing' can be collected and the state of the 'thing' can be changed from anywhere, anytime, by anything". IoT for complex systems is defined as [5] "a self-configuring, adaptive, complex network that interconnects 'things' to the Internet through the use of standard communication protocols. The interconnected things have physical or virtual representation in the digital world, sensing/actuation capability, a programmability feature and are uniquely identifiable. The representation contains information including the thing's identity, status, location or any other business, social or privately relevant information. The things offer services, with or without human intervention, through the exploitation of unique identification, data capture and communication, and actuation capability. The service is exploited through the use of intelligent interfaces and is made available anywhere, anytime, and for anything taking security into consideration". In other words, IoT focuses on process automation as to lessen human interaction. During the automation process IoT uses sensors to collect data, processes the collected data using controllers and actuators are used to complete the automation process [6].

There are numerous application areas of IoT, which include, but are not limited to: smart cities, smart agriculture, smart power grids, smart health, smart transport, smart buildings, smart living solutions, smart human settlements and other [7]. In recent years, IoT applications have increased, especially in smart cities, smart homes, smart agriculture and smart healthcare [8]. IoT offers multiple benefits in before mentioned areas through innovative technologies and solutions.

Application of IoT in agriculture allows monitoring and control of the entire process by using different sensing, mobile, big data and other technologies. IoT offers numerous benefits for agriculture such as optimisation, control and automation of processes which were previously done manually [9]. IoT monitoring systems in agriculture improve the food quality but also productivity and safety aspects [10]. Farooq et al. [11] identified three main application areas of IoT in agriculture: precision farming, livestock and greenhouses. Each of these areas has different fields, one of which is seed germination and seedling development. This is arguably one of the most important phases and as such is the focus of this article. In order for germination to happen, seeds need to have the proper amount of moisture, oxygen, light and temperature [12]. The area in which seed germination and growth occurs under controlled and monitored conditions is called a grow room. Harun et al. [13] identify IoT, specifically IoT-based monitoring systems as a means to achieving a higher percentage of germination and seedling growth.

The aim of the article is to propose a novel IoT-based self-sustaining micro grow room architecture for enabling and optimising the seed germination and seedling development process. One of the main goals is to develop a system that can be deployed efficiently, with minimal financial costs and energy footprint, which would enable its practical usage primarily in private self-sustainable households. The architecture proposed within this article offers remote control, data processing and visualisation, data trend tracking, smart optimisation, actuator control and event notifications.

The aim of the article will be accomplished through four sections. This section gives an introduction to the topic of IoT in general and its application and importance in the field of agriculture, while section 2 focuses on existing solutions and state of the art research on the topic. Through section 3 detailed description of the proposed IoT-based grow room architecture and its components is given. In the end, the experiments are conducted, the results discussed and advantages of the proposed system are described.

RELATED WORK

As mentioned earlier, there are three main application areas of IoT in agriculture: precision farming, livestock and greenhouses [11]. The focus of this article is seed germination and seedling development so this literature review will focus on application of IoT in greenhouses, with emphasis on IoT in grow rooms. While conducting the literature review, research string was defined ((“Internet of Things” OR “IoT”) AND (“grow room” OR “plant nursery” OR “greenhouse”)) and databases for research were defined (IEEE, Elsevier and Web of Science). After the search was conducted, only articles in the last five years were selected which left 42 articles. All of the articles were not relevant and after title, keywords and abstract screening, fifteen most relevant articles were selected for further review. Out of the fifteen articles, seven of them focused specifically on IoT in grow rooms [9, 12, 14-17]. The overview of the selected articles can be seen in Table I.

The article by Kodali et al. [19] describes a model of a smart greenhouse where different actions are carried out according to information collected from different sensors. Irrigation is carried out according to the soil moisture threshold so that optimal amount of water is applied to the plants. From soil health card data, proper amount of nitrogen, phosphorus, potassium and other minerals can be applied by using drip fertigation techniques. Water management tanks are filled with water after measuring the current water level using an ultrasonic sensor. Growing lights are used to provide plants with the requisite wavelength light during the night.

Humidity and temperature sensors regulate the humidity and temperature of the greenhouse by using a fogger. Bee-hive boxes are deployed for pollination and boxes are monitored using ultrasonic sensors to measure honey and send mails to the buyers when they are filled. The authors implemented the proposed model, but the research does not show the differences between plants in a smart greenhouse and those in a regular greenhouse.

Li et al. [20] propose a smart system of greenhouse management based on the IoT using sensor networks and web-based technologies. The sensor network consists of the master control center and various sensors using Zigbee protocols and the proposed system consists of six functional modules: user management module, hardware node management module, system control module, network settings module, monitor module and weather module.

The article by Pallavi et al. [21] proposed a remote sensing of agriculture parameters and control system to the greenhouse agriculture. The system is designed to remotely monitor the greenhouse parameters such as CO₂, soil moisture, temperature, and light. The system also controls different actions like greenhouse windows/doors roll on/off based on the soil moisture

levels. The results are analysed for different greenhouse parameters such as CO₂, soil moisture, temperature, and light for bell pepper plant. The drawback of this article is that there is no comparison between the results of regular greenhouse and the one proposed in this article.

Biqing et al. [22] designed a sugarcane growth monitoring system to realize real-time monitoring of sugarcane growth and analysis of collected data. Collected data include temperature and humidity, sunshine, CO₂ and plant height. Users logged in the system can effectively monitor growing environment of sugarcane and implement remote visual management and improve their production efficiency. The drawback of the proposed monitoring system is lack of automation and controlling possibilities.

The authors Yang et al. [8] designed and implemented an indoor intelligent agricultural IoT system that adopts a three-layer framework: data sensing layer, cloud service layer and user interaction layer. The solution is described in detail, from hardware, systematic service to application. The system monitors temperature, humidity, illumination intensity and content of CO₂, O₂ and NO₂ in the air. Based on analysis results, guidance of plant cultivation is given to user.

The objective of the research by Islam et al. [12] research was to develop an IoT Smart Germination Assistant system to improve the seed germination process. Multiple sensors are used to measure, adjust and control the moisture, humidity, pH level, temperature, and sunlight to the standard value for each crop. The proposed system was implemented and tested with 300 seeds of jute leaf. The experiment showed that the developed system is more effective and efficient than the natural system of seed germination. As only one evaluation experiment was conducted on one type of crop, definite conclusions cannot be drawn as results may vary depending on the seed type, location and environment.

Gonzalez-Amarillo et al. [23] present the design of the IoT-based greenhouse model for the tracking and record keeping of seedlings in the germination and growth stages. The model tracks luminosity, humidity, temperature, and water consumption to reveal overall water use, growth patterns of the plants, and the timeline for harvest of produce. The system also allows automated control of the greenhouse environment using an irrigation system or temperature control and presents traceability of agricultural products from seed to final produce. The proposed system reduces water and energy consumption in the process.

In the article [14] Somov et al. demonstrated the application of IoT in agriculture, more specifically, in tomato greenhouse. Based on the data from different sensors (pH, electric conductivity, solution flow, temperature, photosynthetically active radiation, humidity, CO₂) the growers can make better decisions on a number of issues, predict the crop growth rate,

Table 1. Overview of literature review (continued on p.473).

Reference	Source	Year	Location	Application	Protocol/Network	Sensors	Crop
[19]	Conference	2016	Greenhouse	Monitoring	WiFi	Ultrasonic, moisture, temperature and humidity, LDR	N/O
[20]	Conference	2017	Greenhouse	Monitoring	Zigbee	Temperature and humidity	N/O
[21]	Conference	2017	Greenhouse	Controlling	WiFi	CO ₂ , soil moisture, temperature, light	Bell pepper

Table 1. Overview of literature review (continuation from p.472).

[22]	Journal	2018	Greenhouse	Monitoring	ZigBee	Temperature, humidity, sunshine, CO2	Sugarcane
[8]	Journal	2018	Greenhouse	Monitoring	4G, WiFi	Temperature, humidity, illumination intensity, CO2, O2, NO2	N/O
[12]	Conference	2018	Grow room	Controlling	GSM	Moisture, humidity, pH level, temperature, sunlight	Jute leaf
[23]	Journal	2018	Greenhouse	Controlling	WiFi	Soil humidity, air humidity, temperature, luminosity	N/O
[14]	Journal	2018	Greenhouse and Grow room	Controlling	WSN	PH, electric conductivity, solution flow, temperature, photo-synthetically active radiation, humidity, CO2	Tomato
[24]	Conference	2018	Greenhouse	Controlling	N/O	Electrical conductivity, pH, water temperature, air temperature, humidity	N/O
[9]	Conference	2019	Grow room	Controlling	WiFi	Temperature, humidity, luminosity, soil moisture	N/O
[15]	Conference	2019	Grow room	Controlling	WiFi	Soil moisture	Cocoa
[16]	Journal	2020	Grow room	Controlling	WiFi	Soil moisture	N/O
[17]	Conference	2020	Grow room	Controlling	WiFi	Temperature and humidity, current, soil moisture	N/O
[18]	Journal	2020	Grow room	Monitoring	WiFi	Temperature, humidity	Ocimum basilicum
[25]	Conference	2020	Greenhouse	Monitoring	WiFi	Resistive soil moisture, Capacitive soil moisture, temperature, humidity, light	Spinacia Oleracea and Lactuca Sativa

time tomato harvesting and ensure control of the greenhouse conditions based on mentioned data. The authors also applied Reinforcement learning to find optimal light usage.

Palande et al. [24] focused their research on hydroponic greenhouse. They created a system that can grow plants and vegetables and can operate without depending on the outside climate. They used hydroponics, a method of growing plants without using soil. They automated the system by using microcontrollers and sensors (electrical conductivity probe, pH sensor, water temperature sensor, air temperature and humidity sensor) to reduce human intervention. The proposed system is fully automated, but also small and affordable enough for consumer usage.

Cruz et al. [9] describe the architecture of a mini-greenhouse monitored via IoT. Sensors are used for monitoring and control of the variables that most influence the plant development (temperature, humidity, luminosity and soil moisture). The proposed system consists of a cloud-based storage, web platform, controllers and sensors. The prototype was developed but no experiments were presented. The major advantage of this system is that it uses open source software and generic hardware so the system allows adding new sensors. Unlike previously mentioned research, articles by Jaafar et al. [15] and Methsarani et al. [16] focus only on irrigation control. Jaafar et al. [15] designed an automatic drip irrigation system based on IoT platform which shows better results in plant height and number of leaves than traditional systems. Methsarani et al. [16] developed a wireless smart irrigation system which helps in saving money and water. The system checks the soil moisture level and the water need of the plant and can be used to switch on/off the watering valve.

Phirke et al. [17] designed a Smart Plant Incubator prototype to simulate the optimum atmospheric conditions like temperature, soil moisture, air humidity and light intensity required for the best growth of a specific plant. The incubator is fully automated and plant growth efficiency is maximised. The prototype provides automation and no human is required to monitor changes as it automatically uses the stored data and simulates the climatic conditions.

The article by Franco et al. [18] presents a monitoring system for the germination of *Ocimum basilicum* seeds. The system controls the temperature and humidity variables through the strategy of fuzzy control. Also, it uses image processing for seed monitoring. The germination tests carried out under controlled factors, show results with positive growth trends compared to the tests run under uncontrolled factors and on timed hydration regime. The application of a constant temperature and maintaining a high level of humidity inside the germination chamber, it results in obtaining a short hydration period and obtaining radicle with elongation between 3 to 10 mm. Similarly, monitoring the seeds without interrupting the temperature and humidity level by opening the germination chamber reduces a positive result to the decrease of non-germinated seeds.

Marcos and Mai [25] present a system that helps assist indoor plant growers using IoT. The purpose of the article is mainly focused on determining which light is more suitable for growing Spinach (*Spinacia Oleracea*) and Lettuce (*Lactuca sativa*), but the authors also implement an automated greenhouse system using IoT to determine the feasibility of having an intelligent monitoring system for indoor plant growth. The purpose of the implemented system is to determine the effects of different plant grow light spectra/colours in terms of temperature, humidity, light intensity, and soil moisture.

From the conducted literature review, we can see that there are not many articles on application of IoT in grow rooms or plant nurseries. Most of the research focuses on greenhouses in general [8, 19-25], but grow rooms, as much as they are similar to greenhouses, also have specific requirements. If the articles are analysed according to used

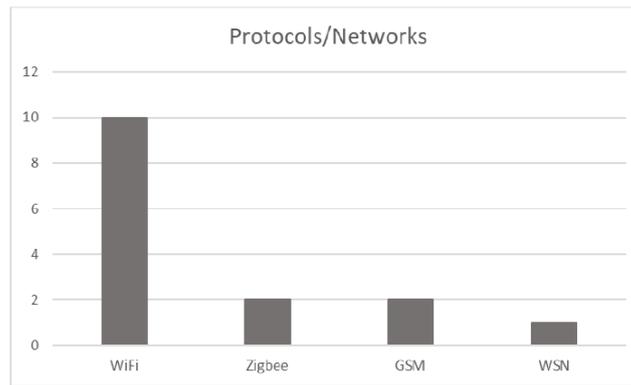


Figure 1. Representation of protocols/networks in state of the art research.

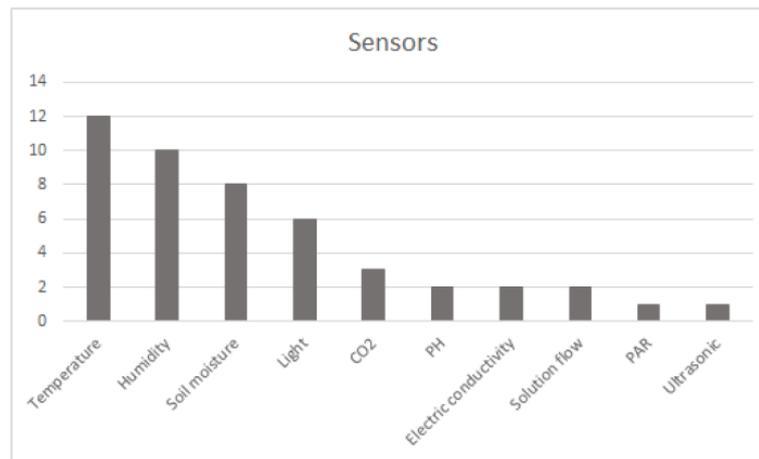


Figure 2. Representation of sensors in state of the art research.

sensors, Figure 2 shows that the most often used sensors are temperature sensor, followed by humidity, soil moisture and light sensor. On the other hand, if the articles are classified by protocol/network used, Figure 1 shows that WiFi is most commonly used and Zigbee, GSM and WSN are rarely used in state of the art research.

The most prominent demerit of the surveyed articles is that most of the articles suggest different systems and prototypes, but only a few [12, 18, 24], show experimental results of the proposed systems and compare the results with the results from regular greenhouses or grow rooms. Also, many of the articles analysed [8, 18-20, 22, 25] focus only on monitoring different variables and not on automation of agricultural processes.

A PROPOSED IOT-BASED GROW ROOM ARCHITECTURE

The proposed architecture describes a self-sustaining IoT-based system which aims to optimise seed germination and seedling development parameters in a controlled micro-climate environment. The system is modular and scalable from two perspectives; (1) its functionalities (and consequently its complexity) can be scaled up and down according to individual requirements by adding or removing modules, without the need for re-configuring the architecture or reprogramming the main code, and (2) a grow/host room can contain one or more smaller-scale grow rooms, each of them controlling their own environment independently. The former can be argued by the user's needs and environmental conditions (for example, there might not be a need for a heater unit if the grow room receives adequate ambient temperature, or a need for camera if the user does not require advanced AI capabilities. The latter can be argued by the heterogeneous needs of each different plant types, where each of them require their own

optimised micro climate and conditions. Because of these requirements, it is essential that the system implementation has reasonable costs and effectiveness.

In one of the most basic forms, the system might consist of a temperature sensor, an MCU, a heater element and grow lights. The temperature sensor reads the air temperature, sends it to the MCU unit, which processes the data, regulates the actuators and sends the data to the cloud and to user endpoints. If the MCU detects low threshold temperature or trend for example, it activates the heater element and sends the event notification and parameter data to the cloud and to user's phone application and/or email. This is a simple automation example coupled with an IoT networking, actuator control, data processing and cloud visualising capabilities. More advanced grow room modules involve humidity tracking (both air and soil humidity) and regulating ventilation and irrigation subsystems; measuring luminosity values and regulating grow lights; applying machine learning methods in detecting and recognising plant development phases and fine-tuning grow lights' parameters such as wavelengths and intensities accordingly. Thus besides a simple automation, the architecture offers remote control and data processing and visualisation, data trend tracking, smart optimisation and actuator control, etc. The AI module could act proactively by analysing data trends (for example, continuous drop in temperature values, and/or weather forecast via third-party API) and act on the actuators in a way to prevent temperature, moisture and/or luminosity shocks to the seedlings. The system's parameters could be customised for individual plant type, as not all plants require the same amounts or intensities of light, moisture, air temperature, etc.

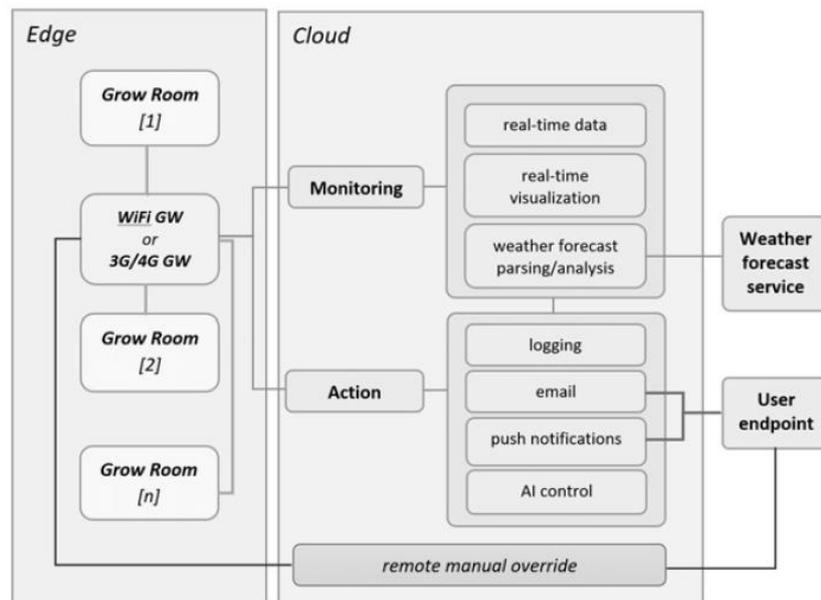


Figure 3. The proposed Grow Room IoT Architecture Components.

The Figure 3 presents the proposed architecture's main building blocks, general connectivity options and cloud interfaces and functionalities. As illustrated, the Edge part of the architecture (physical location of the seedlings called The Host Room) can consist of one or more mutually independent micro grow rooms, all connected to the WiFi or mobile networking interface. Cloud services are represented in two categories: (1) monitoring – receiving real-time data, parsing and visualizing data via graphical interfaces and charts, monitoring data trends from location and from the third-party weather forecast service APIs, with the latter not implemented in the current version of the system and reserved for future research; (2) automation – logging data and creating data sets for future references, customised email and push notifications to user(s) in order to alert the user on critical events; artificial intelligence/machine learning module which could make decisions based on more complex set of input data (weather

forecast, real-time trends, historical recorded data, etc.). The AI module was not implemented in the current version of the system and is also reserved for future research, where it will probably be implemented in the cloud environment because of the computational limitations of the ESP MCUs. Outside of the monitoring and automation categories there is a remote “manual” override which user can use in the event of technical failures (sensor and/or relay failures for example). The user can thus use the switch to directly control the heating, light, irrigation and other components outside the scope of automation and AI.

BASIC SYSTEM IMPLEMENTATION

For the implementation of the proposed architecture, the following components were used:

- housing: IP protected, weatherproof housing for the MCU and the electrical components,
- microcontroller: ESP8266 SoC microcontroller,
- code: C-based code for communicating with sensors actuators, reading values, parsing data, communicating with cloud services, etc.,
- small scale heating element (500W),
- heating mat (17.5W) for aiding seed germination,
- cloud API,
- grow flood lights,
- sensor array: Sensors for reading target parameters and sending data to the MCU,
- network Gateway: WiFi 802.11 access point and Internet Gateway (alternatively, 3G/4G router),
- ESP camera,
- solder board with needed electronic components,
- cloud services for monitoring, displaying and managing data and actuators,
- web based task automator (an event triggering service); for example, for logging detected values onto online spreadsheets,

Figure 4 illustrates grow room components in more detail. ESP Micro-controller is the core edge computing device with embedded WiFi capabilities, connected to the PCB and electronics, to power (AC or battery, or both), to sensors and to the actuators. Because some of the actuators are requiring more than 3.6V provided by the ESP8266 (heaters, lights, pumps, etc.), they are controlled via relays and are requiring connections to their own power sources. Sensor array is scalable, and might be composed of a subset of sensors for reading the following parameters: ambient temperature, ambient humidity, soil humidity, luminosity, 2D imaging, pH, air flow, pressure, and others. Actuators that could be used within the architecture are electrical heaters (up to 220V 16A with the current relay), water pumps, flood lights, fans, blinds motors, etc. The core of the grow room is seedbed itself. For small-scale applications, the grow room can be as small as about 0.5m³, hosting and managing for example about 200-300 pepper and/or tomato seedlings in their early development. Figure 5 shows the user cloud interface with numerical and graphical representations of recorded temperature and humidity fluctuation within the grow room throughout the chosen time period.

The source code implementing the core of the IoT Grow Room system is publicly available on the GitHub service (<https://github.com/tomicic/GrowRoom>).

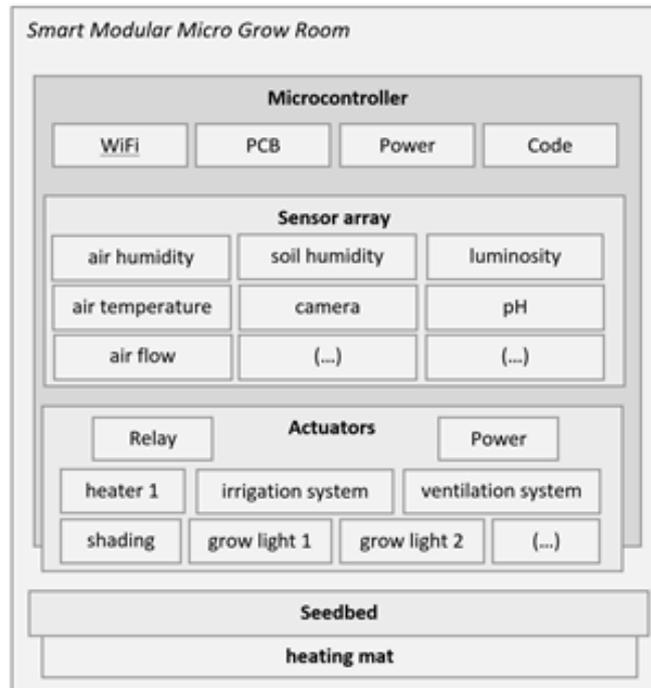


Figure 4. The Proposed Single Grow Room Components.

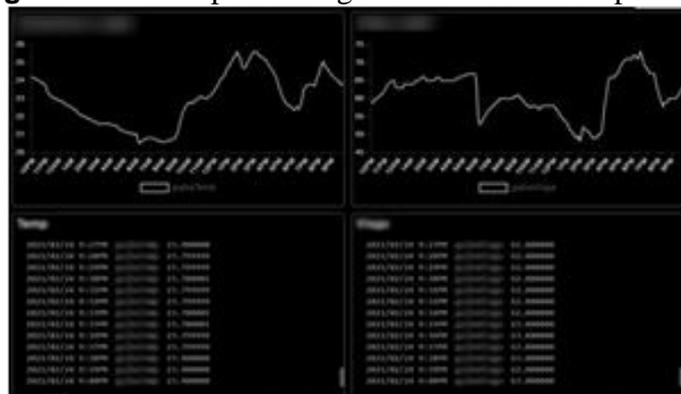


Figure 5. Grow Room interface segment: temperature and moisture monitoring via cloud service, real time graphs and historical text records.

OPERATION AND EXPERIMENTS

The experiments were conducted in northern hemisphere, continental climate, in February and March, when morning outdoor temperatures were recorded up to -7°C , and daily up to 16°C . One room of approximately 6m^2 in size and 15m^3 in volume was used as a host for 3 independent grow rooms, each in volume of about 0.5m^3 , managing the growth of bell pepper and various varieties of tomato seedlings. One batch of each tomato and bell peppers seedbeds were positioned outside the grow rooms, as sort of the control group, depending only on the shared electrical room heater and daylight. The used room heater was convectional, set to power on to 1kW convectional heating when room temperature drops below 10°C . Figure 6 roughly illustrates the positioning within the host room; heater was placed in the center of the room (drawn in grey); micro grow rooms (green) and un-managed seedbeds (red) were placed on the wall shelves.

The proposed grow room system has prevented low temperature shocks to seedlings at numerous occasions, dozens of times per night and morning, at the period of two weeks, while ambient temperatures dropped well below the statistical average of that period of year at the measured

location. In contrast, seedlings that were not protected by this architecture and were placed within a room with thermostat-based electrical heaters died off in significant numbers (about 20 %) or their growth was significantly impeded compared to the seedlings managed by the smart grow room. Small-scale heaters used within the grow rooms managed the temperature dynamics less abruptly combined with the heating effect of flood lights that were turned on in low light conditions, which also meant lower temperature conditions. True leaves were replacing cotyledons in much faster pace within managed grow rooms compared to un-managed seedbeds, which also showed irregular and inconsistent development dynamics (Figure 7).

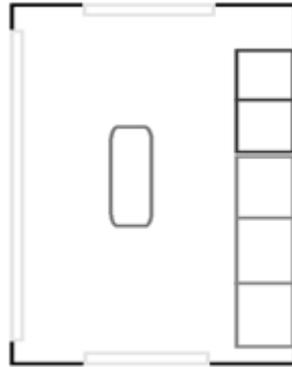


Figure 6. Host room: positioning of components (green – micro smart grow rooms; red – unmanaged seedbeds; yellow – windows; grey – convectional heater).

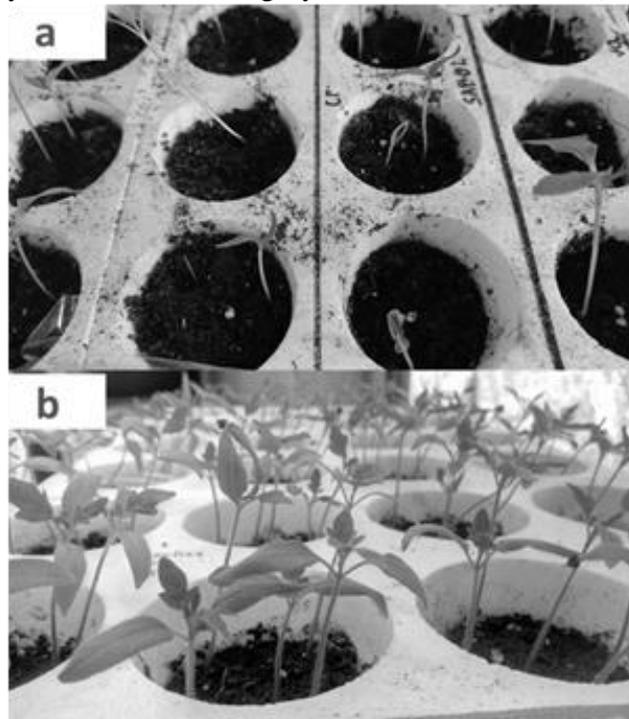


Figure 7. Seedlings' early development: (a) non-managed, (b) managed by the IoT GrowRoom.

Smart grow rooms provided additional LED illumination when there were low ambient light levels detected. Humidity sensors alerted the user when there was a need for watering the seedlings to optimal levels, and water pumps and other components of the small-scale irrigation system might fully automate this process within the architecture. All of the grow room parameters could be tracked in real time on cloud service, which was notifying users on critical events, temperature and humidity fluctuations, parameter trends and power consumption.

The experiment ended at the moment the seedlings were ready to be transplanted to the field. The visual results clearly indicated that seedlings grown within managed grow rooms developed significantly stronger stems, more leaves and larger root system compared to the ones developing in manually managed seedbeds. The results are easily replicable by using the proposed architecture with described components.

DISCUSSION AND CONCLUSION

In this article we have proposed a novel, IoT-based self-sustaining micro grow room architecture for the optimisation and management of seed germination and seedling development process. As detailed in Section III, more than one micro grow room can be located within the same physical location called the host room, and each micro grow room can have its own micro-climate and customised management enabled by the IoT and AI technologies. Compared to the existing solutions, the main advantages of the proposed architecture are as follows: (1) it is an affordable solution for home owners with easily obtainable components and non-complex implementation; (2) considerable energy savings because of the architecture's modular and scalable design; (3) autonomous optimisation of micro-environments for seedling development.

The first advantage can be argued by the usage of easily obtainable, inexpensive components, the plug&play design where the user should only connect the needed sensors and actuators, and with code that will be publicly available on the GitHub platform.

The second advantage can be argued by the potential of the platform to be scaled according to the seedling's number and/or seedbed sizes. In the presented experiment, the host room had a volume of 15 m³, while the micro grow room within was only 0.5m³ in volume and was able to host about 250 bell pepper and various varieties of tomato seedlings. Such a size optimisation itself results in a considerable energy savings in various heating modes. The same applies for the soil humidity levels, retaining humidity longer in such semi-isolated micro environments.

The third advantage can be argued by the use of the IoT and AI technologies. Sensors, micro controller, cloud services and actuators can work autonomously in order to manage the development process. The use of AI could elevate the seedlings' development optimisation to a more customised approach to each individual plant type and the development phase.

Thus said, the implementation presented within this article did not include more advanced features of the proposed architecture such as the machine learning subsystem for plant development phase identification and related parameter customisation, which is reserved for the next phase of the research.

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“IT’S DANGEROUS TO GO ALONE!” SCIENTIFIC EXCELLENCE OF PHD HOLDERS AND THEIR MENTORS – NETWORK ANALYSIS OF CROATIAN DOCTORAL STUDENTS

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ABSTRACT

Collaboration between researchers is seen as paramount in advancing science, be it because of its potential to offer novel ideas crossing scientific fields, because of its ability to boost productivity by having researchers who work well together, or by introducing and retaining new scientists to a wider network of peers, allowing them to access knowledge and information otherwise unavailable. This article sets to explore a specific part of scientific collaboration: mentor-protégés collaboration, especially during the formative years of a protégé’s scientific career, during the writing of their dissertation and five years after. Gathering data on scientific productivity from the publication repository aggregator Croatian Scientific Bibliography, mentor-protégé collaboration was explored in order to test whether mentor’s productivity could affect his or her protégé’s productivity. Analysis of variance and linear regression analysis confirm that mentor productivity is positively correlated with protégé productivity, especially in the case where mentors are highly productive (stars) scientists. Additionally, network values such as betweenness and weighted degree centralities are explored in order to test whether mentors’ values will affect protégé’s position in the network. While mentor-protégé betweenness centrality values are found not to be correlated, weighted degree measures do seem to play an important role in introducing protégés to their mentor’s network of peers and co-authors.

KEY WORDS

scientific productivity, scientific collaboration, social network analysis, betweenness centrality, weighted degree centrality

CLASSIFICATION

JEL: D85, I23, O31

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INTRODUCTION

Getting ahead in academia can be challenging, especially for young researchers. As academia is becoming increasingly competitive, both internationally and within the country and even within universities and faculties [1, 2], researchers often worry about the future of their careers [3].

An example of such competition is given by Musselin [4] who explains how academic competition has evolved in the last decades and now includes not only competition for students, budgets, and professors but competition for quality as measured by algorithms which allow “comparison and rankings between individual researchers, research units, higher education and research institution and countries” [4; p.677]. Such an approach is seen as gradually transforming universities which are introducing management practices, starting to behave strategically and foregoing collegial relationships in favour of hierarchical ones based on productivity, success, reputation, and the ability to attract students and faculty not only from a regional and national pool but from a global pool of potential students and employees, be it by pulling them in or by branching out, opening research and educational centres in foreign countries [4].

Given that researchers’ academic promotion and funding are tightly linked to their previous achievement, which is often measured in terms of the number and quality of their publications [5], which are, in turn, affected by the scientists’ reputation and funding, such concern about their future does not come as a surprise.

When the Matthew effect or “the common cumulative advantage property” [1; p.18], and the “success breeds further academic success” notion [5; p.7] are considered, the unenviable position of younger scientists becomes even more prominent. Explaining the Matthew effect, Merton makes use of examples found in interviews with Nobel laureates, concluding how “they repeatedly observe that eminent scientists get disproportionately great credit for their contributions to science while relatively unknown scientists tend to get disproportionately little credit for comparable contributions” [6; p.2]. Such an effect is, according to Merton, especially visible both in cases collaboration with renowned scientists as well as in cases of “multiple discoveries made by scientists of distinctly different rank” [6; p.2].

So, as do rich get richer, scientists who have already experienced success with publications and are already further along in their careers, also have an easier time with their further career developments, funding, and collaboration [1; p.18]. Hence, as Petersen et al. [1] put it, even a rather small success and achievement in the early stages of a career can have an important role in generating future success and career longevity. In order to achieve that success early, young scientists and PhD candidates seek to connect and collaborate with successful older colleagues and, as Billah and Gauch [7] state, some even choose their advisors based on their h-index score, as they, according to the latest research, should.

This competitive academic environment affects faculties and other research institutions as well, so attracting and retaining successful scientists who generate lucrative projects, innovation and patents in that setting become paramount. Therefore, even when hiring new young researchers, faculties and institutes hiring committees try to assess candidates according to their success potential [7, 8]. Predicting the scientific trajectories of all, and particularly young, researchers is therefore their daily task which takes into account scientists’ publication success and interdisciplinarity rate, length and quality of their training, amount of the funding they received, and again, as will be discussed in detail later, the standing and reputation of scientists’ PhD advisers [3; p.201].

PREVIOUS RESEARCH

SCIENTIFIC EXCELLENCE AND INCREASING RESEARCH COLLABORATION

Research collaboration in terms of a growing tendency to publish in co-authorships has been on the rise for quite a long time. Authors like Henriksen [9], Kuld and O’Hagan [10], and Nabout et al. [11] all show the steady rise of co-authorships across various scientific disciplines by analysing data about scientific publications in various time sections between 1966 and 2014. That way, Henriksen [9], by analysing over 4,5 million articles cited in the Web of Science’s *Social Science Citation Index* over a period of 34 years, shows how both the number of authors per article, as well as the share of articles in domestic and international co-authorships have increased in the observed period. Kuld and O’Hagan [10] came to a similar conclusion when examining articles in scientific journals in the field of economics published between 1996-2014, while Nabout et al. [11] show this trend is present even in scientific fields in which, unlike social sciences, co-authorships have always been considered the norm, analysing articles in the fields of botany, zoology, ecology, and genetics published between 1966 and 2015 and showing a drastic reductions in the number of single-author articles in each of the mentioned disciplines.

Although at least some part of the increase in co-authorship practices can be attributed to a ubiquitous use of information and communication technologies [12] from the 1990s onwards, which enabled authors from different universities, cities and states to collaborate seamlessly, the continuous rise of co-authorships cannot be seen as a sole product of technology, especially as its use has been commonplace for decades.

As Brajdić Vuković et al. [13] put it, examining collaboration practices among Croatian scientists, increases in the frequency of publishing and co-authorship practices can be traced to changes in academia, which, implementing market-oriented techniques became ever more focussed on efficiency and competition, leading to “increasing time pressures, the fragmentation of time into projects and work-packages and metric-oriented evaluation” [13; p.2].

Along the market-oriented focus on productivity, an increase in collaboration could also be explained by the changes in the number of published articles needed to get promoted or tenured. While Croatia’s policies about promotions in different science fields [14-16] show that the number of articles needed has been on the rise since 2005, Henriksen [9] argues that such an increase in conditions incentivizes scientists to “game” the system by co-producing publications, be it by giving co-authorship to scientist who contributed little to the article or even those who did not contribute at all, expecting a future quid-pro-quo.

Clearly, an increase in number of articles needed in order to get promoted in academia does not necessarily push all the scientists into the murky waters of fake co-authorships, but it could lead them to re-evaluate the advantages of collaboration through the perspective of social capital. Explaining a rise in co-authorships via a social capital and social network perspective would find authors engaging in repeated collaborations with a network of trusted peers, coordinated and maintained by mechanisms such as trust and reciprocal obligations. According to Hu and Racherla [17], these networks do not only represent connections among their members, but also “the availability and exchange of knowledge resources within the network” [17; p.303]. Being part of such a “knowledge domain”, as Hu and Racherla [17] define it, means having access to formal (academies and associations) and informal (work groups and task forces) networks that “provide organizational members with a commonly shared platform to collaborate and advance collecting knowledge” [17; p.302] resulting in a growing number of co-authored articles in leading journals.

Apart from being more productive when publishing in co-authorships, what proves to be relevant in the increasing scientific cooperation is a better visibility of the publications themselves, the potential increase in their quality, but also the impact that greater visibility and higher quality articles have on the career development of the researchers. As Abbasi et al. [18] show, co-authored articles and researchers with a higher level of interdependence (i.e. *betweenness centrality*¹), also have higher h-index scores, while Beaver [19] shows that co-authored articles, compared to single-author ones, will be more cited in the long run, even when published in journals with the same impact factor. Taking these findings into account, it seems that researchers who publish in co-authorships would not only benefit in terms of higher productivity but also in terms of higher impact (measured by h-index scores) which would consequently positively reflect on their career advancement.

Although being part of a productive intellectual network, social capital and embeddedness in a productive social network is not just granted to anyone. As Costa [20] argues, obtaining social capital entails an “investment cycle” in which scientists gain social capital by successfully conducting research, which requires resources, which in turn require research appointments and grants, which themselves require a history of publications, which close the cycle with scientists needing to conduct research in order to publish.

Explaining how young scientists can enter this investment cycle, Costa [20] turns to the work of Latour and Woolgar who see social capital as something that can be “borrowed” by advisors and mentors. In that way a protégé can gain access to their mentor’s social network by borrowing social capital, successfully completing their research project and getting awarded with their own social capital which they can then (re)invest in future research and collaboration opportunities. Measured in terms of centrality, a young scientist would “borrow” his or her mentors (weighted) degree² and betweenness centrality scores, gaining access to connections, and potentially their funding, equipment, and knowledge he or she would not have access to otherwise.

STUDENT-MENTOR COLLABORATION AS A SUCCESS PREDICTOR

The impact that collaboration and co-authorship have on a scientists’ success is especially useful in understanding both early career and later success of the young researchers. Since numerous articles have shown that the collaboration of a PhD student with his or her impactful mentor leads to a better publication activity of young researchers and their greater career development [3, 8, 21-23], the term “standing on the shoulders of giants” is gaining a whole new meaning.

One of the greatest predictors of student’s later academic productivity is in fact the early publishing of his or her dissertation’s results. The supervisor’s encouragement is, in general, an important aspect of succeeding in that endeavour [2, 8], gaining access “to the highly productive section of the academic population” [2; p.14], especially if the supervisor himself is part of that cluster.

As Ma et al. [23; p.14077] put it, “mentorship is arguably a scientist’s most significant collaborative relationship”. Given that early collaboration of young scientists with renowned experts in their field leads either to their repeated collaborations or opens the door to collaboration with other esteemed experts [8] Li and thus puts young researchers on the path to their own academic “fame”, that notion seems to hold water. In this context it is particularly interesting to see multiple genealogical studies documenting bonds among the Nobel prize winners, meaning that older laureates trained the younger ones [21-23].

Apart from this inheritance of excellence, another other way mentors make their protégés’ careers easier lays in the so called “chaperone effect” in scientific publishing which refers to an

increased likelihood of a researcher publishing in high-impact, especially multidisciplinary, journal if he or she have already published in the same journal as a young researcher [8, 22]. In that way, not only do young researchers learn how to make their research publishable, but they also learn how to publish in prestigious journals and, more importantly, gain reputation and are given the opportunity publish repeatedly within specific journal [22].

Finally, it should be emphasized that not all scientific disciplines have the same academic trajectory patterns nor the same doctoral programmes, so it does not come as a surprise that the research to date has also shown some differences in their student-mentor collaborations. PhD students in social sciences generally receive less mentoring and experience lower levels of collaborative productivity than their counterparts in natural sciences. In that way, social sciences and their doctoral programs are still more focused on the individual excellence, where one needs to learn to successfully publish on his own, then they incorporate the systematic student-mentor co-authoring policy, currently more present in natural sciences [2; p.14].

Taking into account the potential influence mentors have on their protégés' careers, research questions and hypotheses will focus on exploring whether mentors' productivity has any impact on their protégés' productivity in the Croatian context, as to the authors' knowledge, no such research has been done on this specific research question.

METHODOLOGY

RESEARCH QUESTIONS AND HYPOTHESES

The main goal of this research is to check whether doctoral students who have gained their PhD under the mentorship of successful scientists have significantly higher level of scientific production after finishing their doctoral studies than students who have worked under the mentorship of less successful scientists. The following specific hypotheses arise from this goal:

H₁: doctoral students whose mentors are more productive will also be more productive upon completion of their studies,

H_{1a}: doctoral students whose mentors are more productive will also be more productive five years after completion of their studies,

H₂: doctoral students who co-authored with their mentors after the completion of their studies will be more productive than those who did not,

H_{2a}: doctoral students who co-authored with "star" mentors after the completion of their studies will be more productive than other students,

H₃: doctoral students whose mentors have higher betweenness centrality values will have higher betweenness centrality values upon completion of their studies,

H_{3a}: doctoral students whose mentors have higher weighted degree centrality values will have higher weighted degree centrality upon completion of their studies.

As it can be seen, the moderating variable whose influence is being tested in this research is the productivity and networking of the doctoral students' mentors, or to be exact their "star player" status and the lack of it.

SAMPLE AND DATA COLLECTION

This study focuses on young researchers with active profiles on the publication repository aggregator *Croatian Scientific Bibliography* (CROSBI) who gained their PhD in the period of 2010 and 2015 and whose PhD information are available on the CROSBI site. The data used in the analysis includes the scientific field of the dissertations, the year researchers obtained

their doctoral degrees, the number and classification of articles they published before and after that year and the number and kind of their collaborations both with their mentors as with other researchers.

Gathering information about young PhD holders is not enough, the other focus of this research is getting insight into their mentors' scientific excellence, by gathering information on the number and classification of articles they published, and their collaborations with more and less successful researchers, all in order to determine their "star player" statuses. Additionally, in the few cases where PhD students had more than one mentor, only the most productive and networked mentor (in terms of weighted degree centrality) was retained, as a student would have access to connections of both his/her mentors, and, in order to test whether greater mentor productivity influenced his or her student's productivity, a more productive mentor seemed as an appropriate choice.

To investigate co-authorship networks of the early career researchers and their mentors, but also to make assessment on their excellence, this study uses the social network analysis approach. Social networks, as described by Marin and Wellman [24], represent the set of relevant nodes connected with one or more edges, where nodes can be any object of measurement that can be connected to another, similar object of measurement. As was the case with most of the other research that applied social networks to a co-authorship study in the research communities, where nodes represented researchers and edges co-authorships between pairs of nodes [7; p.27], this study will not be an exception.

DATA PREPARATION AND ANALYSIS METHODOLOGY

In order to efficiently test the hypotheses, certain values will need to be computed: productivity, first appearance, average productivity, a productivity scale, betweenness centrality, weighted degree centrality, mentor-protégés collaboration, and "star" status. Their logic, construction and applications will be briefly explained in the following text.

Productivity will be calculated for every mentor and protégé, taking into account all original scientific articles, preliminary communications, review articles, and professional articles published by all respondents in the time period between 1997 and 2020. This will result in an author-specific *absolute productivity* value which will be further divided in order to test first and second hypotheses.

Absolute productivity will be divided into three different variables (*productivity* -5, *productivity* 0 and *productivity* +5 years) based on the year in which every protégé published his/her doctoral thesis³. Specifically, if protégé A published his doctoral thesis in 2012, his *productivity* -5 would consider all articles published from 1997 to 2007, *productivity* 0 would take into account all articles published from 1997 to 2012, and his *productivity* +5 will take into account all articles published from 1997 to 2017. These different sets of productivity will allow us to test the impact mentors had on protégés' careers.

First appearance is a value which will be assigned to every mentor based on the year they defended their doctoral dissertation, functioning as an approximation of their career length. As this article focuses on respondents who attained a PhD in the period between 2010 and 2015, first appearance will be calculated for respondents who mentored doctoral dissertations in that time period. For mentors that did not upload their PhD dissertation to CROSBİ their first scientific⁴ article will be taken as the year of first appearance. Mentors who did not upload their doctoral dissertations to the CROSBİ database, did not publish relevant scientific articles or published only after the cut-off period of 2010 ($N_{\text{tot}} = 69$) will not be taken into consideration for data analysis and will be considered *missing* on the productivity variable.

First appearance should be an important control value, considering that absolute productivity could offer misleading information, favouring older mentors who have been scientifically active for more time, hence having had the possibility of publishing more articles than the "newer" mentors. After calculating the first-appearance value for all mentors, their absolute productivity will be averaged with their period of activity, neutralizing for the most part, the advantage of older mentors compared to the newer ones.

Specifically, if Mentor A has been active since 1997, publishing 50 articles in that period, his 1997-2010 *average productivity* will have a value of 3,9 (50 articles divided by 13 years of activity) while Mentor B, who has been active since 2005 and has published 25 articles will have an *average productivity* value of 5. Although not a perfect way to neutralize data imperfection, as it is possible that have not been active throughout their whole career (starting from the first-appearance point) or that they published a great deal of scientific articles before attaining their PhD, an average productivity should be a much more clear-cut indicator of mentor productivity than an absolute value.

Finally, in order to test the first hypothesis, mentors' *average productivity* will be divided in quintiles in order to produce the variable *productivity scale*, grouping mentors in five categories: 1 – extremely low productivity, 2 – low productivity, 3 – average productivity, 4 – high productivity, 5 – extremely high productivity. This scale will be based on values of *average productivity*, as, using absolute productivity values, Mentor A would probably be assigned a higher value than Mentor B.

Centrality measures will be computed for all respondents by analysing their connections in the CROSBİ database using Gephi, a network analysis software. To test respondents' positions and centrality values in the scientific network of Croatia, all published articles and collaborations have been gathered from CROSBİ, forming a network that includes 30 141 authors, 526 353 publications, and 1348 420 collaborations between authors in a time period between 1960 and 2020. As network values are very susceptible to missing data, since one missing connection between two authors could greatly affect their network reach and, subsequently, their centrality values, it was necessary for this network to include more types of publications⁵ than those examined for productivity.

After gathering the publications and computing the network, *betweenness centrality* and *weighted degree centrality* scores will be computed for each respondent, with *betweenness centrality* functioning as a measure of how often a specific respondent finds himself as a link on the shortest path between any two other authors in the network, and *weighted degree centrality* as a measure of "reach", showing with how many different authors has a specific respondent co-authored publications accounting for repeated collaborations, indicating stronger connections with authors who tend to repeatedly collaborate in research and publication. Betweenness and weighted degree centrality are both important in setting a protégé on a path of academic excellence, as mentors with higher betweenness centrality scores will be more often in the position of sending and receiving important information to their connections in the network⁶. On the other hand, mentors with higher weighted degree centrality will have access to a larger and denser pool of scientists and potential co-authors, which, according to Krackhardt [25], often indicates a higher degree of trust and, consequently, a higher degree of willingness to help. As in the case of productivity, centrality measures will be computed as three different variables (-5, 0, and +5 years) in order to test whether mentors' centralities values are correlated with the ones of their protégés'.

To test whether collaboration with their mentors will have any effect on either productivity or centrality measures, a bimodal variable has been computed based on whether mentors and

protégés have co-authored publications five years before or after the protégés have published their doctoral dissertation. These variables will help in further differentiating mentors' impacts on their protégés careers.

Finally, in order to better discern whether collaborating with highly productive mentors (stars) leads protégés to start publishing more, a final variable will be computed taking the top 20 % most productive mentors (by average mentor productivity) in each of the examined science fields. Crossing those values with collaboration after PhD attainment will result in a variable with four categories: star mentor that collaborated with respective protégé, star mentor that did not collaborate with protégé, not star mentor that collaborated with protégé, and not star mentor that did not collaborate with protégé. Using ANOVA to compare protégés' productivity based on these four groups should give an answer to whether collaboration and mentors' "star" status has an effect on protégés' productivity.

Testing the hypotheses will be achieved applying simple linear regression to the gathered data in order to investigate the correlation between mentors' and protégés' values, while ANOVA and t-tests will be applied to *productivity scale* and mentor-protégés collaborations in order to inspect whether more productive mentors are more often mentoring more productive protégés and whether protégés that collaborated with their mentors turn to be more productive or connected than those who did not.

RESULTS

In order to explore the effects of co-authorship networks, this study focused on mentors and PhD candidates active in the period between 2010-2015, which amounts to 2 233 of unique mentors and 4 106 of unique PhD candidates, shown in Table 1, grouped by scientific fields. The number of doctoral dissertations does not differ greatly between scientific fields, with the exception of biotechnical sciences, which, compared to the rests is a relatively young field. Average mentor productivity, on the other hand, shows that scientists in the fields of biomedicine, natural sciences, and biotechnical sciences are much more productive than those in the fields of social sciences, humanities, and, somewhat surprisingly, technical sciences⁷. Inspecting for collaborations between mentors and protégés shows that collaborating both before and after a protégés doctoral dissertation is much more common in the STEM⁸ fields than it is in the social and humanities with an average of 63 % and 67 % of mentors collaborating with their protégés in the STEM fields before and after their protégés' doctoral dissertations respectively, while an average of 19 % and 21 % of mentors collaborating with their protégés before and after their dissertations in the fields of social sciences and humanities. Grouping scientific fields into STEM and Social in order to test whether the differences in

Table 1. Protégé-mentor collaborations and productivity across scientific disciplines in Croatia.

Scientific field	Protégé, N	Mentors, N	Avg. mentor productivity	Collaborated before PhD, %	Collaborated after PhD, %
Biomedicine	700	694	6,22	60	61
Biotechnical sciences	370	370	4,96	74	73
Social sciences	888	859	2,41	26	32
Humanities	648	625	2,01	11	10
Natural sciences	782	777	5,37	62	71
Technical sciences	784	778	2,84	56	63

collaboration were statistically significant shows that they indeed are, with Pearson's χ^2 being statistically significant ($p < 0,05$) for both collaborations before and after protégés' doctoral dissertations.

TESTING THE HYPOTHESES

Before testing the hypotheses, it is important to note that, as is the case with any large sample, this one is no exception to outlier problems. Although, there are numerous ways of dealing with outliers and "conforming" them to the "normal" data, none of them are without problems. Additionally, because of the specific nature of this research, where outliers, in terms of very (un)successful mentors and protégés, are highly relevant for the analysis and interesting for the interpretation, they will be kept in the dataset. Apart from the study nature, the application of social network analysis was also a reason for this decision, as network analysis requires the studied network account for the largest possible set of data and connections, where eliminating hyper productive scientists would lead to eliminating a large number of connections needed to calculate centrality measures.

Before applying linear regressions, it is necessary to check if their use is justifiable or, to be exact, whether the assumptions of independence of observations, homoscedasticity, linearity, and normality are satisfied. In order to test the influence mentors' average productivity has on their protégés productivity both on the year they attained their PhD (H_1), as well as five years later (H_{1a}), two separate linear regressions were conducted.

As Table 2 shows, Durbin-Watson statistics for the H_1 regression models are 1,969 and 1,978 which indicates that, since the values are close to 2, the residuals of both models are independent and there is no correlation between them, meaning that the assumption of the independence of observations of both models is satisfied. Naturally, as it can be seen in Figure 1, the decision of keeping the outliers in the analysis affected the normality and homoscedasticity assumptions of both models, which means that it cannot be concluded that the spread of models' variances is equal both for the residuals and the predicted values.

However, as it can be seen in the Figure 2, both models show a linear relationship of independent and dependent variables, indicating that the linearity assumption of this regressions is satisfied. Apart from that, these plots offer a perfect graphical depiction of the network's pronounced outliers.

The first linear regression, testing H_1 , shows that mentors' productivity is a significant ($p < 0,05$), positive and moderately strong predictor of their protégés' productivity at the year of their PhD attainment, with a correlation coefficient of $R = 0,488$, and $R^2 = 0,238$ (Table 2). Applying linear regression using the same mentors' variable but testing for its predictability of protégé productivity five years after gaining their PhD, yields similar results with a correlation coefficient of $R = 0,512$, and an $R^2 = 0,262$ (Table 2). This leads to a conclusion that mentors'

Table 2. Regression models summaries of testing H_1 and H_{1a} .

Model Summary – On the year of PhD attainment							
					Durbin-Watson		
Model	R	R^2	Adjusted R^2	RMSE	Autocorrelation	Statistic	p
H_1	0,488	0,238	0,238	9,317	0,016	1,969	0,318
Model Summary – Five years after PhD attainment							
					Durbin-Watson		
Model	R	R^2	Adjusted R^2	RMSE	Autocorrelation	Statistic	p
H_{1a}	0,512	0,262	0,262	14,208	0,011	1,978	0,487

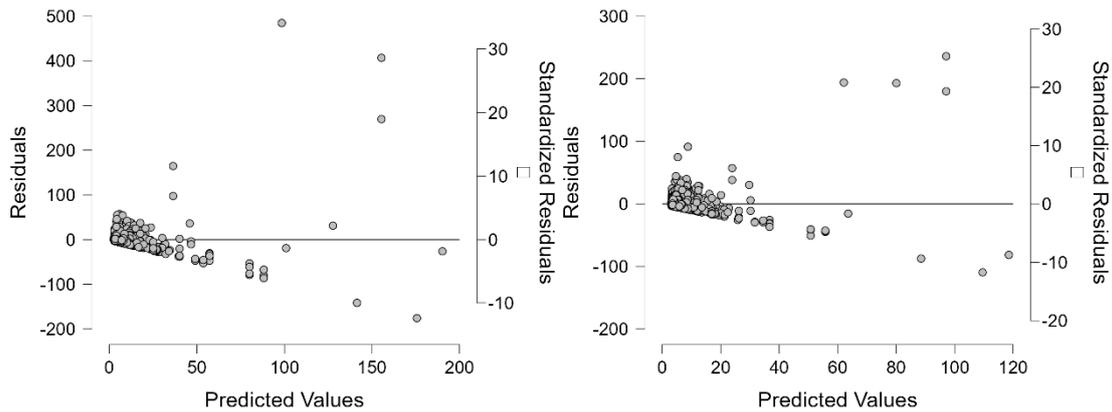


Figure 1. Residuals vs. predicted values (The year of PhD attainment on the left, Five years after on the right).

average productivity explains almost 24 % of their protégés productivity's variability on the year they have attained their PhD, and more than 26 % of the variability of that productivity five years after.

Since the correlations have been found to be significant in both hypotheses, ANOVA with Welch statistics and Games-Howell post-hoc comparisons were applied in order to discern how exactly mentor's productivity correlates with protégé productivity, taking into account that Levene's test was significant, showing that the equal variance assumption was not possible. As explained in the chapter on data preparation and analysis methodology, mentors are graded on a 1-5 scale, depending how productive they were on average, ranging from very low to very high, making up for 5 subcategories.

As it can be seen in Table 3, statistically significant differences are present among almost all groups but perhaps those most notable regard protégés with very highly productive mentors, which are found to be much more productive compared to other subgroups both on the year of PhD attainment as well as five years later.

Based on the results shown in Table 2 and Table 3, both H_1 and H_{1a} hypotheses should be accepted, as doctoral students with more productive mentors tend to have published more both at the end of their studies (H_1), as well as five years later (H_{1a}) but, in order to further test whether collaborating with their mentors made any difference in productivity, H_2 and H_{2a} need to be tested.

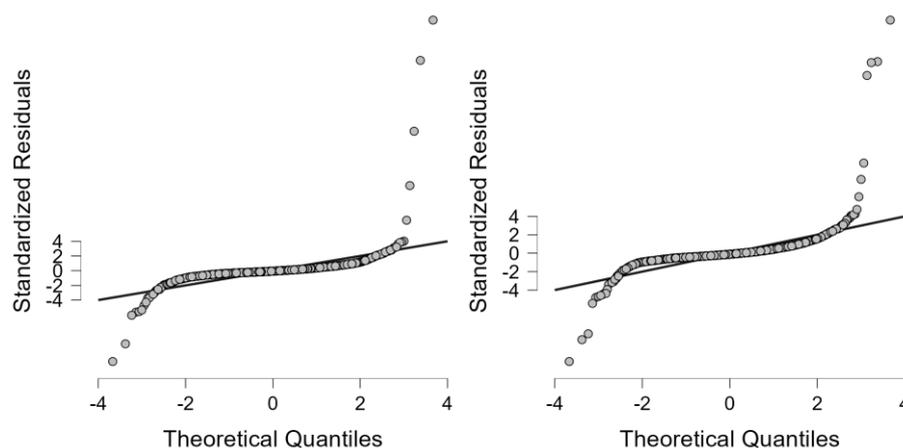


Figure 2. Q-Q Plot Standardized Residuals (The year of PhD attainment on the left, Five years after on the right).

Table 3. Protégés’ productivity.

		N	Mean	Std. Deviation	p < 0,05
On the year of PhD attainment	1 Very low	816	4,13	3,901	3, 4, 5
	2 Low	816	4,54	4,232	3, 4, 5
	3 Average	813	5,67	5,9	1, 2, 5
	4 High	835	6,4	5,478	1, 2, 5
	5 Very high	822	9,57	21,279	1, 2, 3, 4
Five years after PhD attainment	1 Very low	816	4,76	4,389	2, 3, 4, 5
	2 Low	816	5,58	5,605	1, 3, 4, 5
	3 Average	813	6,76	6,339	1, 2, 4, 5
	4 High	835	7,72	6,904	1, 2, 3, 5
	5 Very high	822	12,46	34,522	1, 2, 3, 4

H₂ stated that doctoral students who co-authored with their mentors after the completion of their studies will be more productive than those who did not so. In order to test it, a t-test was applied based on subgroups in which doctoral students either did or did not collaborate with their mentors, testing for both collaborations before PhD attainment as well as five years after and their respective effects on the number of published articles on the two respective time periods.

As can be seen in Table 4, collaboration with mentors does seem to affect protégé productivity, with both protégés who co-authored articles with their mentors before and after attaining their PhD publishing more than their counterparts.

Table 4. Differences in protégés’ productivity by protégé-mentor collaborations.

		N	Mean	Std. Deviation	Sig. (2-tailed)
Collaboration with mentor before PhD attainment	1 Yes	1924	8,23	14,385	<i>p</i> < 0,05
	2 No	2 248	4,21	4,924	
Collaboration with mentor after PhD attainment	1 Yes	2 099	10,14	22,171	<i>p</i> < 0,05
	2 No	2 073	4,7	5,451	

In order to test H_{2a}, specifically, whether mentors’ “star” status and their collaboration with protégé had any effect on their protégés’ productivity, ANOVA was applied to the data, once again using Welch statistics and Game-Howell post hoc comparisons as equal variances could not be assumed according to Levene’s test.

As Table 5 shows, collaborating with one’s mentor seems to lead to a higher productivity, with protégés who engaged in such activities publishing, on average, more than their colleagues who did not choose or did not have an option to do so during and after attaining a PhD. Additionally, if the protégé’s mentor had been assigned a star status, that protégé’s productivity is found to be statistically significantly higher than any other analysed subgroup, with a mean of 10 article published in five years. Perhaps unsurprisingly, protégés who have been mentored by scientists of lower levels of productivity, and who did not engage in co-authorships after attaining a PhD, published the least, and were significantly less productive both compared to the first category, as well as compared to the third category – protégés who, although were not mentored by highly productive scientists, did engage in co-authorships following their graduation.

As Table 4 and Table 5 show, both H₂ and H_{2a} should be accepted, as mentor-protégé collaborations do seem to have a positive effect on productivity, with protégés who co-authored with their mentors publishing more than their counterparts both before and after attaining their PhD (H₂), as well as protégés who collaborated with “star” mentors publishing statistically significantly more than any other examined group (H_{2a}).

Table 5. Differences in protégés' productivity by protégé-mentor collaborations and mentors' "star" status.

	N	Mean	Std. Deviation	$p < 0,05$
1 Star with collaboration	541	10,31	25,62	2, 3, 4
2 Star without collaboration	330	5,28	5,65	1
3 Not star with collaboration	1554	6,01	5,065	1, 4
4 Not star without collaboration	1678	4,91	5,479	1, 3

Finally, to test whether doctoral students whose mentors were more networked become also more networked themselves (H_3 and H_{3a}), linear regression was used again, along with the prior check of the justifiability of its use.

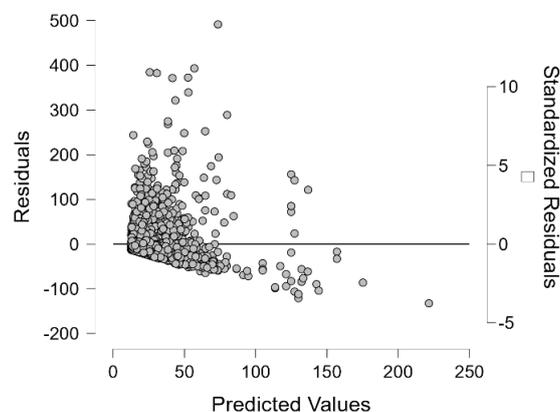
Although linear regression was meant to be applied to both betweenness centrality and weighted degree centrality (WDC), exploring correlations between mentors' and protégés' betweenness centrality values shows that their Pearson's r coefficient is low (0,095) so applying linear regression was not seen as methodologically sound. On the other hand, mentors' WDC is moderately correlated with protégés' WDC, with a Pearson's r coefficient of 0,389, justifying the application of linear regression.

As it can be seen in Table 6, this regression model's Durbin-Watson statistic is 0,819 and indicated that the assumption of the independence of observations is satisfied. As was the case with previous regression models, outliers have also impacted this one's normality and homoscedasticity (Figure 3), but not its linearity which is, together with the differently scattered but equally prominent outliers, shown in the Figure 4.

As seen in Table 6, mentors' WDC values are positively, moderately, and statistically significantly correlated with the WDC values of their protégés, indicating that, unlike betweenness centrality, weighted degree centrality values are, at least in part transitive in their nature. Considering this model's R^2 value of 0,151, it can be concluded that mentors' weighted degree centrality explains slightly more than 15 % of their protégés' one.

Table 6. Regression model summary of testing H_3 .

Model Summary – weighted degree centrality							
					Durbin-Watson		
Model	R	R^2	Adjusted R^2	RMSE	Autocorrelation	Statistic	p
H_3	0,389	0,151	0,151	35,201	0,0904	1,8191	$5,0542 \cdot 10^{-9}$

**Figure 3.** Residuals vs. predicted values (weighted degree centrality).

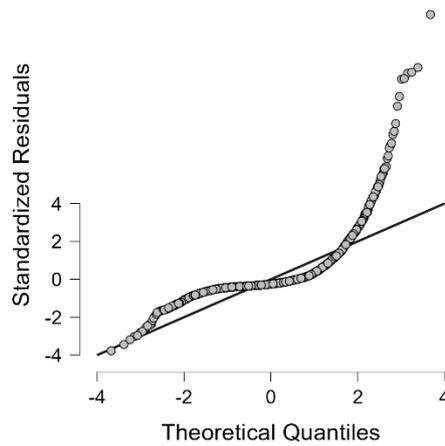


Figure 4. Q-Q Plot Standardized Residuals (weighted degree centrality).

Finally, in order to explore whether mentors with higher WDC values will enable their protégés to attain higher WDC values upon completion of their doctorates, ANOVA was conducted. Once again, as Levene’s test does not allow for equal variance assumptions, Welch statistics and Game-Howell post hoc comparisons were applied with mentors’ WDC turned into quintiles from 1 – very low, to 5 – very high.

As Table 7 shows, all differences between subgroups are statistically significant, with mentors with lower WDC values having protégés with lower WDC values. Moreover, it can be seen that protégés with mentors that enjoy very high WDC values have almost five times more connections than protégés whose mentors have very low WDC values.

Table 7. Differences in protégés’ productivity by protégé-mentor collaboration.

		N	Mean	Std. Deviation	p < 0,05
Five years after PhD attainment	1 Very low	837	5,32	8,727	2, 3, 4, 5
	2 Low	821	11,58	17,814	1, 3, 4, 5
	3 Average	840	20,15	24,527	1, 2, 4, 5
	4 High	836	27,80	35,056	1, 2, 3, 5
	5 Very high	838	47,69	63,066	1, 2, 3, 4

In conclusion, as highly connected (high WDC values) mentors do seem to either use their connections to integrate new scientists into their network or simply function as bridges through which protégés can find co-authors easily, while H_3 has to be rejected, H_{3a} can be accepted. As WDC seems to play a role in helping protégés connect with various authors that are networked with their mentors, the same does not apply to the notion of betweenness centrality. Considering the definition of betweenness centrality being a position of “power” in which a specific author is more often a link between any two other specific authors, it is not entirely surprising that such a position is not easily transferrable to new authors, or in the case of this article, protégés. Even though they may be able to gain access to their mentors’ connections (and often they do, as shown in Table 7), they cannot easily move to positions in which they will be the most important bridges between authors, at least not that early in their careers.

STUDY LIMITATIONS AND FURTHER RESEARCH

Although this research focused exclusively on the relationship between young researchers’ and their mentors’ success, since doctoral students often work on scientific project, meaning they learn from more people at once and collaborate with other researchers besides their mentors, it would be interesting to explore the influence of the whole teams and project affiliation on future careers of Croatian doctoral students.

Apart from the ever-growing project affiliations of the doctoral students, and their necessarily unique experience of scientific production and collaboration, recently there is also an increasing trend of Scandinavian model (article based) doctorates. This has made, as Lokhtina et al. [26] state, co-authorship between doctoral students and their supervisors more relevant than ever. Such encouragement by faculties and other research institutions towards article-based doctoral dissertations should lead to a greater student-mentor collaboration, and consequently to more successful careers of young researchers and their institutions' better reputation and positioning, which is also something that should be further explored.

Additionally, some research findings show that scientists become the most successful when they gain intellectual independence from their mentors [23; p.14077] and that, although there is a positive influence of "star" scientists on their protégés' careers in early stages, that influence weakens over time and may even become a negative one [21; p.1848]. Hence, further research could also explore whether this was true in the Croatian context and whether researchers who, for instance, 10 years after gaining their PhD collaborate less with their mentors are indeed more successful and recognized than those who collaborate more and are, as Qi et al. [21] put it, still in the shadow of a "star".

On the lines of mentor protégé collaboration after PhD attainment, it would be interesting to explore the presence of "gaming" the system or a form of shadow writing in which mentors are possibly included as authors in protégés' future articles without actually contributing to them. Such a practice could be very well present, and it could have led to a overrepresentation of mentor-protégé collaborations but it was impossible to test for given the available data and could be further explored both in terms of questionnaires aimed directly to protégés or by conducting interviews to understand mentor-protégé collaborations and power relations better.

In addition to all the above mentioned further research notes, it would also be interesting to inspect whether are there any differences across the scientific disciplines, as there are in their research and collaboration patterns in general.

Finally, two limitations of this study are linked to its sample. While the first one concerns the very management system of the publication repository aggregator CROSBİ, the second one is linked to a few specific cases of PhD students having more than one mentor.

The first limitation as authors themselves oversee the updating of their profiles, the database could be incomplete or have some of the articles mislabelled. Such a practice could potentially have little repercussions on the profiles of younger researchers and those who are still in the process of advancing in their scientific positions as most universities ask their employees to keep their profiles updated and use them in career advancement evaluation while tenured professors could be found updating their profiles much less regularly.

The second limitation, as explained in the chapter regarding sample and data collection, regards the few cases of students with more than one mentor. In such cases only the most productive and networked mentor has been retained in order to better explore correlations between most productive mentors.

CONCLUSION

The main goal of this article was to explore the interactions between PhD mentors and protégés in terms of productivity and networking, expecting that highly productive mentors will turn their protégés into highly productive authors via mechanisms of information sharing, good practice and introducing their protégés into their network of both strong ties (in terms of repeated co-authorships) as well as weak ties (in terms of access to information outside their close vicinity).

Mentor-protégé collaboration has been shown to be very impactful in terms of boosting protégés' productivity during their doctoral study, but, and perhaps more importantly, it shows long term effects, as protégés who had highly productive mentors will continue to be highly productive even five years after their graduation, corroborating the findings of Li et al. [8].

Such a boost in productivity is not tied exclusively to being mentored by capable and productive scientists who will show their protégés all the "tricks" and good practices in getting published often and easily. It seems to be very much tied to both mentors and protégés engaging in co-authorships, both during the period of doctoral study, as well after the protégé has attained his/her new title. As this analysis shows, protégés that co-authored articles with their mentors published, on average, almost twice as much as those who did not during their doctoral study, and more than twice as much upon study completion. Such results are in line with findings of Li et al., Sekara et al., as well as Hu and Racherla and Hakkarainen et al., and Costa [2, 8, 17, 20, 22], who show the impact mentoring in both a practical way (by "learning the ropes" of publishing practices) as well as in a social-capital way (by borrowing a mentor's social capital in order to gain one own's).

And while mentor productivity seems to function well as a predictor of protégé productivity, collaboration could be interpreted as an equally, if not more important factor. Taking into account the results shown in Table 5, *star* mentors' collaboration with their protégés will lead to protégés publishing an extraordinary number of articles, but protégés who had *star* mentors, and did not co-author articles with them upon completing their studies will, on average, publish just half as much as their "luckier" colleagues. And while that difference in the number of publications is statistically significant, another one, although not statistically significant, is perhaps more interesting in terms of exploring the connections between collaboration and mentor productivity, as it concerns the difference between protégés who had *star* mentors with whom they did not collaborate, and protégés who had "normal" mentors with whom they did collaborate. On average the former group published five articles in five years, while the latter published just a bit more, six articles in five years. Such a difference in the number of publications should be explored further as it did not appear to be statistically significant, but, at the same time could indicate the real value of collaboration in early career phases.

Finally, exploring network values has shown that different centrality measures do indeed offer different opportunities to protégés. While betweenness centrality did not "pass the test" and was not included in linear regression analysis due to its low Pearson's *r* values, that very result could be interpreted as a specific characteristic of betweenness, as a non-transitive measure which is strongly tied to an author that owns it and cannot readily "give it away". On the other hand, weighted degree centrality, a value that measures an author's connectedness to its scientific social surrounding in terms of (repeated) co-authorships does seem to be more transitive and seems to help newly fledged scientists in finding co-authors in their mentors' networks, supporting Latour's and Woolgar's [20] idea of "borrowing" social capital from one's mentors.

In conclusion, picking a mentor for one's own doctoral dissertation seems to be a decision that will have consequences that are more far reaching than the immediate need to be mentored and attain a doctoral title. Collaborating with their mentors and picking up good practices in publishing will influence protégés' careers much more than up to the point of "merely" becoming a philosophy doctor.

REMARKS

¹Betweenness centrality can easily be defined as an extent to which an author is in the shortest path between another pair of co-authors [8].

²With degree centrality representing the number of co-authors a researcher has, and weighted degree centrality taking into account repeated collaborations with such co-authors.

³This year will also be the basis for calculating his/her mentors' productivity –5.

⁴Original scientific papers, preliminary communications, review papers, and professional papers.

⁵In order to compute a denser network than the one composed solely of scientific papers, it included authored books, edited books, book chapters, journal articles, conference proceedings papers, and conference abstracts.

⁶For example, by helping their protégés in reaching authors they would not have access to otherwise, or giving them information regarding specific grants.

⁷ANOVA shows these differences are statistically significant at a confidence level of $p < 0,05$.

⁸Considered, in this case, to be biomedicine, biotechnical sciences, natural sciences, and technical sciences.

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