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WELCOME TO ICSD 2020

On behalf of the organizing committee, we are pleased to announce that the 4th International Conference on Sustainable Development (ICSD-2020) is held from November 04-08, 2020 in Skopje, North Macedonia. ICSD 2020 provides an ideal academic platform for researchers to present the latest research findings and describe emerging technologies, and directions in Sustainable Development issues. The conference seeks to contribute to presenting novel research results in all aspects of Sustainable Development. The conference aims to bring together leading academic scientists, researchers and research scholars to exchange and share their experiences and research results about all aspects of Sustainable Development. It also provides the premier interdisciplinary forum for scientists, engineers, and practitioners to present their latest research results, ideas, developments, and applications in all areas of Engineering and Natural Sciences. The conference will bring together leading academic scientists, researchers and scholars in the domain of interest from around the world. ICSD 2020 is the oncoming event of the successful conference series focusing on Sustainable Development. The scientific program focuses on current advances in the research, production and use of Engineering and Natural Sciences with particular focus on their role in maintaining academic level in Engineering and Applied Sciences and elevating the science level. The conference's goals are to provide a scientific forum for all international prestige scholars around the world and enable the interactive exchange of state-of-the-art knowledge. The conference will focus on evidence-based benefits proven in clinical trials and scientific experiments.

Best regards,

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The UI Green Metric Ranking System: Analyzing Impacts of Categories on Overall Results

Kadriye Elif Macin[1], Osman Atilla Arikan[1], Ibrahim Demir[1]

Abstract

The UI GreenMetric Ranking system is celebrating tenth year anniversary in 2020. The UI GreenMetric has six categories which are; "Setting & Infrastructure" (SI), "Energy & Climate" (EC), "Waste" (WS), "Water" (WR), "Transportation" (TR) and "Education" (ED). The SI category has 15% of the total point while EC category has 21%, WR category has 10%, WS, T and E categories have %18. However, there is still missing points about the exact impacts of categories on overall results. Thus, the aim of this study is to exam previous years ranking results to understand details of category impacts on the UI GreenMetric ranking. The ranking data for the study were taken from the UI GreenMetric's official website. According to results; the EC category determines which university has the higher ranking if two university have the same total point. The WS, TR and ED categories are possible second effective categories however very rarely SI category has second place after EC. Ranking results were also examined for each continent and strong relationship between existence of developed countries and success of the UI GreenMetric performance of a continent was found. New certificates for categories such as "energy efficient campus of the year", "zero waste producer of the year", "water-saver of the year", "green path of the year" and "green producer/consumer of the year" are recommended for embracing categories and increasing their recognition. Besides the updates and change in the category indicators fee-free applications to the UI GreenMetric ranking system should be continued and details of the scoring system should be clarified in the guidelines.

Keywords: Green campus, UI GreenMetric, Higher Education Institutions (HEIs), Sustainability, Sustainable Development Goals (SDGs)

1. INTRODUCTION

The solution of global problems such as staying in planetary boundaries and detention of climate change, depends on the positive steps have taken on a smaller scale such as city, district and even in university campus [1],[2]. Sustainable Development Goals (SDGs) have been developed as a solution to these problems. The triple bottom of sustainability is mandatory in order to fully realization and application of SDGs. Education sector has strong relationship with SDGs. Universities has a direct effect on their stakeholders such as students, employees, alumni, parents and have indirect effects on society [2], since universities are excepted as high-esteem [3]. SDGs Australia report; supports this theory by stating that "*knowledge of universities and their unique position within society, have a critical role to play in the achievement of the SDGs"* [4]. Also, universities are seen as living labs. SDGs and universities relationship has been discussed ambitiously in recent years [2]. Also, some studies showed that it is not possible to reach SDGs without education [4].

The relationship between Higher Education Institutions (HEI's) and the environment began with The Stockholm Declaration in 1972 [5]. The Talloires Declaration was signed in France in 1990 and it had become an important step for HEIs to focusing on environmental problems [5]. UNESCO stated that education is a necessity for sustainable development in 1994 [2]. While USA universities started to establish NGO's for sustainability projects Australian universities prepared strategic plans for reaching sustainability goals at the end of 90's [2]. The Rio + 20 Declaration in 2012 had five scopes for universities; *"Teaching sustainable development concepts, encouraging research on sustainable development issues, **greening of campuses**, supporting sustainability efforts and fostering and engaging in international collaboration"* [2]. After Rio

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Declaration, SDGs were established in 2015. The concept of green campus date back to the 70's, but it has started to gain importance since the 2000s. Related timeline was given in Figure 1.

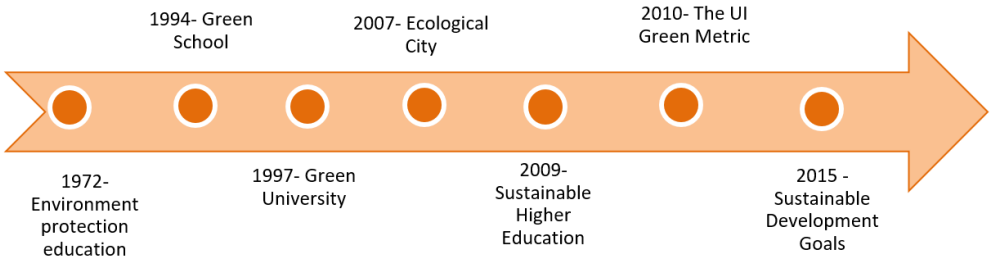


Figure 1. Timeline summary of Green Campus concept, adapted from Tan et. al [2].

"The majority of university campuses in Europe and North America have been involved in greening initiatives over the past two decades, particularly through the development of environmental policies, implementation of action plans, restructuring and signing of courses and research programs" as stated by **Arroyo** [6]. Today, climate change mitigation and campus sustainability have become a global concern for university leaders. Many world universities are taking steps to fight climate change by reducing their carbon footprint and managing sustainability activities [7], [8]. Also, previous studies claimed that per capita energy and water consumption in university campuses were higher than other residents [2]. These recent studies have enabled to accept campuses as mini cities [9] and the green campus concept is presented as a solution for existing problems.

There is no single target for green campus and campus sustainability concepts in the literature [10]. Every institution sets their own goals towards a sustainable campus. Previous studies have established holistic and comprehensive concept suggestions for embracing sustainability in HEIs [9],[11]. These recommendations have been adopted by many universities and scholars. The green campus projects and academic studies have increased rapidly since 2008. The number of publications containing the "green campus" keyword (**Figure 2**) in the last 35 years supports this theory. Also, green campus activities and other university projects are classified in different ranking systems in recent years. University rankings have become popular and representative for university's reputation besides academic publications especially in the last twenty years [7], [12]. The rankings, cover a variety of topics such as research, academic reputation, education, number of female students and international students [7]. The importance of research and academic reputation is in the first place in most of the university rankings while they are followed by education. However, environmental problems have little or no attention [7]. The QS ranking system is one of the ranking systems in the world and it ranks 3000 universities each year according to; academic reputation, employee reputation, academic staff/student ratio, international student and citation per faculty [14]. However, new certificate and ranking systems that highlight sustainability and campus relationship have emerged in the early 2000s with the new wave of sustainability and green campus concept. One of the pioneer and famous system is The Sustainability Tracking, Assessment & Rating System (STARS) which was established in 2006 by the Association for the Advancement of Sustainability in Higher Education [15]. The STARS system consists energy, buildings, waste, water, food & dining, grounds, purchasing and transportation as main categories [14], [16]. STARS classifies universities with certificates instead of competing universities among each other [5]. The UI GreenMetric system was established in 2010 which had been inspired by STARS, Greenship, and Holcim sustainability assessment systems [17]. The UI GreenMetric has encountered increasing interest from all over the world since it does not have any precondition and fee for the applications [15].

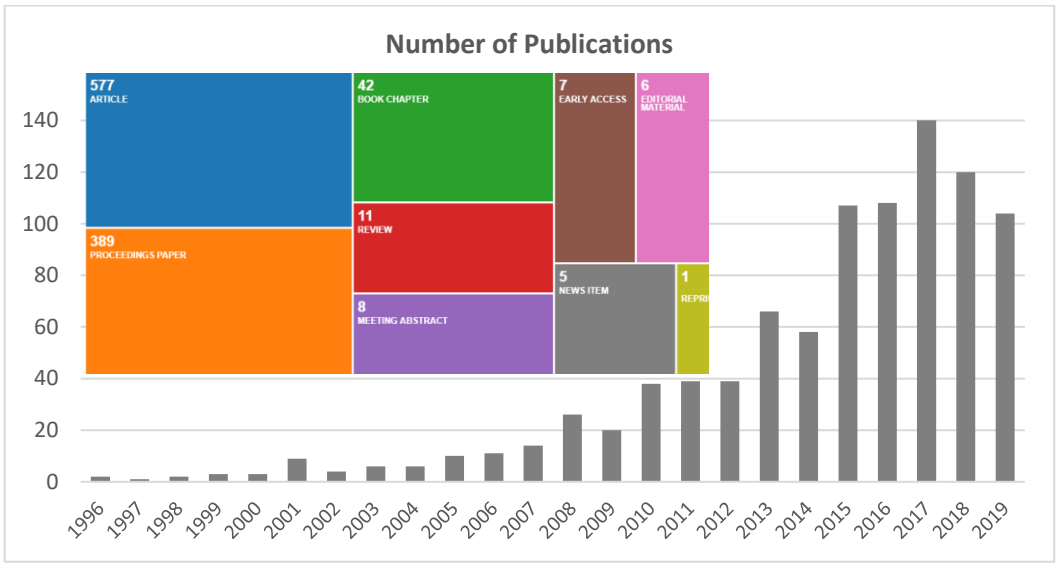


Figure 2. Number of "Green Campus" publications by years in Web of Science [13].

The UI GreenMetric has six categories which are; "Setting & Infrastructure" (SI), "Energy & Climate" (EC), "Waste" (WS), "Water" (WR) "Transportation" (TR) and "Education" (ED) in current scoring system. The UI-Green Metric has been regularly updated since the beginning but it made the biggest change in terms of categories in 2012. The 23 indicators under five categories were used in the 2010 while 34 indicators were used in 2011. Old scoring system was changed in 2012 and **the ED category** was added into scoring system. The names and percentages of the categories of The UI GreenMetric were shown in **Figure 3**. The **EC** category still has the highest impact. The **SI category** used to have the second place in terms of impact on overall results with 24%, now it has the fifth highest impact with 15% [18]. The **WS, TR** and **ED** categories have %18 while **WR** category has 10% of the UI GreenMetric total score. Although there was no change regarding percentage weight of categories after 2012, the indicators within the categories continued to change. The new indicators related to carbon footprint were added to the EC category in 2015. In addition, **WR and TR** categories were updated [18]. The new indicators were established and old indicators such as "*planted vegetation, energy efficient appliances usage, smart building, elements of green building implementation, the greenhouse gas emission reduction program, all of waste and water criteria, the ratio of parking area to total campus area , transportation initiatives to decrease private vehicles on campus, the transportation program designed to limit or decrease the parking area on campus, shuttle services, Zero Emission Vehicles (ZEV) and pedestrian policy on campus, existence of published sustainability report"* were updated to strengthen the relationship between SGDs and universities" as stated in the UI GreenMetric 2020 Guideline [18].

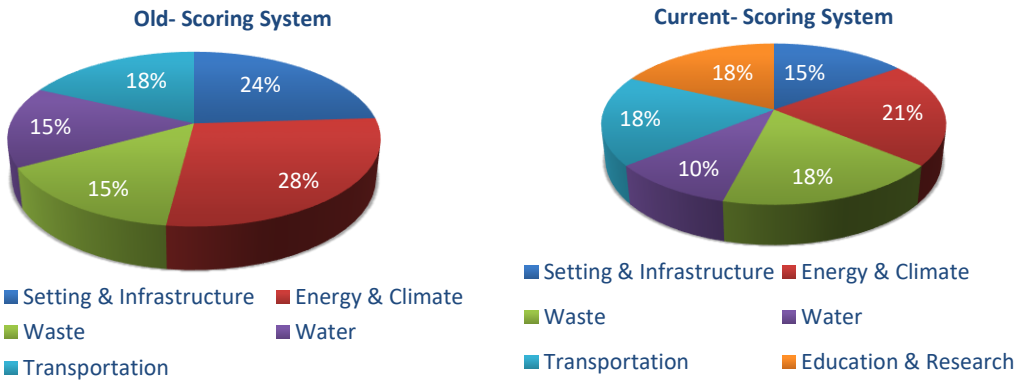


Figure 3. Old and current scores of categories in the UI GreenMetric [7], [18].

Universities submit their applications via a questionnaire in the UI GreenMetric's official website. Submissions start in May and continue until end of October. Results are announced in December. While evidence uploading is mandatory for some questions, in others it up to university's choice. However, there is no direct relationship between the number of evidence requested in a category and the total score of the category. For instance, while six evidences are requested in the **SI** and **WS** categories, four evidence are requested in the **EC** category which has the highest effect with 21%. The UI GreenMetric have received applications from 35 different countries and 95 universities in 2010. These numbers have gradually increased and reached 780 universities from 85 countries by 2019. Despite the increasing interest in academic studies about the UI GreenMetric [1], [19-21], and continues updating of the ranking system, there are still unknowns such as evaluation of applications and exact effects of categories on overall results. Thus, the aim of this study is to examine previous years ranking results for understanding details of the UI GreenMetric's ranking system.

2. MATERIAL AND METHOD

Literature research was done using Scopus, Web of Science (WoS) and Google Scholar search engines. The "Green Metric", "green campus", "sustainability and university" keywords were used to find previous publications. After initial search, snowball method was followed. Additional research was done in WoS by using the keyword "green campus" in order to specify number of academic studies . This study was conducted to clarify impacts of categories on overall results. The ranking data were taken from the Green Metric's official website and analysis were carried out by using data between 2014 and 2019.

3. RESULTS AND DISCUSSION

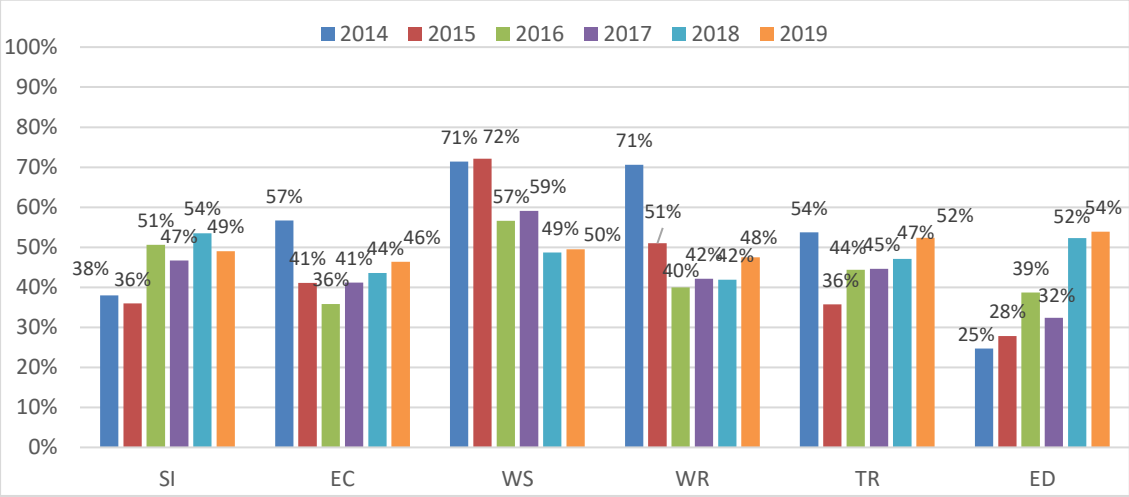
It is known that the UI GreenMetric ranking system has positive effects on sustainable universities and green campus concepts. The number of universities applying to the UI GreenMetric have increased and this shows increasing attention of green campus activities in universities. According to search results; 577 articles and 389 proceeding papers have been published until June 2020. A significant increase in the number of publications has been observed after 2012. The highest number of publications belongs to 2017 as it can be seen in **Figure 2.** According to the UI GreenMetric 2020 guideline 64 publications refer to the UI GreenMetric ranking system in their studies [18].

The UI GreenMetric ranking system was established in 2010 however discussions and studies about the system still continue. Previous studies were mostly focused on content of the UI GreenMetric ranking system and provided valuable suggestions [1], [19-21].

In this study, we tried to determine the category which has the highest impact on success (ranking) of universities by evaluating previous year's results. In order to understand that, universities which have the same overall score but also have different rankings were compared. A preliminary study was carried out by using different ranking ranges averages scores, in order to give suggestions to universities for improving their GreenMetric performance. In addition, category results were compared by continents to understand whether the location of the universities has an effect on the results.

3.1. World overall ranking performance by categories

The UI Green Metric official site has been sharing category results since 2014. Therefore, evaluations were made for the years 2014-2019. While the number universities applied to the UI GreenMetric was 361 in 2014, this number has increased and reached 780 in 2019. The new universities may affect the overall results in both ways, increase or decrease, however they still provide necessary information about general trend of the university performances. The ratio of the maximum score that can be obtained for each category and the average scores of all applied universities were given in **Figure 4.**



SI: Setting & Infrastructure, EC: Energy & Climate, WS: Waste, WR: Water, TR: Transportation, ED: Education

Figure 4. World overall ranking performance by categories (receiving score average/ maximum score of category (%))

The **SI** category performance has decreased in odd-numbered years while it has increased in even-numbered years. The general trend of the **SI** category results show that increase was more than the decrease. Although the **EC** category was experienced a sudden decline in 2015, it has an increasing trend in recent years. The **WS** category has always remained above 50% except in 2018. The **WR** category has experienced a sudden decline in 2015 and 2016, although there is an increase in the following years, it is still below 50%. The **TR** category has increased except for the year 2015. The **ED** category has showed an increase except for 2017 and became the category with the highest increasing trend.

Table 1. Average score of universities in different ranking ranges in 2019.

Ranking range	SI (1500)	EC (2100)	WS (1800)	WR (1000)	TR (1800)	ED (1800)	Total Score (10000)
1-49	1066	1579	1606	838	1459	1562	8110
50-99	916	1387	1475	788	1316	1467	7348
100-199	841	1235	1231	686	1194	1276	6461
200-299	811	1089	1109	572	1089	1108	5778
300-399	759	996	922	484	1015	1009	5185
400-499	738	888	797	438	900	888	4649
500-599	679	804	715	358	778	818	4151
600-699	590	707	457	278	678	667	3376
700-780	416	509	243	102	412	380	2063

SI: Setting & Infrastructure, EC: Energy & Climate, WS: Waste, WR: Water, TR: Transportation, ED: Education

In order to the understand the category which deserves more attention and the priorities for universities to become greener and more successful in the UI GreenMetric ranking system in the coming years, the average scores of certain ranking ranges were calculated using 2019 data. It was seen from **Table 1** that ranking ranges scores of each category stayed behind if they had lower ranking range in the overall results. For instance, 300-399 range universities had average overall results with 5185 and stayed behind the 200- 299 range (5778 overall point) while all other categories also stayed behind. To find an answer to *"What would universities do to be in the upper range?"* question a heat table was created in **Table 2** using **Table 1.** According to **Table 2**, there is a 10% difference between the average performance scores of universities between 1-49 (1579 point) and 50-99 (1387 point) for the **EC** category. As it can be understood from **Table 2**, a university that wants to be in the top 49 and whose ranking is currently between 50-99 should try to improve their institutions in the **EC, WS, ED, SI, WR** and **TR** categories, respectively. The heat table was prepared using average scores. Therefore, the university could be already successful in a certain category even though average score (heat

table) suggests an improvement. Therefore, every university should develop their own plan by considering economic feasibility and social factors of their institutions.

Table 2. Heat table of range difference (%) - (What would universities do to be in the upper range?)

Difference between ranges (%)	SI	EC	WS	WR	TR	ED	Total Score
(1-49)-(50-99)	8	10	9	7	5	8	5
(50-99)-(100-199)	9	5	7	14	10	7	11
(100-199)-(200-299)	7	2	7	7	11	6	9
(200-299)-(300-399)	6	3	4	10	9	4	5
(300-399)-(400-499)	5	1	5	7	5	6	7
(400-499)-(500-599)	5	4	4	5	8	7	4
(500-599)-(600-699)	8	6	5	14	8	6	8
(600-699)-(700-780)	13	12	9	12	18	15	16

% difference with higher ranking changes	1- 3	4-6	7-9	10-13	> 13

3.2. World ranking performance by continents

The UI GreenMetric has been sharing results on a continent basis since 2017. The highest participation was from Asia with 48% (373 universities) while lowest participations belongs to Africa (2% with 14 universities) and Oceania (0.5% with 4 universities) in 2019. The universities in Oceania continent had the highest average points, while African countries had the lowest average in overall results. The %50 (7 universities) of the African universities had 3500 or less points. It is thought that universities from the higher GDP countries like in Oceania have effect on these results. When the categories weree examined, the **SI** category had the highest average score in Oceania, while North America had the second place and they were followed by South America, Asia, Europe and Africa. The most of the European universities were established in the past and their campuses had relatively less green areas than most of the participant Asian universities [20]. Hence, European universities were behind the Asia universities in the **SI** category. The **EC** category had the highest average in Europe, while North America had second higher average and Africa had the lowest. The reason why Europe comes to the fore in the **EC** category is that there are many universities study and practice on renewable energy. In the **WS** category North America was the leader due to the influence of the USA universities, which have better waste management applications in the university campuses. North America was followed by Oceania, Europe, South America, Asia and Africa continents. In the **WR** category North America had the highest average and it was followed by Oceania, South America, Europe, Asia and Africa. Europe had the highest average in the **TR** category. This result was related to the general lifestyle as well as university initiatives. Public transport and bicycle usage are very common in European countries. Therefore, the number fossil fuel vehicles entering the campus is less and the number of zero emission vehicles is higher than other countries. In the **ED** category, the highest average was in the Oceania continent and it was followed by Europe, North America, South America, Asia and Africa. The main reason for this is the institutional sustainability studies which have been initiated in the late 90s, especially at Australian universities [2]. As the **Ragazzi and Ghidini,** were previously stated in their study; the development level of countries has effect on overall results [19]. This theory supported by the performance results of the continents. The UI GreenMetric performance is generally higher in the developed countries.

3.3. Categories impacts on overall results

Evaluation information for the universities with the same score is not given in the guideline. Therefore, the 2019 ranking results were examined to understand the categories which have higher impacts on overall results

According to the percentage weight of categories, the **EC** category is expected to be in the first place and it is followed by **WS, TR, ED, SI, WR** categories respectively. However, when the current ranking results are examined, it is seen that this is not the case. The **EC** category has the first place but impact of other categories is still not certain. In order to determine the second important category, universities with the same overall results and **EC** scores were compared. As it can be seen in **Table 3** results have some uncertainties. In addition to the categories **alphabetical order** could be another parameter for ranking universities. Although the university that came first in alphabetical order was generally had higher ranking, exceptional cases were also observed.

Table 3. Selected ranking scores for comparing impacts of categories on overall results

Rank 2019	University	Country	SI	EC	WS	WR	TR	ED	Total Score	2nd possible category
42	Universidad AutónomaDe Occidente	Colombia	925	**1475**	1725	875	1200	1525	**7725**	WS ,ED, WR ,A
43	Western Michigan University	USA	1375	**1475**	1275	850	1375	1375	**7725**	
168	Pontificia Universidad Javeriana-Bogota	Colombia	625	**1300**	1125	450	1425	1350	**6275**	WS ,TR,ED,A
169	Universidad CES	Colombia	825	**1300**	1050	750	1200	1150	**6275**	
181	National Chin-Yi University of Technology	Chinese Taipei	625	**1050**	1200	600	1050	1650	**6175**	WS,ED
182	Maejo University	Thailand	1350	**1050**	825	600	1250	1100	**6175**	
195	Universidade de Vigo	Spain	850	**1250**	1275	625	1125	975	**6100**	WS,SI
196	Universidad De Antioquia	Colombia	550	**1250**	1125	750	1125	1300	**6100**	
198	University of Guilan	Iran	1125	**1100**	750	500	1125	1500	**6100**	TR,ED, SI,A
199	Universiy of Kufa	Iraq	950	**1100**	1125	825	925	1175	**6100**	
289	Universidad Autonoma Del Estado De Mexico	Mexico	700	**675**	1350	625	1025	1125	**5500**	WS ,ED, WR
290	Akdeniz University	Turkey	1050	**675**	1125	450	1225	975	**5500**	
315	University of Baghdad	Iraq	1100	**725**	600	500	1325	1100	**5350**	ED,SI, WR
316	Babes Bolyai University	Romania	825	**725**	750	300	1600	1150	**5350**	
318	Universidad Pontificia Comillas	Spain	275	**1100**	1125	650	950	1225	**5325**	ED, WR
319	Universita degli Studi di Padova	Italy	800	**1100**	1125	400	1025	875	**5325**	
319	Universita degli Studi di Padova	Italy	800	**1100**	1125	400	1025	875	**5325**	WS ,TR,A
320	University of Jordan	Jordan	900	**1100**	750	450	950	1175	**5325**	
414	Universidad de Pamplona	Colombia	775	**925**	825	350	825	1150	**4850**	WS,TR,ED
415	Razi University Kermanshah	Iran	975	**925**	675	600	775	900	**4850**	
433	Institut Teknologi Sumatera	Indonesia	850	**900**	750	575	875	775	**4725**	TR, WR,A
434	Islamic Azad University	Iran	1200	**900**	900	200	725	800	**4725**	
437	Yeditepe University	Turkey	725	**1050**	900	350	825	850	**4700**	WS ,TR,ED, WR
438	Saurashtra University	India	975	**1050**	825	300	800	750	**4700**	
502	Institute of Business Management	Pakistan	375	**1025**	900	500	825	750	**4375**	TR,ED,SI, WR
503	Bow Valley College	Canada	325	**1025**	1200	375	775	675	**4375**	
515	Voronezh State Technical University	Russia	500	**800**	900	450	700	975	**4325**	WS, WR
516	University of Kragujevac	Serbia	550	**800**	600	425	900	1050	**4325**	
612	Yazd University	Iran	1125	**500**	675	350	875	300	**3825**	SI, WR
613	Gorno Altaisk State University	Russia	425	**500**	750	275	900	975	**3825**	
700	University of Mosul	Iraq	900	**650**	75	0	700	375	**2700**	TR
701	Ivan Franko National University of Lviv	Ukraine	900	**650**	150	0	475	525	**2700**	
714	University of Kirkuk	Iraq	400	**425**	225	0	700	800	**2550**	ED
715	Universidad Autonoma De La Ciudad De Mexico	Mexico	450	**425**	300	200	950	225	**2550**	

A: Alphabetical order, SI: Setting & Infrastructure, EC: Energy & Climate, WS: Waste, WR: Water, TR: Transportation, ED: Education

3.4. Suggestions for the UI-GreenMetric Ranking System

Developers of the UI GreenMetric system were stated that an equal system for all universities is not possible by saying "*The different missions and perspectives created by these dimensions mean that the goal of finding indicators that are equally fair to all, seems practically impossible*". Also, they clarified that the UI GreenMetric is an entry level tool for sustainability activities for universities [7]. Despite that it is possible to make improvements in the system. Following assessments and suggestions were given for the improvement of the UI GreenMetric ranking system:

- All universities are entering the ranking list in the current UI GreenMetric system without any precondition. "**Baseline"** score was suggested in the previous academic study by **Ragazzi and Ghidini** [19]. According to previous study, universities should have minimum (baseline) score to have a place in the UI Green Metric ranking system like other sustainability ranking systems such as STARS. However, it is thought that all universities should be included in the ranking system in order to see the general trend in the world and also to make comparisons between countries and within countries.
- The ranking of universities could change due to change of other universities performances even though their overall performance is constant [19]. This situation was explained by **Ragazzi and Ghidini** as the **relativity of scores** problem [19]. Therefore, making a certain grouping or sustainability classes in the GreenMetric system will ensure that the sustainability performance of a university remains the same even if the overall place in the ranking changes.
- The UI GreenMetric has been a system that constantly renews itself over the years. **Sonetti et al. and Marrone et al.,** stated that this continues updating is the UI Green Metric's strength [1], [20]. While **Ragazzi and Ghidini** indicated that changing indicators in the categories every year prevents making long-term plans [19]. Major changes were done in the UI Green Metric in 2012 and 2018, and minor changes were made in other years. Future major changes should be announced at least one year in advance to universities necessary time for preparation of next year application.
- The comparison between the ranking results and the score expectations of the universities will increase harmony and the transparency of the system. **Sonetti et al.,** recommended a "**satisfaction survey"** to strengthen the feedback system [1]. This survey should be done after the announcement of the ranking and it will enable universities to see the differences between expectations versus real results. Also, it will strength the assessment system of the UI GreenMetric.
- It is known that local conditions of university such as; size and location of the campus, university budget and other factors like old and new buildings affect the success of the sustainability plans [22]. Hence not only overall results but also categories should be examined in detail. **New certificates for categories** such as "energy efficient campus of the year", "zero waste producer of the year", "water-saver of the year", "green path of the year" and "green producer/consumer of the year" are recommended. The awards of "categories" will help universities to highlight the subjects they are successful in. Also, sharing the awarded projects on the UI GreenMetric website will be an incentive for new projects in other universities.
- The continent results in this study have shown that the development levels of the countries affect the UI GreenMetric results. Therefore, "**contribution to surrounding area sustainability**" indicator should be added in the **EC, WS** and **WR** categories for universities that positively affect basic life needs such as climate, waste and water management. The percentage weights of the categories may remain the same, but the addition of this indicator will encourage universities especially in developing countries.
- Details of the ranking system and **impacts of categories** on overall results should be clarified in the future in the UI GreenMetric's guidelines**.** Possible category descending order could be **EC, WS, ED, TR, SI** and **WR.**
- **The fee-free application** is one of the main reason why the UI GreenMetric is getting increasing attention from all over the world, hence fee-free applications should be continued despite the updates in the UI GreenMetric.
- In addition to the evaluation system, it would be a good option to award projects that directly address **global problems** such as "SDG-contributor" or "climate saver" in the annual GreenMetric workshops which are held every year.

- **Green purchasing** is another important factor for reaching institutional sustainability [23] and circular economy. Hence, purchasing indicator could also be added in the ranking system like in the STARS [24].
- Giving more importance to **social aspects** will help universities to embrace sustainability concept in the long term [1],[20]. Employee and student satisfaction indicators will cause increment in the social acceptance of the UI GreenMetric.

4. CONCLUSION

The UI GreenMetric has been getting great interest from all over the world since it was established. The UI Green Metric puts the green campus concept on the agenda of many universities, especially in developing countries. However, it is a fact that GreenMetric needs some updates and improvements. The exact effect of the UI GreenMetric categories should be clarified. It should be stated in the UI GreenMetric guideline that which parameters have priority while ranking universities. In order to understand the importance of categories and for creating successful projects, new awards for each category are recommended. The fee-free application to the UI Green Metric should continue in the future.

There is a significant increase in the number of published studies about green campus during last ten years. The possible effect of the UI GreenMetric on these studies should be analyzed in the future. Many universities carry out green campus projects under the management of "sustainability offices" in order to achieve more comprehensive results. The relationship between the UI GreenMetric ranking system performance of a university and the presence of sustainability office is also an important topic to be addressed. Although, ranking systems are important in terms of establishing standards and putting targets for universities they could cause a dilemma. After a certain point, universities may aim to be successful only in the ranking indicators. Hence, universities should put targets by considering their institutional weaknesses and they should aim more comprehensive targets such as SDGs.

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Education Effects on Participant's Awareness: Zero Waste Management Education in Istanbul Technical University (ITU) Ayazaga Campus

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Abstract

Turkey Ministry of Environment and Urbanization published Zero Waste (ZW) Regulation in July 2019. "Zero Waste Management Act" (ZWMA) was started in Istanbul Technical University (ITU) Ayazaga Campus as a part of a larger scale project called as "Green Campus". Education is first and crucial step to success in the sustainability acts. The aim of this study was to determine ZW management education effects on participant's knowledge. In this scope; ZW educations were given to administrative staff in 2019-2020 academic year. This study was conducted by using online questionnaires. The questionnaires included questions related to educational content and instructor, participant's willingness to ZW management and technical aspects of ZW approach. The results showed that 82% of the participants understood waste management (WM) hierarchy priority clearly and 93% understood recycling containers classification in the new ZWMA. However, they were confused about current WM practices in Turkey, totally 52% of participants chose recycling, composting and recovery as most frequently applied WM practices instead of landfilling. Based on the results it is understood that education has a significant positive effect on participant's knowledge. This study contributes to existing knowledge of WM by providing data about participant's awareness and it would be pioneer to further sustainability activities in the campus.

Keywords: Education, higher education institutions (HEIs), sustainability, university, zero waste.

1. INTRODUCTION

Sustainability term had stepped into human's life in the 1970s with the understanding of human beings cannot survive without the "environment" [1]. Sustainable development was defined as *"meeting the needs of the present without compromising the ability of future generations to meet their own needs."* by UN [2]. Higher Education Institutions (HEIs) have started interest with the sustainability concept after the UN Stockholm Conference in 1972 [3]. However, UN- Conference on Sustainable Development in 2012 (Rio+20) was a milestone in terms of the importance of the relationship between (Sustainable Development Goals) SDGs and education [1].

Universities have new responsibilities for reaching SDGs after the Rio conference [1]. University campuses are complex systems where all education and researches are carried out by consuming material, energy and water [4]. Sustainability in universities was defined as *"A higher educational institution, as a whole or as a part, that addresses, involves and promotes, on a regional or a global level, the minimization of negative environmental, economic, societal, and health effects generated in the use of their resources in order to fulfill its functions of teaching, research, outreach and partnership, and stewardship in ways to help society make the transition to sustainable life-styles*." by Velazquez [5].

HEIs are basically creating ideas and solutions by consuming products where they also have environmental, economic and social responsibilities for the society. Besides, universities should be pioneer to other institutions.

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Hence, universities are morally responsible for finding practical and theoretical solutions to environmental problems [6]. In this purposes, universities have been attempting various plans to become more sustainable or green campuses [7]. However, it was recently discovered that education is a key for long term success of sustainability goals in universities. Education activities regarding sustainability could be planned formal or non-formal way. Conferences, seminars and workshops are considered as non-formal education while undergraduate, graduate courses and certificate programs defined as formal education [5]. Formal education could be done via distance learning or on campus under the scope of curriculum [5]. Non-formal education could be done any time during an academic year without strict plan and date unlike the formal education.

Istanbul Technical University (ITU) started sustainability educations with Zero Waste Management (ZWM) in September 2019. Educations were conducted under the scope of non-formal education. However, ITU sustainability vision includes formal education for following years. ZWM was chosen as a first education topic because the Ministry of Environment and Urbanization was published Zero Waste Regulation in July 2019 [8]. According to regulation, universities are responsible for reaching zero waste (ZW) goal to landfills. Waste management (WM) studies have generally focused on environmental consequences and left out other sustainability pillars which are economic and social [9]. Hence, this study is expected to be the first step of "ZWM goal" developed within the scope of a sustainability vision at ITU. It will be an important opportunity to see education effects on participant's awareness and the changes in WM activities.

The aim of this study is to determine ZWM education effects on participant's knowledge. In this scope; education was given about ZWM and sustainability to ITU Ayazaga administrative staff. Also new ZWM plan in ITU Ayazaga Campus was introduced to participants. Then, a questionnaire was conducted to learn participant's knowledge and suggestions about ZWM activities. Environment, economy and social aspects are three pillars of sustainability and they should examine simultaneously for sustainability goals. In this scope; questionnaire results will be considered while planning future ZWM activities in the campus. The previously published research using surveys were conducted with campus stakeholders to understand their awareness and willingness about sustainability initiatives [3],[10]. This study will contribute to the current literature with adding information regarding successful sustainability activities in particular WM in HEIs.

2. MATERIAL AND METHOD

ZW educations were given to administrative staff one in fall and three in spring semesters in 2019-2020 academic year. Education information was covered not only about ZW but also on sustainability, WM practices in Turkey and circular economy concepts. Since all education content and lecturer were exactly the same in all four educations, it was possible to evaluate the overall results together. Questionnaire sent to participants online after education and 10 days have given them to answer. Questionnaire was answered by totally 89 people.

The questionnaire was aimed to learn (i) participant's thoughts about education and (ii) participant's knowledge about educational content. The 5 point Likert scale questions were used to learn the participant's thoughts about education itself. Multiple choice questions were used for educational content. Also an open ended question was asked to learn suggestions of participants regarding to ZWM activities on campus and further educations.

The possible limitation of the study could come from non-responders, participants who participated in education but did not answer the questionnaire. However, their ratio is below than 10 % of the participant's and this ratio can be accepted according to previous survey study [10].

3. RESULTS

One of the important aspects of the questionnaire is to learn the participant's thoughts about ZW education and the results are shown in **Table 1.** According to the results 87.2 % of participants were found education successful and efficient. Also, 82.2% thought that their awareness about environmental issues was increased after education.

Table 1. *Participants thoughts about education (%)*

Education (%)	**Strongly disagree**	**Disagree**	**Neither agree or disagree**	**Agree***	**Strongly agree***
Education contribution to you is very high and it is helpful for raising your awareness	1.1	2.2	14.4	34.4	47.8
Education is generally successful and efficient	0.0	1.1	11.2	29.2	58.4
Clarity of presentation/education is high	0.0	1.1	10.0	38.9	50.0
The performance of the educator/lecturer is enough and efficient	1.1	0.0	10.0	35.6	53.3

*Sum of strongly agree and agree is accepted as understanding of the concept

Results in **Table 2** shows that 82.4 % of the participants understand WM hierarchy priority clearly. However, they are confused about current WM practices in Turkey, totally 52% of participants choose recycling, composting and recovery as a most frequently applied WM practices instead of landfilling. Even though recycling rate has increased in recent years, landfilling is still the most applied WM method in Turkey [11].

Table 2. *Participants knowledge about WM (%)*

WM questions (%)	**Disposal**	**Recycle**	**Reuse**	**Reduce**	**Prevention**
Which one is the first step of waste hierarchy (priority)?	0.0	1.1	0.0	16.5	82.4
	Recycle	**Recovery**	**Compost**	**Incineration**	**Landfill**
Which WM method is the most practiced method in Turkey?	34.8	6.7	10.1	5.6	42.7

The waste will be separated four waste categories in order to increase recycling on campus. Blue container will be used for paper and cardboard while green for glass, yellow for plastic/metals and grey for other wastes. It is apparent from **Table 3** that 93.3% participants understand recycling containers separation in the campus. 94.4 % of participants, known glass and paper wastes container color right while 87.6% known plastic wastes colors.

Table 3. *Participants knowledge about the ZWM in ITU after education (%)*

ZWM in ITU (%)	**1**	**2**	**3**	**4**	**<4**
What will be the number of containers in ITU-ZWM ?	0.0	0.0	5.6	93.3	1.1
Which one is the color of glass wastes ?	**Red**	**Blue**	**Green**	**Yellow**	**Grey**
	0.0	1.1	94.4	3.4	1.1
Which one is the color of paper wastes ?	**Red**	**Blue**	**Green**	**Yellow**	**Grey**
	0.0	94.4	1.1	2.2	2.2
Which one is the color of plastic wastes ?	**Red**	**Blue**	**Green**	**Yellow**	**Grey**
	0.0	1.1	9.0	87.6	2.2

Education also included information related to economic aspects of sustainability since three main pillars of sustainability, which are environmental, economic and social, are merged each other. *Which economy approach is preferred for the ZW goal?* question was asked in questionnaire and most of the participants understood the circular economy and ZW relationship. According to **Figure 1.**, most of the participants (69.3%) chose circular

economy is more sustainable economy approach which encourages waste upcycling activities for reaching ZW goal.

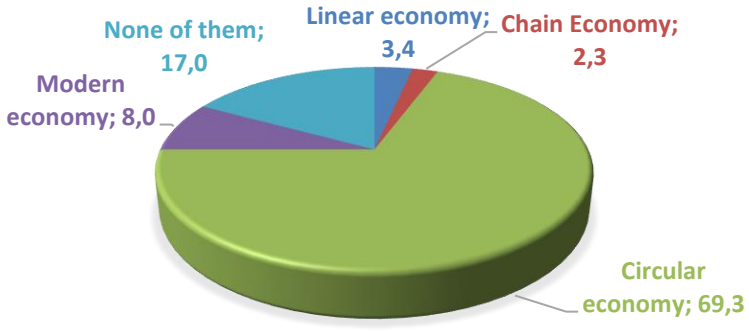

Figure 1. Which economy approach is preferred for the ZW goal?

The questionnaire also had an open ended question to learn participant's suggestions about further ZWM activities and future educations. Most of the participants were pleased with education and they recommended to give this education regularly to all stakeholders of the campus. They also suggested to create posters and slogans about ZWM to change perceptions of people. There were different opinions about "waste reduction in daily life" examples in education. While some participants were very pleased with examples other says they should be expanded to all activities in a daily life, for instance; energy and water savings in the university. Although the main goal was to measure the success of education, some participants complained about questionnaire itself, they were perceived the questionnaire as an exam.

The knowledge of the participants about ZW was learned verbally before the education. The questionnaires were held after the education to "find out the success of the education". This situation prevented the comparison of before and after knowledge of participants by questionnaire. Therefore, the difference in participant's knowledge can be followed by behavioral changes for instance; the change in the amount of waste and recycling performance in the campus.

4. DISCUSSION

This study set out with the aim of assessing the effect of ZWM education on participant's knowledge. The results of this study in **Table 2** indicate that participants perfectly understood WM hierarchy priority, however; they were confused about current WM practices in Turkey. Although landfill was chosen as the most selected answer with 42.7% in the questionnaire, it is still far away from the real life. Almost 80% of the municipal wastes were still sent to landfills in Turkey [11]. A possible explanation of this result may be the main focus of the education, which is representing ZWM concept and its relationship with sustainability. Although current WM practices in Turkey were mentioned in the education, the main focus was on waste prevention and recycling options for reaching ZWM goal.

It is understood from **Table 3** that study was reached the main goal which is increasing participant's knowledge about ZWM activities. Even the least known question, which is the color of plastic waste containers, had 87% correct response. The one of the possible reason of this result is that plastic wastes container color is less known compared to paper and glass containers. Blue and green containers already exists in the current waste management system. However, even though red and yellow colors are new options in questionnaire no one selected red containers as answer for new ZWM activities in ITU. These results support the idea of education and sustainability activities have positive effects on participant's knowledge. A study conducted in Turkey concluded that students who took sustainability courses and/or studied at universities or where sustainability

practices conducted, had tendency to research the sustainability subject personally [12]. Also, they had enough knowledge to define sustainability [12]. Similar work in Lithuania has shown that; green university students (universities applied to the UI GreenMetric Ranking system) are more sensitive to the sustainability activities than non-green university students [13].

The WM also has substantial economic consequences in addition to the environmental results. For instance; the recycling activities in campuses will contribute profit of university budget [14]. Hence, participant's awareness about economy and WM relationship is crucial and according to **Figure 1.** 69.3% of participants were familiar with circular economy concept after education.

Environmental changes depend on behavioral changes of the public [6]. Administrative staff is an important "stakeholder" on campuses, but this education must also be applied to other stakeholders. This suggestion also came from the participants at the open ended question in survey. Students are the most effective stakeholder group in terms of population. This kind of education attempts are important since they help to create a culture in campus even though the results are not seen right away [6]. It is also important that they carry this culture to their professional lives when they become alumni. Hence, university commitments on SDGs or other environmental topics should be compatible with curriculum to increase participation of campus stakeholders. This will help to increase student's awareness about sustainability and other environmental goals such as ZWM. Further studies on ZWM topic are recommended especially in order to follow education effects on behavioral changes of participants as well as change in WM performance of the campus.

5. CONCLUSION

The aim of this study was to understand education effects on participant's knowledge in aspects of ZWM. However, individual attempts are not enough. Clear vision and a management are essential for long-term success of sustainability. Sustainability activities in ITU have been continuing with top-down approach. It is understood from both face to face interviews and questionnaire results that people are willing to participate sustainability acts. However, they don't have any attempts before the initial act comes from the university management. WM has economic and social consequences besides environmental ones. Hence, this study is assumed as a crucial step for the sustainability studies in campus. As it is suggested by participants these educations should be expanded to all stakeholders on campus. Formal WM and sustainability education program should be included in all undergraduate curriculum.

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The Effect of Acids on the Chemical Stability of UV Inkjet Prints on Papers with Straw Pulp

Ivana Plazonić [1], Katja Petric Maretić [2], Irena Bates [2], Maja Rudolf [2], Valentina Radić Seleš [2], Jakov Radovčić [2]

Abstract

The bonding potential of pulp fibers is reduced by the paper recycling process. The most common technique for recovering this lost potential of secondary fibers involves upgrading the recycled pulp by blending it with virgin softwood pulps. In this research, we asses print stability on acid agents of UV inkjet prints when using straw pulp as reinforcing fibers in recycled papers. For that purpose, printing substrates were formed on the Rapid Kothen device from pulp obtained by blending different proportions of straw pulp and pulp of recycled fibers. Each printing substrate was printed in full tone with cyan, magenta, yellow, and black inks by digital technique of UV inkjet printing. Printed substrates were treated with various inorganic and organic acids under the conditions defined in the international standard ISO 2836:2004. Based on the measured spectrophotometric values of the untreated and acid-treated prints, the Euclidean color difference (ΔE_{00}) was defined and the stability of prints was assessed. The results of spectrophotometric measurements indicate small to medium color differences of the prints due to the effect of all acids ($\Delta E_{00max.} < 2.4$) and it can be concluded that straw pulp in printing substrates from recycled fibers contributes to good chemical stability of prints. This research concludes that straw, as an annual renewable resource, can be used in conjunction with waste paper as an alternative to wood, which is currently the dominant raw material for graphic industry and producing paper.

Keywords: acids, chemical stability, paper, straw pulp, UV inkjet printing

1. INTRODUCTION

Ink and printing substrate are the two components that have the greatest influence on image or text reproduction quality. Therefore, an adequate printing substrate is critical for any particular printing technique based on the function of the final product. Paper as the most commonly used printing substrate for all printing techniques is traditionally produced from cellulose fibers derived from wood. During the last decades, the increased focus on waste paper recovery and use in paper and paperboard production was widespread due to environmental concerns. Substitution of virgin wood pulp by waste paper has been accepted globally, and today recovered paper accounts for around 50% of the total papermaking fibers worldwide [1]. It is important to emphasize that paper production cannot be based only on waste paper as a source of fibers, as it can neither be efficiently used for all paper grades, nor can it be used infinitely many times. However, depending on the final paper quality and its price, the utilization rates by paper grades vary significantly, ranging from 10% to more than 90%. In newsprint, the utilization rate is extremely high up to 92.8%, while in packaging papers it is, on average, 75.3%. For other graphic paper, it is only 10.6% [1]. In paper production from waste paper during the recycling process it is important to continuously incorporate a certain amount of virgin fibers for strength, quality, and availability reasons. Given recycled fibers are not suitable for some products, as was already mentioned, the need for virgin fibers in the paper industry still exists. An alternative to conventional virgin wood fibers could be found in

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rapidly renewable sources (hemp, flax, bamboo, kenaf) and agricultural residues (wheat straw and bagasse) [2]. The great variety of characteristics, fiber dimensions and chemical composition of these alternative raw materials give them great potential to produce different types of papers [3]. The results of the previous study revealed that straw as an agricultural residue has fibers similar in length to hardwood species (common beech (*Fagus sylvatica L.*) and white poplar (*Populus alba L.*) which are most commonly used in cellulose and papermaking industries [4]. In addition, it has been proven that straw as non-wood plant material has nearly the same cellulose content as most wood species, lower content of lignin and higher amount of ash and solvent extractives [5]. The potential of wheat straw, the plant raw material that, according to annual yield, takes the first place in Europe and the second one in the world is recognized due to its availability which is one of the characteristics that a raw material for the paper industry must fulfill [6]. Wheat straw is applied as fibrous raw material for pulping and papermaking industry in countries with a lack of wood supply or in agricultural countries where this source is available in huge quantities [7]. However, if the paper made from straw pulp is intended for printing, the requirements for such papers are even higher. The printing substrates must hold most of the ink in the upper ten micrometers i.e. the ink layer should remain at or near the surface after drying in order to provide an optimum print density and good color saturation. But if the colorants are fixed to the surface of the printing substrate, they will be directly exposed to light, pollution, and other agents. Therefore, such print will be vulnerable to decomposition of the dye. Generally, the interaction of the ink with the substrate is key to producing high strength, well defined, durable images fit for any application [8].

As the quality and stability of the print directly depend on the composition of the paper as a printing substrate, it is important to determine which cellulose fibers (from the aspect of their origin) give quality prints. In this study emphasis is placed on evaluation of the straw pulp usability in the production of paper intended for printing based on the chemical stability of prints made on such substrates.

2. MATERIALS AND METHODS

2.1. Papers with straw pulp

Laboratory papers of approximately 42.5 g/m^2, formed by Rapid-Kothen sheet former (FRANK-PTI) according to standard EN ISO 5269-2:2004 [9], were made entirely of recycled wood pulp or from mixture of recycled wood and straw pulp of wheat, barley and triticale (Table 1.). Semi chemical straw pulp was obtained from crop residue leftover on fields after harvesting which was collected, manually cut, and processed by soda pulping method [10,11].

Table 1. Mark of papers used as printing substrates

Mark of paper	Composition		Production type
	Straw pulp, %	Recycled pulp, %	
K	0	100	commercial
N	0	100	laboratory
1NW, 1NB, 1NTR	10	90	
2NW, 2NB, 2NTR	20	80	
3NW, 3NB, 3NTR	30	70	

** straw type: W = wheat; B = barley; TR = triticale*

2.2. UV inkjet printing

All laboratory sheets and commercial paper were printed by digital EFI Rastek H652 UV curable inkjet printer. Each printing substrate was printed in full tone with cyan, magenta, yellow and black inks with the resolution of 600 × 600 dots per inch (dpi) (with high quality mode 8 pass) and printing speed of 12.10 m^2/ hr. In total 44 different UV inkjet prints were prepared for chemical stability analysis.

2.3. Chemical stability analysis

The method of assessing the resistance of printed samples to acid satisfied the international standard ISO 2836:2004 in the field of graphic industry [12]. All printed samples were cut to 2 cm x 5 cm dimensions before determining chemical stability. The treatment with acid solutions was performed as follows. First, two paper filters were soaked in an acid solution (v/v = 5%). They were then put onto the lower glass plate with a printed sample located in between. Finally, the upper glass plate is placed on top and weighted by a 1kg weight. The printed samples were thus exposed to each acid from 10 minutes to 60 minutes, depending on the type of acid (Table 2), after which each printed sample was washed with distilled water and dried in an oven for 30 minutes at 30°C.

Table 2. Acids used as chemical agents and test conditions

Acid	Concentration % by volume	Receptor surface	Duration of exposure, min	Contact conditions
Hydrochloric (HCl)	5	filter paper	10	1 kg on 54 cm^2
Sulfuric (H_2SO_4)	5		10	
Acetic (CH_3COOH)	5		30	
Citric ($C_6H_8O_7$)	5		60	

Evaluation of chemical stability of UV inkjet prints on papers with straw pulp was done based on the Euclidean color difference (ΔE_{00}) which was calculated according to the equation (1). Colorimetric values were measured by spectrophotometer X-Rite SpectroEye before and after acid treatment (Table 3).

Table 3. Color data measurements on UV inkjet prints

			
cyan	magenta	yellow	black

Color data were measured under illuminant D50, 2° standard observers. The symbol ΔE_{00} is used to denote distance in the uniform color space [13] and is defined as:

$$\Delta E_{00} = \sqrt{\left(\frac{\Delta L'}{k_L S_L}\right)^2 + \left(\frac{\Delta C'}{k_C S_C}\right)^2 + \left(\frac{\Delta H'}{k_H S_H}\right)^2 + R_T \left(\frac{\Delta C'}{k_C S_C}\right)\left(\frac{\Delta H'}{k_H S_H}\right)} \quad (1)$$

Where: ΔE_{00} – total colour difference, the Euclidean colour difference

$\Delta L'$ – the transformed lightness difference between print before and after acid treatment

$\Delta C'$ – the transformed chroma difference between print before and after acid treatment

$\Delta H'$ – the transformed hue difference between print before and after acid treatment

RT – the rotation function

k_L, k_C, k_H – the parametric factors for variation in the experimental conditions

S_L, S_C, S_H – the weighting functions

The results of change in visual perception of color due to the acid treatments is reported as an average of ten measurements from each print sample. On a typical scale, the ΔE_{00} value will range from 0 to 100 (Table 4).

Table 4. Interpretation of ΔE_{00} value [14]

ΔE_{00}	Perception
≤ 1.0	Differences in color are unrecognizable by a standard observer.
1 - 2	Only an experienced observer is able to perceive the differences.
2 – 3.5	An inexperienced observer is able to perceive the differences.
3.5 - 5	Every observer can easily see the difference.
> 5	An observer recognizes two different colors.

If the color differences value after chemical treatment is lower than 2 it is defined as chemically stable print as very small or small noticeable difference in the tone can be recognized by standard observer. As the value of the Euclidean color difference increases, the change in color is more clearly visible by a standard observer.

3. RESULTS AND DISCUSSION

Inorganic and organic acids used as chemical agents have different strength in solution. Namely, inorganic hydrochloric (HCl) and sulfuric (H_2SO_4) acids are strong acids which means that in an aqueous solution they dissociate completely, while organic citric ($C_6H_8O_7$) and acetic (CH_3COOH) acids only partially dissociate in solution, so they are classified as weak ones. The quantitative measure of the strength of acid in a solution is defined by K_a value (acidity constant). Weak acids have very small K_a values and therefore higher values for pKa (pKa in range from -2 to 12) compared to strong acids, which have very high K_a values and slightly negative pKa values (pKa lower than -2).

The Euclidean color difference of UV inkjet prints on different printing substrates due to hydrochloric acid, sulfuric acid, acetic acid, and citric acid treatments are presented in Figures 2-5.

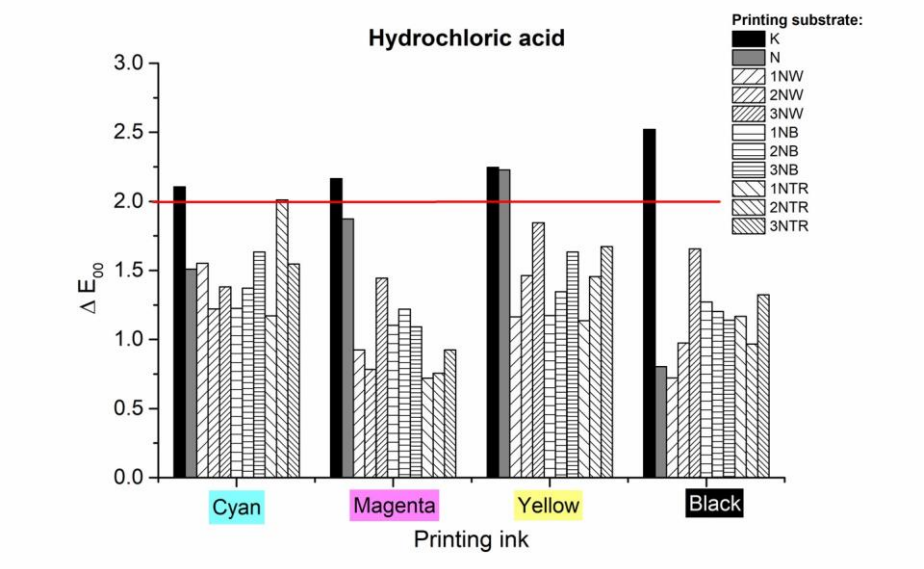

Figure 2. The Euclidean color difference of UV inkjet prints on different printing substrates after hydrochloric acid treatment

From gained results of spectrophotometric measurements of prints treated with hydrochloric acid presented at Figure 2, it is evident that commercial paper substrate (K) provides prints of lower stability in comparison with paper substrates produced at laboratory scale. However, CMYK prints on commercial paper substrate can be considered as satisfactory stable on hydrochloric acid because the change in color of the print is barely noticeable to a standard observer ($\Delta E_{00max.} < 2.4$). All laboratory papers provide good chemical stability of CMYK prints, especially those with addition of straw pulp. Generally, the most stable prints on printing substrates with straw pulp are those made with magenta and black (ΔE_{00} in range from 0.72 to 1.45 and 0.72 to 1.66, respectively). Slightly larger changes in the quality of reproduction due to the hydrochloric acid treatment were noticed on the prints with cyan and yellow inks.

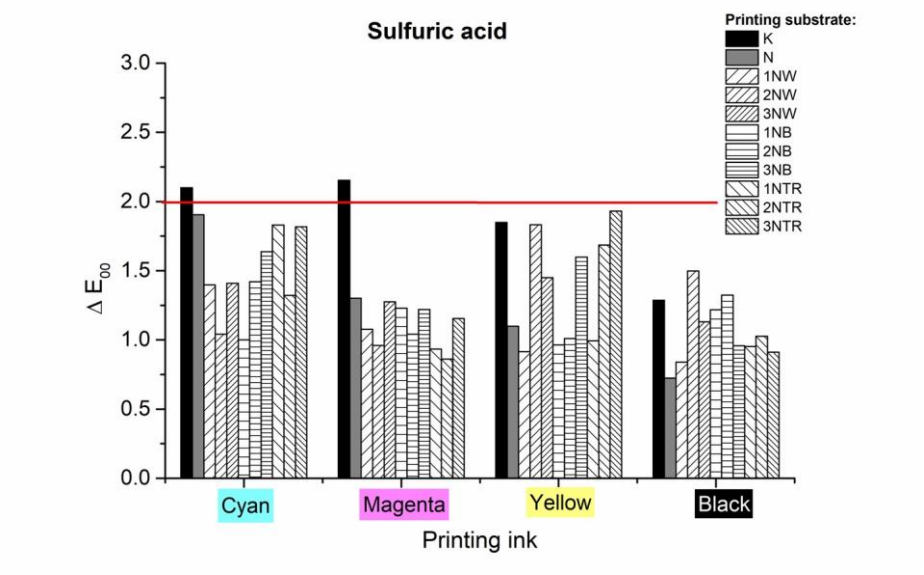

Figure 3. The Euclidean color difference of UV inkjet prints on different printing substrates after sulfuric acid treatment

The influence of sulfuric acid on color stability of UV inkjet prints is presented at Figure 3. The similar behaviour on CMYK prints was observed after sulfuric acid treatment but the values of the Euclidean color difference were slightly lower than due to hydrochloric acid treatment. Impact of sulfuric acid on the Euclidian color difference of prints is slightly more pronounced for magenta and cyan prints made on commercial printing substrate (K), while for yellow and black ink printed on commercial and laboratory printing substrates without straw pulp (N) or with straw pulp is approximately the same. The Euclidean color difference of prints on printing substrate with straw pulp is in range from 0.84 for black print on printing substrate with 10% of wheat pulp (1NW) to 1.93 for yellow print on printing substrate with 30% of triticale pulp (3NTR). Straw pulp of wheat, barley and triticale partially forms printing substrates which provide approximately the same stability of prints after treatment with strong hydrochloric and sulfuric acids.

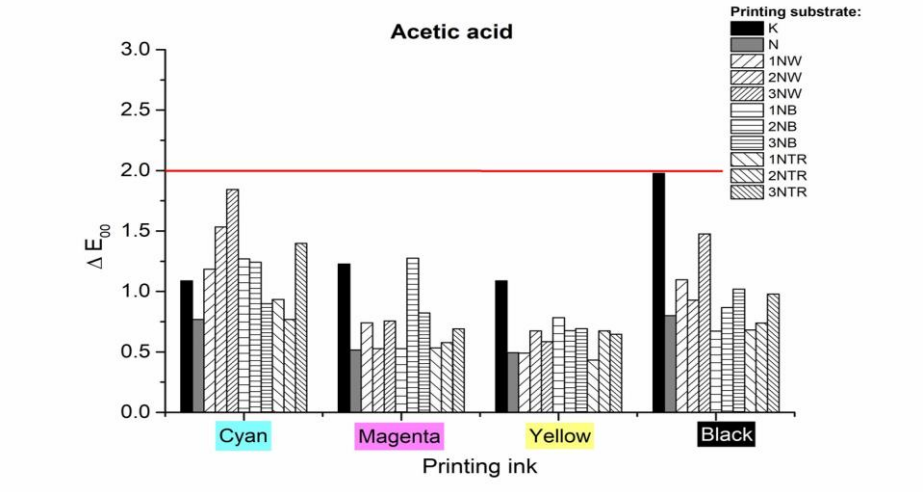

Figure 4. The Euclidean color difference of UV inkjet prints on different printing substrates after acetic acid treatment

Figure 4 presents results of acetic acid impact on chemical stability of UV inkjet prints on printing substrates with straw pulp. It is clearly visible that commercial printing substrate provides similar stability of prints as printing substrates made at laboratory scale, except for prints with black ink. The highest degradation on black print is measured on commercial printing substrate (K) with ΔE_{00} value of 1.98. The most stabile print, regardless on which printing substrate it is printed, is yellow (ΔE_{00} = 0.49 - 1.09). Cyan and black prints made on printing substrates with straw pulp have showed the highest degradation of color after acetic acid treatment (ΔE_{00} up to 1.84).

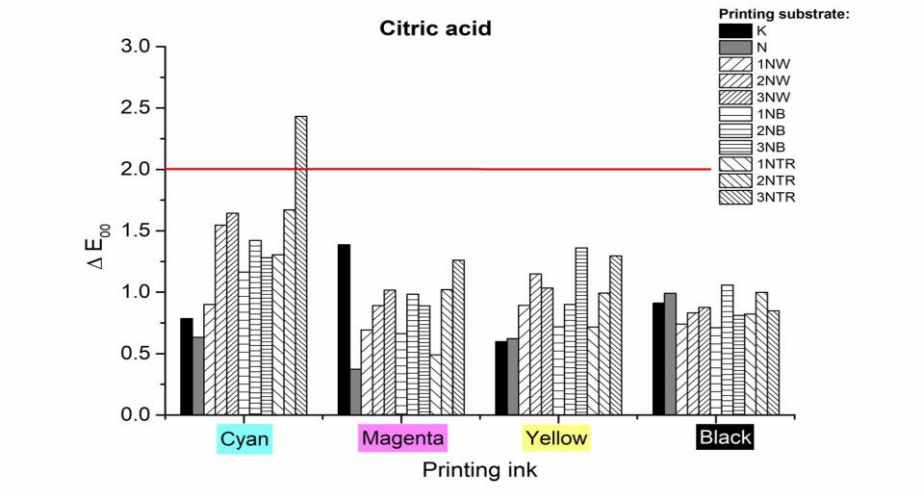

Figure 5. The Euclidean color difference of UV inkjet prints on different printing substrates after citric acid treatment

The influence of citric acid on degradation in color of UV inkjet prints is presented at Figure 5. The highest degradation of color by this organic acid is observed on cyan prints (3NTR printing substrate with ΔE_{00} = 2.43), while magenta, yellow and black prints show similar color degradation. As citric and acetic acids are weaker than inorganic acid used for chemical stability assessment their effect on prints is smaller. Generally, for all printed colors the Euclidean color difference after treatment with these organic acids are lower than 1.5. It is

interesting that for organic acid treatment the type of paper production (commercial or laboratory) did not show significant differences in chemical stability of prints as with strong inorganic acids.

4. CONCLUSION

The main aim of this research was to evaluate the usability of straw pulp for paper production intended for printing based on the chemical stability of UV inkjet prints on such printing substrates after acid treatment. As the results of spectrophotometric measurements indicated by a standard observer unrecognizable or hardly perceive color differences for all four analyzed colors due to the action of inorganic or organic acids ($\Delta E_{00max.} < 2.4$) it can be concluded that addition of straw pulp in printing substrates contributes to good chemical stability of prints. This research concludes that straw, as an annual renewable resource, can be used in conjunction with waste paper as an alternative to wood, which is currently the dominant raw material for graphic industry and producing paper.

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Analysis of Natural and Artificial Aging Influence on UV Inkjet Prints on Printing Substrates with Straw Pulp

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Abstract

Paper substrate, as the most common used substrate for printing labels or packaging, is traditionally produced from cellulose fibres derived from wood. The growth of a large number of industries has led to a significant increase in the use of such resource, which consequently led to a global awareness of the possibility of forest exploitation and the importance of reusing waste paper as a source of fibres. Hence, paper fibres can be recycled up to seven times and it is important to enrich paper pulp with virgin fibres during paper production. In such a way, the characteristics of the paper and the quality of the printed elements are improved. In this paper, cereal straw as an alternative resource of virgin fibres was turned into pulp and mixed with recycled wood pulp to conduct printing substrates using laboratory equipment. Since aging is an inevitable process of any printing substrates and prints, and the degradation of print quality due to aging largely depends on the properties of the printing substrate, ink and type of printing. This research was focused on analyzing optical stability of prints made on printing substrates with straw pulp by UV inkjet technique after natural and artificial aging. From a comparison of the aging processes based on the Euclidean difference results, it was observed that natural aging of UV inkjet prints yields less colour changes compared to artificial aging. Greater or equal optical stability after aging was perceived for prints on printing substrates with wheat, barley and triticale pulp compared to prints on substrates made with recycled wood pulp.

Keywords: aging, optical stability, printing substrate, straw pulp, UV inkjet printing

1. INTRODUCTION

Aging can be defined as irreversible changes that occur slowly over time [1], and in the case of paper and print this process may result in deterioration of useful properties, resulting in an unsuitable final graphic product. Although cellulose due to accidental hydrolysis of glycosidic bonds between glucose residues into cellulose macromolecules, oxidation and crosslinking affects the natural aging of paper, it is shown that the energy radiation, temperature and relative humidity (RH) are crucial to the longevity of paper substrate. The degree of polymerization (DP) of cellulose is also been reduced by aging process which causes deterioration of the optical properties of the cellulose and thus paper as a sheet made from randomly deposited cellulose fibres in network. The deterioration in print quality due to aging is largely dependent not only on the properties of the paper as a printing substrate, but also on the ink and type of printing process [2].

Since paper substrates have been traditionally produced from wood-derived cellulose fibres, the consumption of wood raw materials has increased significantly in recent years, which led to a global awareness of the possibility of forest exploitation and the importance of reusing waste paper as a source of cellulose fibres.

Over the past decade, the use of recovered paper in the paper and cardboard industry has grown all over the world. Recycled paper makes up about 50% of the total production of paper fibres used worldwide. The

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utilization rates of recycled paper substrates are very different, depending on the desired quality and final purpose. In the year 2010, the main purpose of recycled paper in Europe was for packaging production with 63.7%, for publications with 26.0% (18.6% for newsprint and 7.4% for other graphic products), for household and sanitary with 6.9%, and only 3.4% for other paper grades [3]. Substitution virgin wood fibres with recycled fibres also reduces greenhouse gas emissions by about 37% [4]. Paper production cannot be supplied only with recycled fibres derived from waste paper, because they cannot be used effectively in all paper grades, nor can they be reused constantly as raw material. Therefore, recycled pulp needs to be enriched with a certain amount of virgin fibres in order to increase the strength (wood cellulose fibres decay with each recycling process) and the quality of the paper [3].

Many countries around the world are struggling with the forest shortages, and this problem could become even greater in the coming years. Aware of this environmental problem, researchers constantly introduce alternative sources of cellulose fibres. Alternative resources of non-wood virgin fibres are divided into this groups: purpose dedicated crops, agricultural residues, industrial residues and uncultivated crops that occur naturally [5]. The most widely used are cane bagasse, bamboo, kenaf, hemp, sisal, abaca, cotton linter and reeds, as well as some exotic raw materials like aquatic plants, tea waste, palm leaf and banana stem. Most of these plants are annual plants that develop the full potential of fibre in one growing season [6].

Printed paper substrates are frequently used in a variety of everyday applications, from newspapers to packaging material and labels. Since the colour durability and permanence of a graphic product play an important role in ensuring accuracy, prints should not be degraded in quality before the product is sold or during usage [7]. Therefore, this research is focused on the analysis of optical stability of prints made on printing substrates without and with straw pulp by UV curable inkjet digital technique after natural aging and artificial aging. Laboratory printing substrates made with cereal straw were compared to laboratory printing substrates made only from recycled fibres which are used as reference paper (N), while commercial printing substrates were used as control substrate (K).

2. MATERIALS AND METHODS

2.1. Papers with straw pulp

The straw of the most common crop species in Croatia: wheat (*Triticum spp.*), barley (*Hordeum vulgare L.*) or triticale (*Triticale sp.*) straw were collected after the harvest and manually cut using scissors into 3 cm long pieces. Purified straw was conducted into semichemical pulp according soda pulping method [8]. Laboratory papers of approx. 42.5 g/m^2 were formed by Rapid-Kothen sheet former (FRANK-PTI) according to standard EN ISO 5269-2:2004 [9] whereby straw pulp (wheat, barley or triticale) was added in proportions of 10%, 20% or 30% into reference pulp of recycled paper (Table 1).

According to their composition, 10 different laboratory papers were formed. They were compared to each other and observed in relation to commercial paper made from recycled wood pulp.

Table 2. Commercial paper and laboratory papers composition

MARK OF SUBSTRATE	COMMERCIAL PRINTING SUBSTRATES - COMPOSITION
K	Commercial paper - 100% recycled wood pulp
MARK OF SUBSTRATE	**Laboratory printing substrates - Composition**
N	100% recycled wood pulp - reference paper
1NW	10% wheat pulp + 90% recycled wood pulp
2NW	20% wheat pulp + 80% recycled wood pulp
3NW	30% wheat pulp + 70% recycled wood pulp
1NB	10% barley pulp + 90% recycled wood pulp
2NB	20% barley pulp + 80% recycled wood pulp
3NB	30% barley pulp + 70% recycled wood pulp
1NT	10% triticale pulp + 90% recycled wood pulp
2NT	20% triticale pulp + 80% recycled wood pulp
3NT	30% triticale pulp + 70% recycled wood pulp

2.2. UV curable inkjet printing

In order to analyze changes in optical properties of printed commercial and laboratory substrates, both sample types were printed by digital EFI Rastek H652 UV inkjet digital machine at ambient conditions of 55% RH and temperature of 23^0. Cyan, magenta, yellow and black UV curable inks were printed in fulltone on each laboratory paper and commercial paper with the resolution of 600 × 600 dots per inch (dpi) (with high quality mode 8 pass) and printing speed of 12.10 m^2/ h. EFI Rastek digatal machine uses the Toshiba Tec CA-5 printhead for each color. These printheads offer the ability to print grayscale, which means it can produce droplets of different sizes from 6 pl to 42 pl, which creates prints of the higher quality.

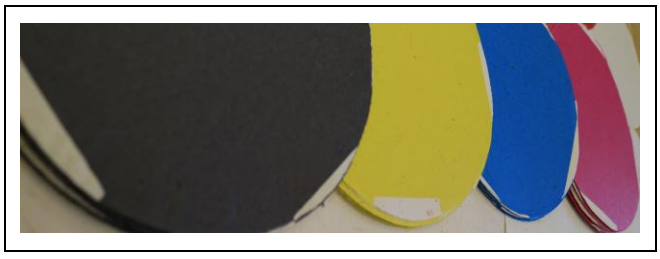


Figure 1. Printed commercial and laboratory substrates

2.3. The process of prints aging

The experimental part of this research was divided into two parts applying two types of aging processes: artificial aging and natural aging.

2.3.1. Artificial aging process of prints

Printed commercial and laboratory paper substrates without and with straw pulp were shaped into 60 mm x 90 mm strips and placed side by side on a white background in the Suntest XLS + test chamber. The imitation of natural aging treatment was performed by xenon lamp with a daylight filter, emitting visible and close to ultraviolet electromagnetic radiation with the wavelength in a range from 290 nm to 800 nm.
The artificial aging procedure was performed in two cycles of 48 hours according to ASTM D 6789-02 [10], during which the light intensity level was 765 ± 50 W/m^2.

Table 2. Conditions during artificial aging treatment

Cycle of aging	**Duration of the aging process (h)**	**Heat flow rate intensity (J/s·m^2)**	**Ambient condition**	
			Temperature (°C)	Relative humidity (%)
I	48	765	24.8	54.7
II	96	765	23.5	47.4

2.3.2. Natural aging process of prints

The printed samples were stored during period of 365 days side by side in a black bookcase in a dark and dry place to analyze the influences of the natural aging process.

Spectrophotometric analysis

Spectrophotometric measurements in the visible part of electromagnetic spectrum were performed before and after aging processes on all printed substrates by SpectroEye device, X-rite (D50, 2°). Spectrophotometric measurements provided data on the optical properties of analyzed prints that were observed using colorimetric characteristics by CIE L*a*b* values. The colorimetric values L*a*b* were used to define the optical degradation of printed substrates, before and after aging processes, which were ultimately presented on the basis of the Euclidean differences (ΔE00*). Colour difference or the Euclidean difference (ΔE00*) is the numerical value for describing difference between two colours. Analysis of optical stability of cyan, magenta, yellow and black UV inkjet prints without and with straw pulp was determined based on the Euclidean colour difference which was calculated according equation (1).

$$\Delta E_{00} = \sqrt{\left(\frac{\Delta L'}{k_L S_L}\right)^2 + \left(\frac{\Delta C'}{k_C S_C}\right)^2 + \left(\frac{\Delta H'}{k_H S_H}\right)^2 + R_T \left(\frac{\Delta C'}{k_C S_C}\right)\left(\frac{\Delta H'}{k_H S_H}\right)} \quad (1)$$

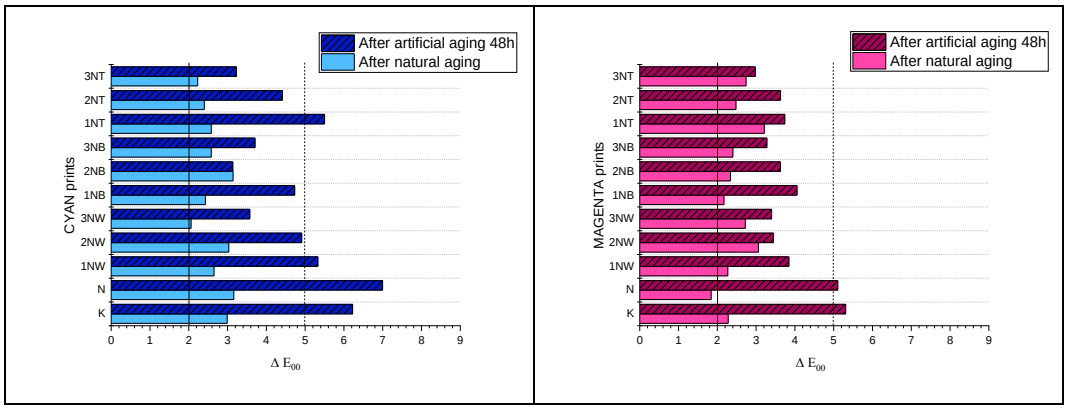
Values ΔL' (lightness), ΔC' (chroma) and ΔH' (hue) are calculated based on the colorimetric values of the analyzed prints after the aging process L*1, a*1, b*1 and the colorimetric values of prints before aging process L*2, a*2, b*2 , where ΔL', Δa*, Δb* are differences between colorimetric values of the print after the aging process and colorimetric values before the aging process, RT is the rotation function SL, SC, SH are weighting functions for lightness, chroma and hue, factors kL, kC, kH are defined with respect to observation conditions. In the CIE L*a*b*colour space the value L' represents the lightness of the colour and the value +a* represents redness or the value –a* represents greenness, and the +b* value represents yellowness or the value –b* represents blueness [11,12]

According to the Euclidean differences definition ΔE00*≤ 2 is classified as very small noticeable difference for standard observer, while ΔE00*=5 is defined like a big noticeable difference in the colour whose standard observer can recognized [13].

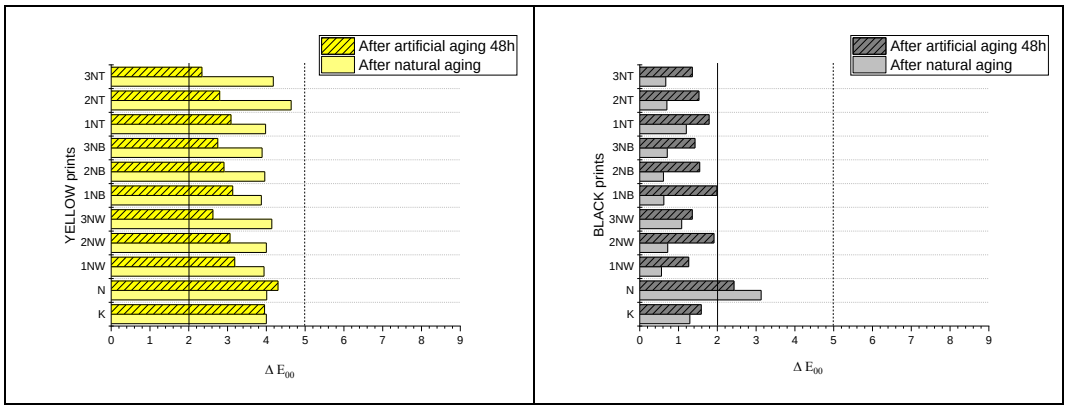
Figure 2. Spectrophotometric measurements

3. RESULTS AND DISCUSSION

The comparison of optical stability of prints performed on papers without and with straw pulp after first artificial aging cycle of 48 hours and natural aging process observed on the basis of the Euclidean difference is presented in Figure 3.



a) *b)*

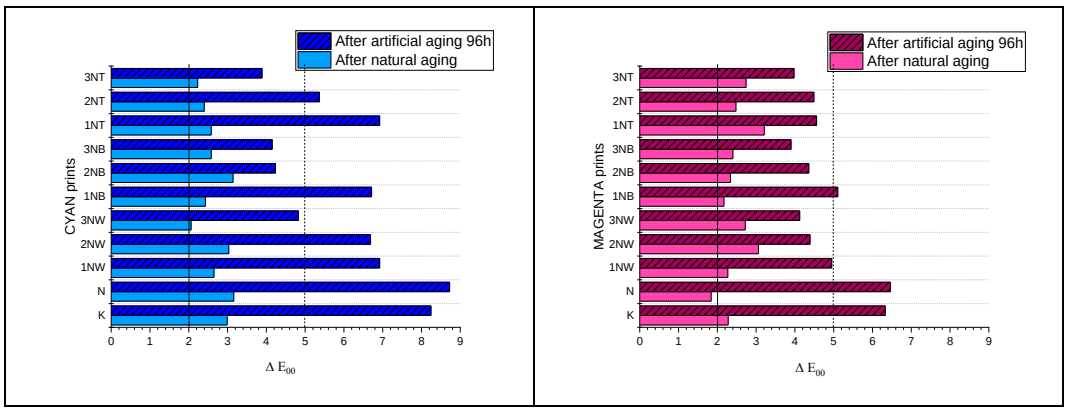


c) *d)*

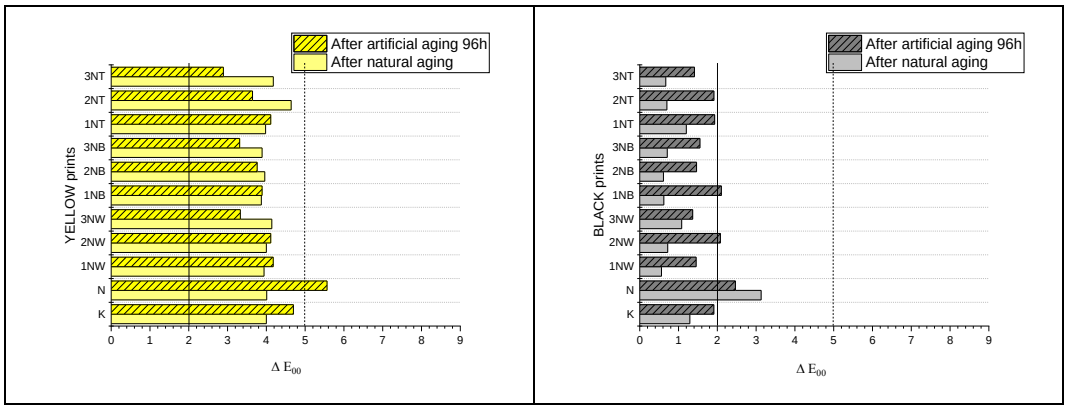
Figure 3. The comparison of the first cycle of artificial aging and natural aging processes based on the Euclidean colour difference of cyan (a), magenta (b), yellow (c) and black (d) UV inkjet prints

According to spectrophotometric measurements the addition of wheat, barley and triticale pulp into laboratory substrates provide equal or slightly greater optical stability during aging process. Observing all results it could be assumed that magenta and cyan prints made on the reference paper (N) and commercial paper (K) show the most pronounced changes in the coloration after the artificial treatment of 48 hours while the less visible changes are observed on printed substrates with the addition of straw pulp. From obtained results of all yellow prints it is evident that printed substrates with the addition of straw pulp have slightly larger colour changes during natural aging than after first cycle of artificial aging treatment. Given treatments of aging, black prints have similar behaviour as cyan and magenta prints. After both of observed aging treatments, a slight reduction in the colour of the black print was obtained, which is defined according to tolerance definition as a small noticeable difference in the tone that standard observer can recognize. Generally, the most stable prints, regardless of the substrate composition, are those obtained with black UV inkjet ink, where the largest Euclidean colour difference after natural aging is $\Delta E_{00(N)} = 3.2$, while the Euclidean colour difference after artificial aging is up to $\Delta E_{00(N)} = 2.43$.

The comparison of optical properties of prints performed on papers without and with straw pulp after second artificial aging cycle (in total 96 hours) and natural aging process observed on the basis of the Euclidean difference is presented in Figure 4.



a) *b)*



c) *d)*

Figure 4. The comparison of the second cycle of artificial aging and natural aging processes based on the Euclidean colour difference of cyan (a), magenta (b), yellow (c) and black (d) UV inkjet prints

From the Figure 4 it is visible that greater colour deviations were obtained on all printed substrates without and with wheat, barley or triticale pulp after artificial aging period for 96 hours, which are defined as significant noticeable difference in the print tone that standard observer can recognize.

From the value of the Euclidean colour difference, it is noticeable that the colour degradation of the UV inkjet prints decreases with the gradual addition of straw pulp in laboratory substrates.

When comparing colour difference after second artificial aging treatment and after natural aging process it is possible to define that 96-hour artificial aging treatment yielded the same colorimetric differences as the natural aging on yellow printed substrates, regardless of the substrate composition.

The black UV inkjet ink on the prints after a longer period of artificial aging treatment provides the most stable prints on all observed printed substrates, where the highest colorimetric difference goes up to a value of $\Delta E_{00(N)} = 3.3$.

4. CONCLUSION

Based on obtained data from the comparison of the aging processes, the following conclusions can be drawn:

- Prints on laboratory substrates containing wheat, barley or triticale straw pulp have greater optical stability after artificial aging treatments compared to printing substrates made from recycled wood pulp.
- The greatest optical instability after natural aging was noticed for yellow prints on all printing substrates, while only after artificial aging of 96 hours the same colorimetric differences were obtained as after natural aging.
- Cyan, magenta and black prints obtained on printing substrates with and without straw pulp after natural aging for a period of one year have shown greater stability compared to prints after artificial aging treatment.
- The greatest ability to remain chemically and physically stable over long periods of time was noticed for black prints on all observed substrates.

- Experimental observation of optical stability confirmed that laboratory papers with addition of straw pulp could be used for certain categories of printing papers, such as for packaging, labels or some publications.

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Biography: Irena Bates, an assistant professor, was born in Zagreb. After she had graduated from the Grammar School of Science and Mathematics in Zagreb in 1997, she continued her education by attending university studies at the Faculty of Graphic Arts in Zagreb, majoring in technical processes and technology. During her undergraduate studies she worked for two years as a student assistant at the Department of Materials in Graphic Technology. She graduated from the Faculty of Graphic Arts in 2003 with the thesis "Screen Printing Inks". After she had completed her first-level university studies, she was employed by the "Sun Chemical", a worldwide producer of printing inks and pigments. However, in 2004, she decided to enrol in a postgraduate study programme at the Faculty of Graphic Arts in Zagreb. Since November 2006, she has been employed at the Faculty of Graphic Arts in Zagreb, Department of Printing. In 2008, driven by her interest in continued advancement, she participated for three months in the research training at the Department for Information and Graphic Technology of the Faculty of Natural Sciences and Engineering of the University of Ljubljana in Slovenia. Doctorate on 21.02.2013 with the dissertation thesis "The study of flexographic print reproduction specific parameters" under the supervision of Assoc. D.Sc. Igor Zjakić. Thereby has gained academic degree of Doctor of Science from the scientific field of technical sciences and the scientific field of graphic technology. She is an associate in many projects of the Ministry of Science, Education and Sports, and from 2017 she is head of the scientific UIP-2017-05-2573 project "Printability, quality and utilization of substrates with non-wood fibres" of Croatian Science Foundation (11.12.2017 - 07.03.2023).

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The Impact of Information Systems on Hospitality Business Branding – The Strategic Role of Sustainability

Nikolaos Georgopoulos[1], Sotiris Varelas[2], Panagiota Karvela[3]

Abstract

This specific research discusses the impact of Information Systems in the industry of Hospitality Business Branding regarding the strategic role of the sustainability. The study area of this research concerns Sustainability, Information Systems and Hospitality Branding. There are many approaches regarding to the definition of Sustainable Hospitality, most of them are developed around the concept of business efficiency and competitive advantage. It enables companies to increase their business performance by developing sustainable strategies, develop an environmentally friendly business profile and potentially gain competitive advantage. These outcomes are strongly supported by Information Systems. The purpose of this research is to fulfill the gaps in the literature review on how Information Systems and Sustainable Development could help the Hospitality Branding and to be the prologue for a further investigation on a case study to determine the potential strategies.

Keywords: Branding, Hospitality, Information Systems, Sustainability

1. INTRODUCTION

As far this paper is concerned, the study area is about Branding, Sustainability, Information Systems and Hospitality. Nowadays, the concept of sustainability is increasingly important and should be at the forefront of every company. However, some companies, consider that the cost of sustainability is too high to adopt. Char's survey [1] compared companies that had adopted a sustainability philosophy and others that had not. It showed that many non-sustainable companies, which claimed that these policies are very costly, were wrong. The findings showed that sustainability does not have a negative impact on the cost of goods sold, profit margin or operating costs.

The hospitality industry is considered to be the world's fastest growing sector, having a very high impact on local, national, and global economies. According to Jones P. et al [2], there are many approaches regarding to the definition of Sustainable Hospitality, most of them are developed around the concept of business efficiency and competitive advantage.

It enables companies to increase their business performance by developing sustainable strategies, develop an environmentally friendly business profile and potentially gain competitive advantage. These outcomes are strongly

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supported by Information Systems. A positive correlation between the green operations of the hotels and the customer behavior has been detected and this relation could lead the company to a better business performance. Information Systems could also contribute to the Sustainable Hospitality by providing better and more accurate data regarding the social pillar of sustainability, which are very difficult to quantify and also, what strategies should be followed in order to achieve that.

2. MATERIALS AND METHODS

The aim of this research is to present how sustainability through the use of information systems can support the efforts made from Greek hospitality enterprises to leverage their efforts to higher brand awareness and attract tourists. The selection criteria of these literature sources were based on the relevance to the topic of the paper based on specific keywords for a 10-year period and more. Moreover, a gap in the literature review was found and investigated about what strategies a hotel should follow in order to transit to the sustainable development and improve its brand image. In order to address this gap, an extensive literature review was conducted. The steps that were followed are discussed in the below Figure 1. In addition, to address all these gaps, current research tries firstly to clarify the connection of Sustainable Development and Hospitality Business Branding and secondly to examine the impact of Information Systems in Sustainable Hospitality and how this combination increase the business brand performance. Combining and understanding the obtained knowledge, gives a better chance to analyze the relationship between Information Systems, Sustainability and Hospitality Business Branding.

A literature review is necessary because it can give information about what papers have been already published, concerning about the subject which is under examination and helps the researchers to support their arguments in providing an original contribution [3]. The keywords that have been used in the search were: Branding, Hospitality and Sustainable Development, as well as combination of the above. The papers that were mined are from the database of Scopus and Researchgate.

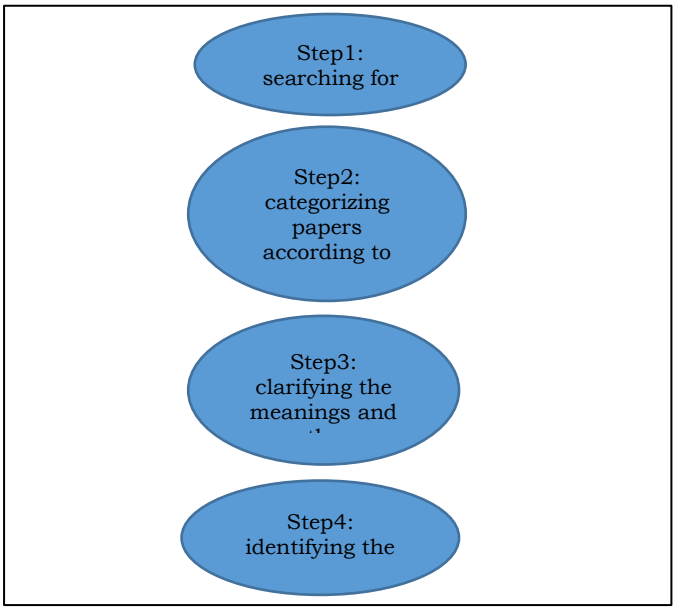

Figure 1: Steps of methodology

3. RESULTS AND DISCUSSION

3.1. Sustainable Development

The definition of Sustainable Development developed by the Brundtland Commission during the 1987 and refers to "the ability to make development sustainable, to ensure that it meets the needs of the present without compromising the ability of future generations to meet their own needs"', which is the most common definition and most frequent in the international literature review [4]. The desired outcome is when the society where living conditions and the use of resources continue to meet human needs without undermining the integrity and stability of natural systems [5].

During 2002, the World Summit on Sustainable Development developed a further expansion of the common definition using the definition of the three pillars of sustainable development [6]. So, sustainability focuses on 3 main pillars, which are the environment, the society and the economy [6]. Sustainability is a process that pushes the evolution and transformation of the 3 pillars (environment, social and economic) for a better quality of life [7].

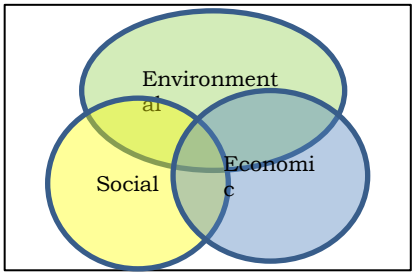

Figure 2: The 3 Pillars of Sustainability

Corporations, in order to succeed better financial profits, have to recognize that they belong and operate inside a larger natural and task environment. So, firms must behave in an environmentally and socially sustainable manner [8]. According to the above, there is an increasing pressure on corporations to think about their social and environmental impacts [9].

3.2. Sustainability Within The Hospitality Industry

The relationship between tourism and sustainability is very complex [10]. So, the key to improve and evolve this relationship is by developing a greater sense of responsibility towards and within the stakeholders who take part in the tourism system. In addition, a positive correlation among the operations (regarding the environmental pillar) of the hotels and the customer behavior has been raised and this relation could lead the company to an increase of the business performance or to a competitive advantage inside the task environment. Nowadays, there are a lot of research on sustainability within the hospitality industry and several research agendas are receiving more attention. The research of [11], proposed that customer behavior and operational decisions are main key drivers of environmental sustainability and revealed that “there is a positive link between environmental sustainability and operating performance”.

In fact, this sector has many difficulties in order to find the right combination to achieve the three pillars of sustainability [12]. According to [13], “the triple-bottom-line concept suggests that firms not only need to engage in socially and environmentally responsible behavior, but also that positive financial gains can be made in the process”, and their three dimensions (when integrated) represent the Sustainability term.

Legrand and Sloan [14] based on the World Commission on Environment and Development defined “sustainable hospitality” as the “hospitality industry development and management that meets the needs of today’s guests, hoteliers and stakeholders without compromising the ability of future guests, hoteliers and stakeholders to enjoy the benefits from the same services, products and experiences”.

There is increasing academic concern for the role and the effect of sustainable development within the hospitality industry. There are many companies which are committed to report their sustainable issues including environmental goals, etc., but most of them provide details or the real numbers.

Sustainability is an integral part of hospitality and as a valuable resource cannot be bought or sold [15]. So, hospitality companies do not have only financial (economic) but also ecological (environmental) and social (equity) impacts of their business on the environment [16].

3.3. Branding And Sustainability

According to Berry [17] Branding has also applied successfully in the field of hospitality industry and investigates how hospitality companies use the meaning of branding in order to link the features of the companies to the needs and expectations of the visitors. A brand in the hospitality industry is the promise of the future satisfaction that consumers are going to receive [17].

As it is well known the concept of sustainability was introduced approximately four decades ago [18]. Nowadays, this concept is becoming more and more significant in the domain of marketing literature [18]. The terms that are used to describe specifically the sustainability marketing vary in the literature review and include terms such as green branding, environmental marketing and ecological marketing etc. [19]. The goal of sustainability marketing is to deliver and increase customer value by creating social and environmental value [20].

Sustainability is very essential for the different operational business management [13], so it might be essential for the brand management. This is because the contribution of sustainable development in branding could lead to a competitive advantage for the company and express this contribution about sustainability to its customers [21].

However, it is very surprising the fact that there are not many researches concerning the relation between sustainability and branding principles [22]. But the approach of this paper according to branding is not from the side of brand as a quality assurance process but from the side of customers perception and added value. It is understandable that through branding hotel firms offer the tourist a clear picture of what to expect and can be used as a differentiation element.

According to Berry [17] the industry of Hospitality is a highly personalized service industry, and it builds strong brands by engaging consumers emotionally. The branding of services is different from the products as it is not based on the feature and benefits of the tangible things, but the emphasis is given to the unique characteristics of the intangible services. So, due to its intangible nature, there is a problem in the service industry which is the lack of indicators in order to evaluate factors by which a customer will be able to evaluate a service [23]. Krishnan and Hartline [24] suggested that a good service brand can be able to assure customers about the provided service quality.

According to Šeric´ et al. [25], perceived quality refers to the customer's ability to evaluate the products and services that offered by a hospitality brand. Brand interaction is the interaction between the customer and the brand of the company. So, perceived quality concerns about the expected offerings by a customer and brand interaction concerns about the actual offerings provided to the customer.

It is very important to better understand the interaction of sustainability and branding because this combination will help hospitality and tourism marketers in order to minimize the gap between the expected and actual outcomes of a visitor. Furthermore, the interaction between sustainability and branding has been closely related with the customer's trust, commitment, and loyalty ([25], [26]).

The combination of trust and emotional commitment positively, through the three pillars of sustainability and the use of Information Systems, affects the business performance of the company [27]. There are areas where Information Systems could be linked to the provision of sustainable services between the services of hosting services in order to have high results of a customer.

A significant amount of papers has studied the strategic role that information systems play and their correlation with sustainability in the tourism industry, and in particular hospitality businesses. There are different scientific papers which focus on new technologies and their implementation at the ages of crisis and specially covid-19 ([28], [29]).

The interaction between stakeholders, business digitalization and agility is the main characteristic of the hospitality business [30]. Information and Communication Technologies (ICT) has been developed in an increasing rate and the fast flow of data allowed tourism companies to significantly increase the sustainability of their provided services.

3.4. Smart Hospitality Through Information Technology (It) - Solution For Environmental Sustainability.

Nowadays, there is a tremendous increase and development of the digital age and its technological achievements have forced the tourism industry to transform their organizations and brands [12]. Information systems include 4 main elements: Information Technology, processes, people, and organizational structure.

Information technology (IT) has a complex relationship with the environmental sustainability because it could be the problem and the solution to it. According to Wang et al. [31] IT has a negative impact on the environmental pillar of sustainability during the different stages of its life cycle, but at the same time IT also presents some opportunities for companies to achieve environmental sustainability by using all the IT in order to make green and environmental the management and the operations.

In order to achieve environmental sustainability, firms have to develop sustainable capabilities so as to increase their performance and at the same time to minimize the environmental footprint of their activities on the natural environment [31]. There is a gap in the literature review, that environmental sustainability is one of the world's most important problem, but at the same time cannot explain where and how IT can contribute to make the world a better place. The integration of IT in the environmental management processes could be a chance to create valuable capabilities, in order to transform the environmental management processes, so as to pursue environmental sustainability and increase of the business performance.

Information Systems could contribute to the Sustainable Hospitality by providing better and more accurate data regarding the social pillar of sustainability. These data concern the relationship between the company and its partners and its customers. This kind of data are very difficult to quantify, so managers with this kind of information would be able to follow sustainable strategies. The application of information systems creates added value for tourism sector organizations and enhances their competitive edge.

Also, IT allows hotel owners to improve the level of sustainable services they offer. This could lead to an improvement of the economical pillar of the sustainability because the managers are able to control the processes and safe time from this application. This could lead to an increase of the business performance. Investment in IT may have a greater impact on the company's economic pillar than comparable spending on either advertising or R&D, and IT investments may be more effective and efficient in improving profitability by increasing revenue through increasing customer satisfaction and customer retention ratios.

Information Technology has a controversial role because it may have a negative impact on the natural environment at various stages in its life cycle, but at the same presents opportunities for companies to pursue environmental sustainability by using it in different environmental procedures. "Smart hospitality" and in general the information systems will give the opportunity to hotel owners to improve the level of services that they provide to their guests, using sustainable smart and interconnected devices and applications, which belong to an information system network. The transition to green and smart hospitality is very important and can also offer several advantages to both the visitors and the owners and branding.

In this paper the analysis of Information System showed that there are several advantages to both the guests and the hosts. There are some information systems, which impact positively on hotel performance and sustainability [32]:

- P.M.S. (Hotel Property Management System)
- Channel Management Systems
- F.O.M. (Front Office Management)
- P.O.S. (Point of Sales).
- B.O.M. (Back Office Management)
- (Management Information Systems)
- Reservation Systems

- Data Analytics – Analytics Clouds

Information Systems could provide the guests with more more green and sustainable services. Moreover visitors could have easy access to any information they need, they will be able to reassure the room's conditions according to their own preferences and feel more safer during this difficult period of time, this of the post COVID-19 period [33].

At the same time, hosts and hotel owners can reduce their costs through energy saving, increase their brand awareness and ratings due to more satisfied customers, and they can easily monitor and control the conditions inside the rooms, spot potential problems and follow a predictive maintenance approach.

4. CONCLUSION

The challenge for the future of Greek tourism is to understand the needs and wants of tourists and always regarding sustainable development, with respect to the natural and social environment of the place to acquire competitive advantage. The key to success is the Greek hospitality businesses to focus in developing an effective brand strategy, based on sustainability, which will make hotel businesses gain a viable competitive advantage through this added value.

Hotel managers should become more aware about sustainable changes and incorporate them into their brand personalities inspired by the 17 SDGs. It is not just about investing in corporate social responsibility and the certifications but going beyond and having sustainability as a brand purpose, deeply inserted in its personality to generate a positive impact on society and the planet. Moreover, linking sustainability to Branding, using Information Systems is a promising route for branding strategies in hotel management and goes further than profit, growth and employment agendas.

To sum up, Sustainability is becoming an integral part of organizations' philosophy. Nonetheless, there are few scientific papers available addressing the topic of sustainability connected with branding principles. This paper argued that sustainability should be systematically incorporated into main branding principles in both the visible and invisible parts of a brand during both its development and its implementation.

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Sustainable Development for Small Scale Industries in Textile Dyeing & Printing

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Abstract

Sustainable development has become a global aspect and a major concern for textile industry. As described by the Brundtland Commission's Report [1]t, Our Common Future, sustainable development is "Development that meets the needs of the present without compromising the ability of future generations to meet their own needs". As Cepolina (2012) [2], suggested that to overcome the damages of the industrial economy, the ecological approach should be adopted for transformation in the manufacturing efficiency, and organizations can increase profits by following the sustainable manufacturing model. Yet some of the research states otherwise, like Florida and Davison (2001) [3], that business benefits are important motivations for adopting innovative environmental practices. Analyzing the financial and environmental performances of the firms will help in exploring the relation between sustainable environmental practices of firms and their business benefits, or, financial performance. Financial and environmental performance data of selected textile dyeing and printing MSMEs was collected and analyzed to test the hypothesis that better environmental performance leads to a better financial performance. Data was collected from 30 MSMEs, and quantitative analysis was performed using multiple linear regressions. The result shows that Environmental Performance of a firm impacts its Financial Performance measures, like Gross margin (GM). This study provides critical understanding of the relation between financial and environmental performance and hence could be an important input for the policy making and incentivizing the MSMEs in appropriate ways to get commitment for sustainable environmental practices.

Keywords: Environmental, Sustainability, Financial Performance, Textile Dyeing and Printing, MSME

1. INTRODUCTION

The textile industry has both cultural and economic importance for the developing countries. It perpetuates the heritage, traditional skills and talent of the country. Its economic importance is linked to its high employment potential, low capital investment, high added-value and export potential. India is the second largest exporter of dyestuffs and intermediates among developing countries, after China. As reported by Mathur N. (2005)[4], production of dyestuff and pigments in India is close to 80,000 tones.

The industry also brings with it a range of problems, one of which is increased pollution. Textile industry is one of the most polluting industries. Environmental issues arise at all stages of the textile and apparel supply chain. The strenuous production of textile and its consumption has contributed to increasing pollution, water shortages, fossil fuel and raw material depletion, and climate change. Pollution of drinking water through chemicals released from production processes is a grave threat. How the firms manage their supply chains significantly influences their performance of environmental sustainability.

This study is conducted on the Micro, Small and Medium Enterprises (MSMEs) of the dyeing and printing industries in the region of Jodhpur, Rajasthan, and provides critical understanding of the relation between financial and environmental performance. Hence, this study could be an important input for the policy making and incentivizing the MSMEs in appropriate ways to get commitment for sustainable environmental practices. In Rajasthan state particularly, textile mills represent an important economic sector and mostly engaged in cotton and synthetic textile printing and dyeing. The textile SME units at Jodhpur play a vital role in the economic growth of Rajasthan. Jodhpur

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witnessed a big demand of its colorful printing and dyeing for years. A rapid industrialization has happened over the last 3-4 decades, which has led to rising pollution levels.

These industries liberate a variety of chemicals, dyes, acids and alkalis besides other toxic compounds like heavy metals, which are known for their hazardous properties and are subject of environmental concern since these dyes can enter the environment through dyeing and printing operations, as wastewater effluents. Sustainability is now a significant issue for the region, and sustainable textile production is now the demand by the Govt and many other regulatory boards. National Green Tribunal's (NGT) [5], circuit bench of Jodhpur has ordered the closure of 739 textile units in Balotra and its surrounding areas of Jasol and Bithuja.

2. REVIEW OF LITERATURE

Environmental sustainability for the region is important issue, both government and dyeing and printing units of the region play a significant role to help in maintaining a balance between the issues of sustainability. Sustainability and sustainable development pay attention on balancing between competing needs (our need to move forward technologically and economically) and the needs to protect the environments in which we and others live. The most widely used definition of sustainable development is the one from the Brundtland Commission's Report [1], Our Common Future. It describes sustainable development as, "development that meets the needs of the present without compromising the ability of future generations to meet their own needs".

While there has been an active debate among researchers about relationship between sustainable development and economic profitability, there are two schools of thoughts between the link of environmental activities and economic performance. The first one supports the positive relation between the environmental performance and the economic performance, while the other one supports the negative relation between the environmental performance and the economic performance.

Al-Tuwaijiri et. al. (2003) [6], stated, while performing their research on various industries of U.S. about the relations among Environmental performance, environmental disclosure and economic performance that good environmental performance of a firm is associated with its good economic performance.

While comparing the financial performance of organizations on adoption of emission reduction practices, Hart and Ahuja (1996) [7] found that good environmental practices enhanced the financial performance for high polluting organizations than the low polluting organizations. Since there are plenty of low cost improvements to be done, the closer an organization gets to zero pollution, it become expensive and while going further it increases the cost.

Suzana N. Russell1 & Harvey H. Millar (2014) [8], found a significant negative relationship between sustainability practices and business performance and no significant relationship between sustainability practices and competitive advantage. The results from the study imply that adopting sustainable manufacturing practices may not lead to better business performance and improved competitiveness.

As discussed by E. Claver et al. (2007) [9], the graph below shows that economic performance depends on the type of environmental management applied (end-of pipe technologies or pollution prevention technologies); the upper curve shows good environmental management which produces both cost efficiency and market gains, while the lower curve represents poor (inefficient) management.

While discussing the manufacturing cost, Rusinko (2007) [10], confirmed that pollution prevention practices seem to be consistently and robustly associated with decreasing manufacturing costs among U.S. commercial carpet manufacturers. This seems rational since pollution prevention practices reduce and/or recycle resources and waste products, which would tend to have an immediate and downward effect on manufacturing costs.

Very similar to E. Claver, H. R. Dixon-Fowler (2012) [11], stated that “In case of proactive environmental initiative or reactive environmental initiative, organizations reap similar positive financial returns. Further, organizations pursuing both strategies do not appear to benefit more than organizations taking either a proactive or reactive approach. Perhaps there is still enough ‘‘low-hanging’’ fruit available for end-of-pipe solutions to be still profitable, although this could change over time as they run out.”

Adding to the conflicting studies, the results from a study on 61 publicly-listed and 14000 certified textiles or textiles related organizations in the U.S. by Chris et.al. (2012) [12], suggest that adopting EMS or adopting an

environmentally friendly operation strategy is wise, which earns long-lasting positive impact on organizations' profit margins

Nham et. al. (2012) [13], studied the relationship between firm's environmental and financial performances in Vietnam's small and medium manufacturing firms. The results of this study indicated that better pollution control neither improves nor undermines financial success. While studying the high polluting SMEs, their result supports the hypothesis "the lower environmental performance a firm has, the higher its financial performance is".

While explaining about the Indian textile industry Baskaran et al. (2011) [14], state that the Indian textile industry is less efficient and less competitive because the skilled workforce is scarce (most of the task are performed manually), it needs adequate power supply and need to adopt best supply chain practices.

Kai Chang (2015) [15], found that corporate environmental performance showed an increasing trend from 2008 to 2012, which means that listed organizations pay much attention to environmental information disclosure and gradually strengthen their environmental propensity. Corporates with greater environmental performance in heavy pollution industries increase their financial burdens and increase higher operation risk, thereby environmental performance has a significantly negative effect on financial performance.

Cepolina (2012) [2], suggested that to overcome the damages of the industrial economy, the ecological approach should be adopted for transformation in the manufacturing efficiency.

Extending the understanding of sustainable development, a concept of Triple bottom line (TBL) was introduced by John Elkington (1994) [16], which explains that TBL is an accounting framework with three parts: social, environmental and financial, and are also called "three pillars of sustainability".

While there are two schools of thoughts between the link of environmental activities and economic performance, this study seeks to clarify the connection between environmental and social sustainable development and economic performance in the textile dyeing and printing industry which would further help in identifying the ways to achieve the sustainable development in textile dyeing and printing domain. Since most of the existing studies that connect the three elements of sustainability are conducted in a global as well as broader industrial context, there is a great potential to conduct research specific to the context of the dyeing and printing industry of India. Region of Jodhpur, in the state of Rajasthan has been chosen for that.

3. THEORETICAL FRAMEWORK

The framework used for sustainable business model for units is used from the TBL framework proposed by John Elkington (1994). The framework for sustainable model includes three elements, Environmental Performance, Financial Performance, and the Social Performance of the units. Further, the environmental Performance was broken down into Environmental indicators emerged from the literature review; similarly the financial indicators were also picked up from the literature review, that are depicted in the figures below.

Fig-1: Sustainable business model

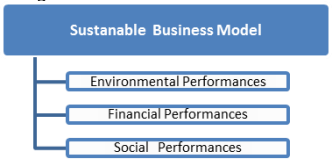


Fig-2: Environmental Performance

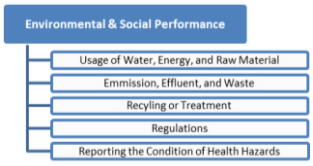
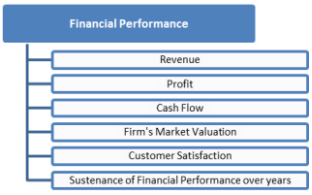


Fig-3: Financial Performance



Here Environmental performance means the measurable results of an organization's management of its environmental aspects. Financial Performance is a measure of how well a firm can use assets from its primary mode of business and generate revenues.

4. DATA COLLECTION

The initial sample for the study was picked randomly from the population of the companies that are registered in the Jodhpur industrial area that in the MSME category, and further shortlisted based on their enrolment to Central Effluent Treatment Plant (CETP). This set of companies included both, compliant, as well as non-compliant units, as per CETP norms. The final set of companies was based on the willingness of the owners to provide data/ information. The study was conducted on a final sample size of 30 units, from which, the data was collected through unstructured questionnaire interview schedule. The MSME units in the data sample were of varied sizes, in term of their production volume. The production volume is measured in meters/ day of fabric output, and it ranged from 1,000 to 40,000 meter/day.

This study is based on primary research. It uses the inductive approach, where the data is collected first and analysed statistically, to examine the relationship between the variables and finally produces the results. Raw data was collected on parameters that represent organization's environmental and financial performance, as described in next section.

5. VARIABLES

5.1 *Environmental Performance (EP)*

Usage of water: Water consumed by the dyeing and printing units is a very important variable for environmental sustainability; the firms should be very efficient with the consumption of water and minimize the wastage of it. Data for usage of water was provided in Kilo Lit per day by the units. To normalize it across the varied sizes of the firm, a variable Water Consumption in kilo liter per 1000 m. of Fabric Output was used.

With the increase in the size of the unit, or increase in daily production output, the water consumption per thousand m. of printing seems to be going down. This trend is intuitive since the economies of scale are expected to bring in some efficiency in water usage. To use it as a numerical variable in the quantitative analysis, the water consumption per 1000 m output was converted into a percentile value, and a score of 1 to 5 was assigned (Score of 1 for lowest performance and 5 for the best performance).

Raw material usage (chemicals and dye on fabric): How much quantities of chemicals and dye are used in printing and dyeing process is probably the most important variable from soil and water pollution, as well as environmental sustainability perspective. Data for this variable was provided in Kilograms per day by the units, and to normalize it across the varied sizes of the firm, a variable Consumption of Chemicals & Dye in kilograms per 1000 m. of Fabric Output was used.

With the increase in the size of the unit, the water consumption per thousand m. of printing seems to be going down, barring a few outliers of very large and very small firms. This trend is intuitive since the economies of scale are expected to bring in some efficiency in water usage. To use in quantitative analysis, it was converted into a percentile value, and a score 1 to 5 was assigned (Score of 1 for lowest performance and 5 for the best performance).

Labor intensity: The metric Number of labor per 1000 m. of output was measured, which reflects the labor intensity of a firm. The declining trend of this metric suggests that larger firms are less labor intensive, and probably have higher investment in equipment and machinery. This trend is quite intuitive. This variable was also converted into percentiles and given a score of 1 to 5 for use in quantitative analysis (Score of 1 for lowest performance and 5 for the best performance).

Figure 4: Usage of water

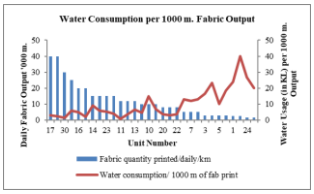


Figure 5: Raw material usage

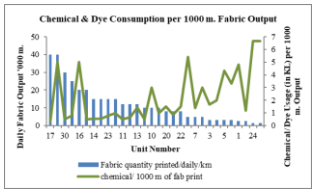
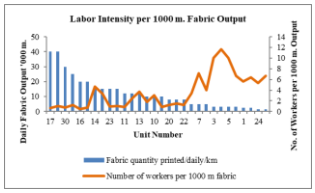


Figure 6: Labour intensity



Recycling or treatment: The dyeing and printing are connected to the CETP to send their affluent for processing, and some of them also have provision of doing pre-primary treatment before sending, to reduce the impurities in the effluent. Further, there is a meter installed at each unit that measures the volume of effluent was sent to CETP, with upper cap, but a few firms had bypassed that meter as well. A 5-point scale was structured to compare the treatment methods across the units and get to a score for each unit.

1. Not connected to CETP
2. No pre-primary treatment but effluent to CETP with meter by passed
3. No pre-primary treatment but effluent to CETP with meter on
4. Pre-primary treatment and effluent to CETP with meter bypassed
5. Pre-primary treatment and effluent to CETP with meter on

Regulations: Most of the units at the Basani area are doing job work. That is being responsible for printing only. While conducting the interviews, it was discovered that many of the owners do not have the awareness on the regulations is low. A 5-point scale was structured to score the firms on the awareness of, and adherence to the environmental regulations.

1. Not aware of regulations and hence not conducting
2. Aware of regulations but not conducting since their fabric is not getting exported
3. Aware of regulations and hence conducting 2-3 test in house (like rubbing fastness)
4. Aware of regulations but not conducting since agents will get it done
5. Aware of regulations and conducting the tests themselves

Health Hazard: The workers at Dyeing and printing units at Basani are facing many health hazards. Health and safety of the workers is not a major concern. While conducting the interviews various details of workers' health issues were discovered, which were converted in a five-point scale.

All the above indicators represent some aspect of the Environmental and Social performance of the unit. After scoring each unit on all the above variables, a composite Environmental Performance (EP) variable was created by averaging across all the above variables and used in the further quantitative analysis.

5.2 *Financial performance*

Financial performance of a unit (or firm) can be measured by multiple variables, like revenue, profit, cash flow etc. For the purpose of this study, Return On Assets (ROA), Gross Margin (GM), Operating Margin (OM) and Return On Equity (ROE) is used as a representative of Financial Performance.

Return on Assets (ROA): ROA is a financial ratio that shows the percentage of profit a company earns in relation to its overall resources. It is computed by dividing net income before depreciation interest and tax, by average total assets.

Gross Margin (GM): GM is company's total sales revenue minus its cost of goods sold (COGS), divided by total sales revenue, expressed as a percentage. The gross margin represents the percent of total sales revenue that the company retains after incurring the direct costs associated with producing the goods and services it sells.

Operating Margin (OM): OM measures how much profit a company makes on a dollar of sales, after paying for variable costs of production such as wages and raw materials, but before paying interest or tax. It is calculated by dividing a company's operating profit by its net sales.

Return on Equity (ROE): ROE measures how much profit is being created by the equity of firm. This can be calculated by dividing net income by shareholders' equity.

5.3 *Other Variables*

Since the objective of the study is to understand the relation between the Environmental Performance (EP) and the Financial Performance (FP), of the textile dyeing and printing firms/ units, it is important to identify the other

variables that could have impact on the Financial Performance of the unit. Below are the other variables that were observed.

$$FP = f(EP,\ Other\ Variables) \quad (1)$$

Education and awareness level of Management on Environmental best practices (EA): The level of education is expected to influence the awareness towards environmentally safe practices and hence higher environmental performance. The scoring is given as: 0. Illiterate, 1. Under high school, 2.High school, 3. Graduate, 4.Post Graduate, 5.Education with environmental studies

Scale of operations (FQ): Larger scale of operations is likely to impact the efficiency of processes and hence have an influence on environmental performance and in turn on financial performance, normalized for the number of hours of operation for a standard 12 hour shift, and then given a score based on percentile values.

Level of automation (NW): It is expected that use of machines would make the Dyeing and Printing process efficient and hence dye and water wastage will be lesser. Hence the level of automation and use of equipment is likely to influence the environmental performance of the unit and in turn the financial performance of the unit. Usually when the use of automation and machines increases, the number of labor deployed by the firm decreases, hence we have created a proxy variable, which is number of workers per 1000 meter fabric printed.

5.4 *Interaction Variables*

Interaction of NW and FQ: It is hypothesized that the higher level of automation (that is, low NW) when the scale of operation is large (that is, high FQ), together impact the Environmental Performance and might impact the other variables also.

Interaction of NW and EA: It is also hypothesized that the Managers with higher education levels and environmental awareness (that is, high EA) would lead to actual improvement in EP and other variables.

Interaction of FQ and EA: Similarly, it is also hypothesized that Managers with higher education levels and environmental awareness (that is, high EA) would be able to deliver improved EP and other variables, when the scale of operation is large (that is, high FQ).

To summarize, Table-1 list of all the variables considered in the quantitative analysis:

Table-1: List of All Variables

• EP = Environmental Performance of the units • Financial Performance Variables – ROA = Return on Assets – GM = Gross Margin of units – OM = Operating Margin – ROE = Return on Equity – ROCE = Return on Capital Employed	• Other Variables – NW = Number of workers per 1000 meter fabric, a proxy for Automation – FQ = Fabric quantity printed, a proxy for the Scale of Production – EA = Education and Awareness of the management/ owner • Interaction Variables – NW*FQ – NW* EA – FQ*EA

6. DATA ANALYSIS

To explore if there exists any relation between the variables that are hypothesized a regression model is being made. To ensure that there exists a nonlinear relation between variables, the squared terms are also added in the regression model.We run a multiple linear regression financial variables dependent one by one with the rest of variables.

Gross Margin

The generic regression equation for GM is:

$$GM_i = \beta_0 + \beta_1.\mathrm{NW_i} + \beta_2.\mathrm{NW_i^2} + \beta_3.\mathrm{FQ_i} + \beta_4.\mathrm{FQ_i^2} + \beta_5.\mathrm{EA_i} + \beta_6.\mathrm{EA_i^2} + \beta_7.EP_i + \beta_8.EP_i^2 + \beta_9.\mathrm{NW} * \mathrm{FQ} + \beta_{10}.\mathrm{FQ} * \mathrm{EA} + \beta_{11}.\mathrm{EA} * \mathrm{NW} + \varepsilon_i \quad (2)$$

Where $i = 1\ to\ n$

The final output of stepwise regression shows that only EP had a significant relation withGM. R^2 of the final equation was 0.464, and Adj-R^2 was 0.445. The equation is:

$$GM_i = 24.641 - 3.384.EP_i + \varepsilon_i \quad (3)$$

It is noticeable that NW, FQ and EA and interaction variables did not come out as significant variable. This could be because the entire variability of these variables is captured in Environmental Performance (EP). There is a possibility that these variables have a relation with Environmental Performance (EP), which in -turn impacts the GM. To test that, we separately analyzed relation of these variables with EP.

Environmental Performance

A stepwise multiple linear Regressions were run for EP with FQ, NW, EA and their quadratic terms. That would mean, GM is a function of EP, and EP in turn is a function of NW, FQ and EA. Hence to test it out we run another stepwise multiple regressions for EP. EP as a function of NW, FQ, EA, NW*FQ, NW*EA and EA*FQ.

The generic regression equation assumed is:

$$\mathrm{EP_i} = \beta_0 + \beta_1.\mathrm{NW_i} + \beta_2.\mathrm{NW_i^2} + \beta_3.\mathrm{FQ_i} + \beta_4.\mathrm{FQ_i^2} + \beta_5.\mathrm{EA_i} + \beta_6.\mathrm{EA_i^2} + \beta_7.NW_i.FQ_i + \beta_8.FQ_i.EA_i + \beta_9.EA_i.NW_i + \in_i \quad (4)$$

Where $i = 1\ to\ n$

R^2 of the final equation was 0.604, and Adj-R^2 was 0.575. The equation is:

$$EP_i = 1.621 + 0.0235.FQ_i + 0.37.EA_i + \in_i \quad (5)$$

The three interaction variables, $NW.FQ$, $FQ.EA$, and $EA.NW$ were not found to have any significant impact on Environmental Performance (EP), and hence were not included in the final equation. We observed that EP has good relation with EA and FQ. The relation of EP with NW was not significant, which could be possibly because of increase in wastage of water/ material with the increase in untrained workers or the low health input of most of the workers.

Operating Margin

Similar to the regression run for Gross Margin, rest of the financial variables will run the stepwise Regression. Here it is performed for Operating Margin (OM) as well. Keeping the Operating Margin as dependent variable, it will be with NW, EA, FQ, their squared terms and the interaction variables. The generic regression equation assumed is:

$$\mathrm{OM_i} = \beta_0 + \beta_1.\mathrm{NW_i} + \beta_2.\mathrm{NW_i^2} + \beta_3.\mathrm{FQ_i} + \beta_4.\mathrm{FQ_i^2} + \beta_5.\mathrm{EA_i} + \beta_6.\mathrm{EA_i^2} + \beta_7.\mathrm{EP_i} + \beta_8.\mathrm{EP_i^2} + \beta_9.\mathrm{NW} * \mathrm{FQ} + \beta_{10}.\mathrm{FQ} * \mathrm{EA} + \beta_{11}.\mathrm{EA} * \mathrm{NW} + \varepsilon_i \quad (6)$$

Where $i = 1\ to\ n$

R2 of the final equation was 0.320, and Adj-R2 was 0.295. The equation is:

$$\mathrm{OM_i} = 12.627 + -1.635.EP_i + \varepsilon_i \quad (7)$$ It is found that only EP has a significant relation with OM. It is observed that this is quite similar to the result of GM, where only EP was found significant and has a negative relation with EP, for higher values of EP the OM seems to be declining. This could be possibly because of the extra expense for better EP.

Return On Assets

Next is the Return On Assets vs. rest of the variables to perform stepwise regression analysis. The generic regression equation assumed is:

$$\mathrm{ROA_i} = \beta_0 + \beta_1.\mathrm{NW_i} + \beta_2.\mathrm{NW_i^2} + \beta_3.\mathrm{FQ_i} + \beta_4.\mathrm{FQ_i^2} + \beta_5.\mathrm{EA_i} + \beta_6.\mathrm{EA_i^2} + \beta_7.EP_i + \beta_8.EP_i^2 + \beta_9.\mathrm{NW} * \mathrm{FQ} + \beta_{10}.\mathrm{FQ} * \mathrm{EA} + \beta_{11}.\mathrm{EA} * \mathrm{NW} + \varepsilon_i \quad (8)$$

Where i = 1 to n

R2 of the final equation was 0.502, and Adj-R2 was 0.465. The equation is:

$$\mathrm{ROA_i} = 221.331 + -.541.\mathrm{NW_i^2} + .796.\mathrm{NW} * FQ_i + \varepsilon_i \quad (9)$$

As per the Regression result only NW^2 showed the relation with ROA and one interaction variable also came out significant. NW^2 has a negative coefficient which means when NW increases, NW^2 increases at the squared rates and the ROA decreases with it. NW is a variable that is a proxy for level of automation in the unit. It is the no of workers required /1000 meters. Hence higher value of NW represents lower value of automation. Hence the negative sign of NW^2 is quite intuitive. The interpretation is that when automation decreases ROA also decrease.

There is a high correlation between NW and FQ, that can explain the presence of interaction variable in the regression results. For the higher value of FQ the NW has a lower value due to the high automated firms produce high quantity of fabric.

$$\mathrm{ROA_i} = \beta_0 + \beta_2.\mathrm{NW_i^2} + \beta_9.\frac{\mathrm{TW}}{FQ} * \mathrm{FQ} + \varepsilon_i \quad (10)$$

Where TW= Total no. of workers employed in the firm

$$\mathrm{ROA_i} = \beta_0 + \beta_2.\mathrm{NW_i^2} + \beta_9.\mathrm{TW} + \varepsilon_i \quad (11)$$

ROE

Here we will be running the stepwise regression for ROE as dependent variable vs. rest of the variables. The generic regression equation for ROE, assumed is:

$$\mathrm{ROE_i} = \beta_0 + \beta_1.\mathrm{NW_i} + \beta_2.\mathrm{NW_i^2} + \beta_3.\mathrm{FQ_i} + \beta_4.\mathrm{FQ_i^2} + \beta_5.\mathrm{EA_i} + \beta_6.\mathrm{EA_i^2} + \beta_7.EP_i + \beta_8.EP_i^2 + \beta_9.\mathrm{NW} * \mathrm{FQ} + \beta_{10}.\mathrm{FQ} * \mathrm{EA} + \beta_{11}.\mathrm{EA} * \mathrm{NW} + \varepsilon_i \quad (12)$$

Where $i = 1\ to\ n$

R2 of the final equation was 0.271, and Adj-R2 was 0.243. The equation is:

$$\mathrm{ROE_i} = 63.968 + 11.751.\mathrm{NW_i} + \varepsilon_i \quad (13)$$

Regression details here show that only NW is significant. That could be possibly because of Debt, Equity ratio, which is much dispersed and varied. Few units have the loan amount much more than the Equity and some have Equity more than the debt, hence the returns observed are accordingly.

Table 2. Summary of all regression results

	Dependent Variable	Equation	Independent variables	R^2	Adjusted R^2
1	GM	$GM_i = 24.641 + -3.384.EP_i + \varepsilon_i$	-EP	0.464	0.445
2	EP	$EP_i = 1.621 + 0.0235.FQ_i + 0.37.EA_i + \varepsilon_i$	FQ & EA	0.604	0.575
3	OM	$\mathrm{OP_i} = 12.627 - 1.635.EP_i + \varepsilon_i$	-EP	0.320	0.295
4	ROA	$\mathrm{ROA_i} = 221.331 - 0.541.\mathrm{NW_i^2} + 0.796.\mathrm{NW} * FQ_i + \varepsilon_i$	NW^2 & NW*FQ	0.502	0.465
5	ROE	$\mathrm{ROE_i} = 63.968 + 11.751.\mathrm{NW_i} + \varepsilon_i$	NW	0.271	0.243

7. CONCLUSION

The result of this study show that Environmental Performance (EP) of a firm significantly impacts its Financial Performance measures for the MSME textile dyeing and printing units in the Jodhpur's Basni region. Units that are operating at a higher value on the Environmental Performance, seem to have a lower Gross Margin ratio (GM). Other variables included in the study did not seem to have any significant impact on the GM. A possible and intuitive

explanation is that the units incur higher operating costs if they have to keep up the Environmental Performance, which results in lower Gross Margin.

Further, the Environmental Performance of the units is significantly impacted by the Fabric Quantity produced (FQ), that is, the scale of production, and the Education & Awareness (EA) of the owners and managers. Larger scales of operation provide an opportunity for efficient usage of water and raw material, and there is lesser wastage, and hence higher is the Environmental Performance. Also, the higher awareness levels of owners or managers definitely is another important factor, as the educated owners/ managers do understand the importance of environmentally sustainable manufacturing and supply chain practices, and hence put in efforts towards that.

It is found that only EP has a significant relation with OM, which is negative. The firms spending more for a better environmental performance are on lower Operating margin, very similar to the results of Gross margin vs. Environmental performance. This could be possibly because of the extra expense for better EP.

Considering the results of similar regression analysis for ROA only squared term of Automation NW2 showed the relation with ROA and one interaction variable NW* FQ also came out significant. As explained earlier that higher value of NW represents lower value of automation. Hence the negative sign of NW2 is quite intuitive. The interpretation is that when automation decreases ROA also decrease. The graph between the NW and FQ showed high correlation, and this can explain the presence of interaction variable in the regression results. For the higher value of FQ the NW has a lower value which is probably due to the high automated firms produce high quantity of fabric.

The regression analysis of ROE showed that only NW is significant. That could be possibly because of Debt, Equity ratio, which is much dispersed and varied. Few units have the loan amount much more than the Equity and some have Equity more than the debt, hence the returns observed are accordingly.

Overall, this study provides critical understanding of the relation between financial and environmental performance of the textile dyeing and printing units, and hence could be an important input for the policy making and incentivizing the MSMEs in appropriate ways to get commitment for sustainable environmental practices.

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A Preliminary evaluation of the endemic and relict flora in Important Plant Area of Drenova-Nikolica, Albania

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Abstract

Important Plant Area of Drenova-Nikolica is located in southeast of Albania, in Korca region and covers 1890 ha. The study of the endemic and relicts species of this area is performed for the first time. In the present study, 57 endemic and relict species were recorded, belonging to 46 genera and 33 families. The most species-rich families are Salicaceae and Pinaceae by 7 and 5 species respectively, while the genera with the largest number of species are Salix and Populus. Studied flora comprises 15 endemic species, 5 endemic-relict and 37 relict plants. There are 2 Albanian endemic species, 13 Balkan endemic species, 1 Balkan subendemic species and 4 Apenine-Balkan subendemic species in the flora of investigated area. Out of studied relict species 39 are Tertiary relicts, Quaternary glacial relicts are 2 taxa (Arabis alpine L. and Gentiana verna L.) and only one is Quaternary interglacial relicts (Morina persica L). The results of the analysis of life forms show that the most abundant are Phanerophytes (54.39%) followed by Hemicryptophytes (36.84%). The spectrum of biological types shows prevalence of herbaceous perennials (42.11%), followed by tree species (31.58%). The most of the species are European-Asiatic and Balkan floristic elements (14.04%), followed sub-Mediterranean floristic elements (8.77%). The high number of endemics and relicts taxa shows that studied territory requires special attention for plant conservation.

Keywords: Important Plant Areas, serpentine endemics, biological type, relict taxa, floristic element, life forms.

1. INTRODUCTION

The Albanian flora is rich and diverse, more than 110 species per 1000 km^2 occurs within the Albanian territory (Mullaj et al., 2017), and a source of many new floristic and taxonomic finds. The present-day vegetation is of the sub-Mediterranean type with an altitudinal distribution of the plant communities (Fouache et al., 2010). During last 30 years more than 600 species are added on the list of Albanian flora leading the number to 4004 taxa occurring in the wild, 3,800 of which are native and 204 are introduced (Barina et al., 2018).

Important Plant Areas (IPAs) in Albania, include some of the most important natural values of the country from both biological and ecological point of view (Shuka et al., 2008). Drenova-Nikolica Important Plant Areas (IPA) is one of 45 protected areas in Albania (Radford et al. 2011). Still there is a lack of information and investigation of flora data for this specific area, thought is rich with rare species (relict and endemic species).

The site, with area from1890 ha, is located in Southeast of Albania in Korca region and belongs to the eastern subzone of Mediterranean Mountain Climate. It is one of the coldest regions of the Albanian territory (Shuka and Malo, 2010). The local climate characterized by annual rainfall averaging 800–1000 mm, temperatures varying from 25^o C in July to 2^{o}C in January (Fouache et al., 2010). The area of Drenova-Nikolica mostly composed by Serpentine (ophiolithic, ultramafic) rock, originated from Tertiary period (Shuka and Malo, 2010) and participates on Morava ophiolithic massif. The Morava ophiolithic massif is a small, elongated-shaped ophiolithte body trending from NNE to SSW, located east of the town of Korca, and the Morava mountain massif extends over 22 km from Dishnica in the north to south of the village of Nikolica (Bani et al., 2017). In this massif, a sedimentary sequence crops out in the east, near Boboshtica, deposited directly on highly serpentinized peridotites (Bani et al., 2017). Serpentine soils are characterized by peculiar chemical and physical properties, deeply influencing the life of plants that grows on

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them (Brooks, 1987; Coppia et al. 2014). The worldwide occurrence of serpentine-specific endemics highlights the global significance of this soil type in creating and preserving plant diversity (Coppia et al. 2014).
Serpentine rock belongs to the group of siliceous rocks characterized by calcium deficiency, high concentrations of iron, magnesium, nickel, cobalt and chromium, and reduced nutrients. Many interesting basiphilous-calcifuge plants flourish on serpentine owing to this factor and it is one of the most important reasons why the serpentine flora, differing from that occurring on limestone or other siliceous substrates (Jakovljević et al., 2011). Some plant species have evolved to grow only the ecological condition presented by the metalliferous environment like serpentines. Serpentine (ophiolithic) substrate covers large areas in the Balkans, more so than in any other part of Europe, and biodiversity in the area is high, with a great number of interesting local and regional endemics (Stevanović et al., 2003).
The habitats of Drenova – Nikolica Important Plant Area have relatively the small surfaces that are conditioned by relief factors and process of habitat fragmentation and structural-erosive relief is the present (Shuka and Malo, 2010). In its serpentine habitats are find two Albanian endemic species *Acantholimon albanicum* Schaëarz & F.K. Meyer and *Festucopsis serpentini* (C.E.Hubb.) Melderis., as well as *Campanula hawkinsiana* Hausskn. & Heldr., a relict and sub-endemic specie. An "endemic" species, however, grows naturally in a single geographical area, the size of which could be either narrow or relatively large, not all endemic species are rare, just as not all rare species must necessarily be endemic (Isik, 2011).
With high interest are also the relict species. According to Grandcolas et al. (2014), a relict species as potentially biased samples of taxonomic groups because all of their close relatives went extinct. Relicts are diverse, either old or young species that show or do not show ancestral states in terms of characters or spatial distribution. Therefore, they should not be used a priori to assert phenotypic/genotypic conservatism or biota permanence. Relicts inform us about extinction/diversification processes and can be ranked of very high value for conservation biology, being the only surviving representatives of large groups that are mainly extinct. (Grandcolas et al., 2014).
This paper present a preliminary study deals with the endemics and relicts plants and its aim is to present a list of biodiversity of this group of rare species that occur on the territory of Drenova – Nikolica Important Plant Area and assessing some species-related characters such as corological types, life forms and biological types. The results can be consider as a basis to promote more comprehensive floristic studies that require more detailed inventory and we hope that will contribute to specify criteria for the implementation of preservation policies of this Important Plant Area.

2. MATERIALS AND METHODS

The floristic survey was performed between 2017 and 2020. In the inventory of floristic composition, the route method was used. In this paper, as Albanian endemics are species that are occured only in Albania. The subendemics of Balkan, are termed taxa that are found with only one or two neighboring countries (Shuka et al., 2018) and Balkan endemics, are taxa with natural distributions only to the territory of the Balkan Peninsula (Anačkov et al., 2016; Tomović et al., 2014). The flora of Drenova - Nikolica area includes some important taxa ranging not only across the Balkan Peninsula, but also close to the neighboring geographic regions. They belong to the group of rare taxa of Albania that are not strictly Balkan endemics, but Apenine-Balkan endemics. These taxa also are included in the article and are considered as endemics.
Plant identification was performed mainly by Albanian Floras (Paparisto et al., 1988; Qosja et al., 1992, 1996; Vangjeli et al., 2000, Vangjeli, 2015, 2017, Demiri, 1983). The nomenclature used was according to the databases of the Plant List (theplantlist.org) and Checklist of vascular plants of Albania (Barina et al., 2018).
The life forms assigned based on classification by Raunkiaer (1934). The chorological types of plant taxa were defined according Assyov & Petrova (2012) and Asenov (2015), supplemented with the new chorological data published by Vangjeli (2017).
Biological types were given according to Flora of Albania (Paparisto et al., 1988; Qosja et al., 1992, 1996; Vangjeli et al., 2000; Vangjeli et al., 2003 and Berisha et al., 2012).The relics were determined according to Zahariev (2016) and Zahariev et al. (2018). The connection between the recorded plant species and the corresponding endemic elements is made according to some botanical publications (Vaso et al., 2017; Rakaj, 2009; Mahmutaj et al., 2014; Aneva et al., 2015; Petrova & Vladimirov, 2010; Tomović et al., 2014; Vuksanović et al., 2016).
The floristic list is given in table 1, 2 and 3 with symbols and abbreviations, according to the following legend: *Biological types*: b-p - biennial- perennial; p –perennial; sh- shrubs; sh-t shrub or tree; t-trees. *Life forms*: H- hemicryptophyte; G- geophyte; Ch- chamaephyte; Ph- phanerophyte. *Chorological types*: Ap- Apennine, As- Asian, Arc-Alp – Arctic- Alpine, Bal- Balkan, Carp- Carpathian, CAs – Central Asian, E-East, Eur- European, Med-

Mediterranean, Ot- Oriental-Turanian, Pont- Pontic, subBoreal– Sub Boreal, SubMed- Sub-Mediterranean, SEEur - South East European, Sib – Siberian, S – South. Endemic plants: Bal - Balkan endemic; Alb-end – Albanian endemic; SubE– Sub-endemic of Balkan; SEnd Bal & Ape - Apenine-Balkan sub endemics. *Relicts*: ter- Tertiary relict; qgr- Quaternary glacial relict; qir - Quaternary interglacial relicts.

3. RESULTS AND DISCUSSION

Important Plant Areas (IPAs) are the most important places in the world for wild plant diversity, because they have the richest flora of any other part of a country. They contain locally endemic species found only within one country. However, the data on the distribution and status of plants, especially of the group of rare species, i.e. the group of relict and endemic species of vascular plant, are insufficient or absent. An inventory of endemic and relict plants on the territory of Drenova-Nikolica IPA is made for the first time. Despite its outstanding species richness and evolutionary importance, there is no comprehensive work available summarizing the diversity and distribution of endemic vascular flora in Drenova Nikolica area. In this study, we have prepared a partial and preliminary list of the group of relict and endemic species of vascular plants, based on about 500 plant taxa recorded so far. The results show significant diversity of relic and endemic plant.

The floristic investigation showed that flora of investigated territory included 57 endemic and relict species belong to 46 genera and 33 families (Tab. 1, 2, 3). The most of the families and genera are presented with smaller number of lower taxa: from 1 to 4. The largest families in terms of a number of species were Salicaceae and Pinaceae by 7 and 5 species respectively (Fig. 1). Betulaceae and Sapindaceae families are represented with 3 species, while 10 families are represented with 2 species and 19 other families are represented only with one species. In addition to these, two families, including Pinaceae and Betulaceae with 4 and 3 genera respectively, are the richest families in terms of genera (Fig. 2), whereas 8 other families are represented with 2 genera and 24 families with only a single genus.

The genera with the largest number of species were *Salix* with 4 species, followed by *Populus* with 3 species, while *Abies*, *Acer*, *Campanula*, *Gentiana*, *Juniperus* and *Pinus* are represented with 2 species each (Fig. 3), and 38 others genera are presented only with one species.

Table 1. The relict plant species to the flora in Drenova – Nikolica IPA

Nr.	Species name	Family	Life forms	Chorological types	Biological type	Relict plants
1.	*Abies alba* Mill.	*Pinaceae*	Ph	Boreal	t	ter
2.	*Acer campestre* L.	Sapindaceae	Ph	Eur-Ot	t	ter
3.	*Acer pseudoplatanus* L.	Sapindaceae	Ph	Eur-Med	t	ter
4.	*Arabis alpina* L.	Brassicaceae	H	Arc-Alp	p	qgr
5.	*Betula pendula* Roth	Betulaceae	Ph	Eur-Sib	t	ter
6.	*Carpinus betulus* L.	Betulaceae	Ph	Eur-subMed	p	ter
7.	*Castanea sativa* Mill.	Fagaceae	Ph	Med	t	ter
8.	*Clematis vitalba* L.	Ranunculaceae	Ch	Eur	p	ter
9.	*Corylus avellana* L.	Betulaceae	Ph	Med-CAs	sh-t	ter
10.	*Cotinus coggygria* Scop. [*Rhus cotinus* L.]	Anacardiaceae	Ph	Med-As	sh	ter
11.	*Daphne mezereum* L.	Thymelaeaceae	Ph	Eur-Sib	sh	ter
12.	*Fraxinus ornus* L.	Oleaceae	Ph	subMed	t	ter
13.	*Gentiana lutea* L.	Gentianaceae	H	Eur	p	ter
14.	*Gentiana verna* L	Gentianaceae	H	Eur-As	p	qgr
15.	*Hedera helix* L.	Araliaceae	Ch	Eur-As	sh	ter
16.	*Ilex aquifolium* L.	Aquifoliaceae	Ph	subMed	p	ter
17.	*Juglans regia* L.	Juglandaceae	Ph	Eur-As/Paleo	t	ter
18.	*Juniperus communis* L.	Cupressaceae	Ph	subBoreal	sh	ter

19.	*Juniperus oxycedrus* L.	Cupressaceae	Ph	Med	sh	ter
20.	*Lonicera etrusca* Santi	Caprifoliaceae	Ph	Med	sh	ter
21.	*Morina persica* L.	Caprifoliaceae	H	Med-Ot	p	qir
22.	*Picea abies* (L.) H.Karst.	Pinaceae	Ph	Boreal	t	ter
23.	*Pinus nigra* J.FArnold	Pinaceae	Ph	subMed	t	ter
24.	*Pinus sylvestris* L.	Pinaceae	Ph	subBoreal	t	ter
25.	*Populus alba* L.	Salicaceae	Ph	Eur-As	t	ter
26.	*Populus tremula* L.	Salicaceae	Ph	subBoreal	t	ter
27.	*Pyracantha coccinea* M.Roem.	Rosaceae	Ph	Pont-Med	sh	ter
28.	*Rumex acetosa* L.	Polygonaceae	H	Boreal	p	ter
29.	*Salix alba* L.	Salicaceae	Ph	Eur-As	t	ter
30.	*Salix caprea* L.	Salicaceae	Ph	subBoreal	t	ter
31.	*Salix cinerea* L.	Salicaceae	Ph	Eur-As	t	ter
32.	*Salix purpurea* L.	Salicaceae	Ph	Eur-Med-Cas	sh	ter
33.	*Sanicula europaea* L.	Apiaceae	H	Eur-Sib	p	ter
34.	*Sorbus aria* (L.) Crantz	Rosaceae	Ph	Eur	sh-t	ter
35.	*Syringa vulgaris* L.	Oleaceae	Ph	Carp-Bal	sh	ter
36.	*Viburnum lantana* L.	Adoxaceae	Ph	Euro-Med	sh	ter
37.	*Viscum album* L.	Santalaceae	Ch	Eur-As	sh	ter

Table 2. The endemic-relict plant species to the flora in Drenova – Nikolica IPA

Nr.	Species name	Family	Life forms	Chorological types	Biological type	Relict plants	Endemic
1.	*Abies borisii-regis* Mattf. Notizbl.	Pinaceae	Ph	Bal	t	ter	Bal-end
2.	*Aesculus hippocastanum* L.	Sapindaceae	Ph	Bal	t	ter	Bal-end
3.	*Campanula hawkinsiana* Hausskn. & Heldr.	Campanulaceae	H	Bal	p	ter	Sub ende
4.	*Halacsya sendtneri* (Boiss.) Dorfl.	Boraginaceae	H	Bal	p	ter	Bal-end
5.	*Pinus nigra* J.FArnold	Pinaceae	Ph	subMed	t	ter	SEnd Bal &Ape

Table 3. The endemic plant species to the flora in Drenova – Nikolica IPA

Nr.	Species	Family	Life forms	Chorological types	Biological type	Endemic
	Acantholimon albanicum Schaëarz & F.K. Meyer	Plumbaginaceae	Ch	Bal	sh	Alb-end
	Campanula foliosa Ten.	Campanulaceae	H	SEEur	p	Bal-end
	Crocus veluchensis Herb.	Iridaceae	G	Bal	p	Bal-end
	Doronicum columnae Ten.	Asteraceae	H	Pont-Med	p	SEnd Bal&Ape
	Festucopsis serpentini (C.E.Hubb.) Melderis	Poaceae	H	Bal	p	Alb-end
	Heracleum sphondylium L.	Apiaceae	H	Eur	b-p	Bal-end
	Hypericum barbatum Jacq.	Hypericaceae	H	subMed	p	SEnd Bal & Ap
	Leontodon crispus Vill.	Asteraceae	H	Pont-Med	p	Bal-end

	Myosotis alpestris F.W. Schmidt	Boraginaceae	H	Eur-Med	p	Bal-end
	Pedicularis hoermanniana K.Malý	Orobanchaceae	H	Bal-Alp	p	Bal-end
	Pinguicula hirtiflora Ten.	Lentibulariaceae	H	Bal-Alp	p	SEnd Bal&Ape
	Sedum serpentini Janchen	Crassulaceae	H	subMed	p	Bal-end
	Stachys recta L.	Lamiaceae	H	Eur-Med	p	Bal-end
	Trifolium medium L	Fabaceae	H	Eur-As	p	Bal-end
	Viola orphanidis Boiss.	Violaceae	H	Bal	p	Bal-end

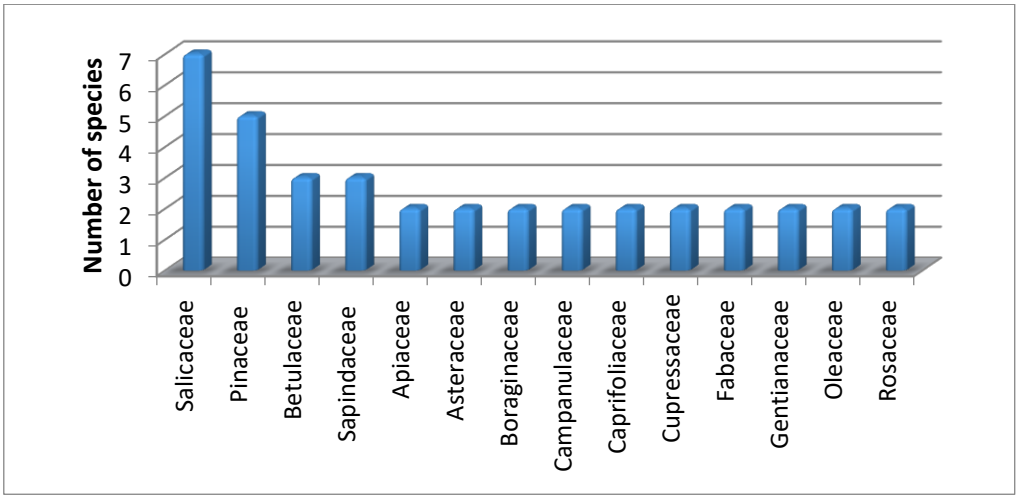

Figure 1. The richest families in terms of number of taxa(Only families represented by 2 or more species are included)

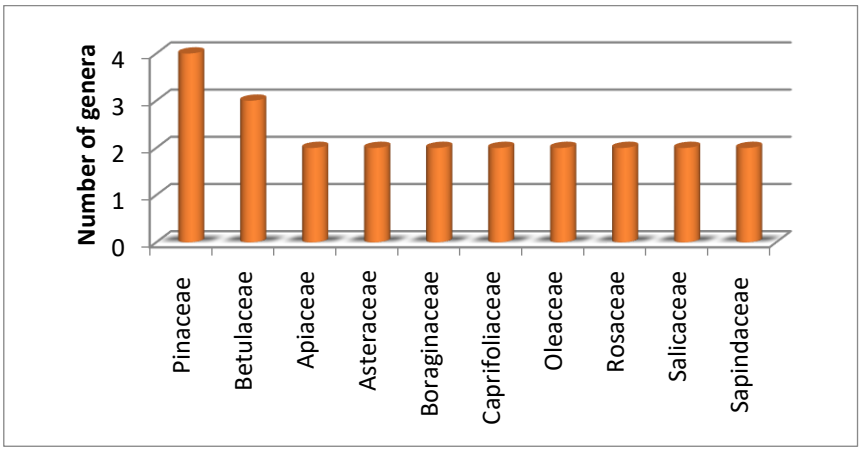

Figure 2. The richest families in terms of number of genera (Only families represented by 2 or more species are included)

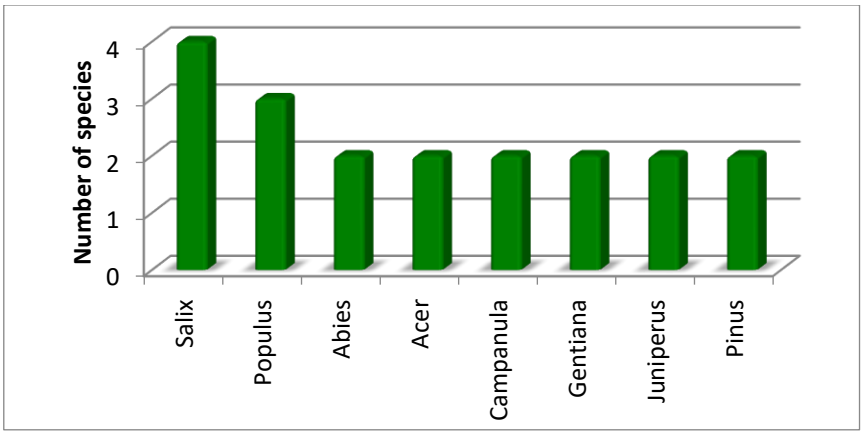

Figure 3. The richest genera in terms of number of species (Only families represented by 2 or more species are included)

The endemic plants are among the plant groups important for understanding the florogenetic tendencies and phytogeographic characteristics of each region (Ranđelović et al., 2008). Endemism is one of the most important concepts in biogeography and the number of endemic species in a biogeographic region is a first step for assessing the conservation situation of that region. The areas with high number of endemic species are of high priority to preserve biodiversity. Therefore, documenting endemic richness in an area is important not only for setting their conservation priorities, but also for understanding the evolutionary and ecological processes that have shaped the area.

The relief of studied area, together with mountainous terrain and soils from serpentine rocks has created the conditions for the growth, isolation and protection of a large number of ancient endemic and relic species. As part of the rare species, 15 endemic taxa (26.32% of all studied species), 37 species of relict origin (64.91%) and, another 5 species (8.77%) are endemic-relics within the group of the Tertiary relicts were identified (*Aesculus hippocastanum* L., *Abies borisii-regis* Mattf. Notizbl., *Campanula hawkinsiana* Hausskn. & Heldr., *Halacsya sendtneri* (Boiss.) Dorfl., and *Pinus nigra* J.F. Arnold) The endemic plant group of this area comprises 20 endemic species (35.09% of all studied species) by different categories: 13 species are Balkan endemics, 2 are Albanian endemics (*Acantholimon albanicum* Schaëarz & F.K. Meyer and *Festucopsis serpentini* (C.E.Hubb.) Melderis), one is Balkan sub-endemic within the group of the Tertiary relicts (*Campanula hawkinsiana* Hausskn. & Heldr.), and 4 species are Apenine-Balkan sub endemics.

The list of identified taxes mainly includes endemics that found in the Balkan territory. The occurrence of common sub-endemic taxa in the Balkans and Apennine Peninsula like *Pinus nigra* Arnold, *Hypericum barbatum* Jacq., *Pinguicula hirtiflora* Ten., and *Doronicum columnae* Ten., point to ancient amphiadriatic floristic link (Rakaj, 2009). Presence of the serpentine substrate is a particularly important factor in the formation of highly diverse flora in the study area.

The location of some endemic species such as *Acantholimon albanicum* Schaëarz & F.K. Meyer, *Festucopsis serpentini* (C.E.Hubb.) Melderis, *Campanula hawkinsiana* Hausskn. & Heldr., *Sedum serpentini* Janchen, *Pinguicula hirtiflora* Ten., and *Halacsya sendtneri* (Boiss.) Dorfl., is serpentines complex of Skërka, along the beginning of the road from Boboshtica to Dardha village. The serpentine rocks, such as in Skërka area, are the habitat to a specialized flora not only for the endemic species mentioned but also for other important species as *Euphorbia spinosa* L., *Onosma echioides* L., *Alyssum murale* Waldst. & Kit., *Alyssum montanum* L., *Rumex scutatus* L., *Plantago subulata* L., *Artemisia alba* Turra, etc., which are not part of this article. Special attention deserves obligate serpentinophytes, especially these that are considered as locally endemic serpentinophytes, which is rather isolated, indicating long evolution times. *Halacsya sendtneri* and *Campanula hawkinsiana* are considered strictly serpentinophytic palaeoendemics. The *C. hawkinsiana* shares a distribution area between Greece and Albania. It is found from the Pindus Mts in Greece, in Polican (Gjirokastër, S Albania), Gjergjevicë, near Panarit village and Devoll valley: near the bridge of Lozhan village (Korcë, SE Albania), Nemërckë (Përmet, S Albania) and Shebenik (Librazhd, EC Albania) (Meco et al., 2017; Mahmutaj et al., 2015; Shuka and Jahollari, 2007). Drenova-Nikolica site is a new locality of its natural distribution in Albania.

The high numbers of endemics recorded in area, indicate the importance of serpentine habitats as centers for floristic differentiation and speciation (Stevanović et al., 2003; Shuka and Hallaci, 2010).
The paleo-environmental conditions in Drenova-Nikolica IPA have allowed the existence of 42 relict taxa. They are 73.68% % of the total number of studied species. Tertiary relicts are 39 taxa or 68.42% of the total number of studied species, out of them 5 (11.90% of relict plant) are endemic-relict. *Arabis alpine* L. and *Gentiana verna* L. are Quaternary glacial relicts and, only one is Quaternary interglacial relicts *(Morina persica* L). The *Halacsya sendtneri* has its origin from the tertiary period and so is considered as paleoendemics or relicts of glacial age (Shuka and Hallaci, 2010). The tertiary flora, contributes to regarding Dronova-Nikoloca IPA as one of the Tertiary refuges in Albania.
Relict serpentinophytes are characterized with a filogenetic isolation, because of the lack of close family species and because they are situated geographically far away from species of the same genre (Stevanović et al., 2003; Shuka and Hallaci, 2010). Presence of relict species shows how old and preserved the investigated flora is. They should also be considered from the point of view of conservation biology, as relicts usually suffer more severely from human activities than do non-relict populations.
Table 4 shows classification of vegetation composition based on biological types. The floristic analysis to biological types show that the largest is the group of perennial herbaceous plants with 24 species (42.11% of the total number of species), followed by 18 tree species (31.58%), 12 shrubs species (21.05%), 2 shrub/trees species (3.51%), and only one biennial- perennial (1.75%). The predominance of perennial herbaceous plants explained by the greater presence of endemic and relict species in serpentine habitats and by the wide variety of communities and habitats on the territory of Drenova-Nikolica IPA. Tree species are represented in relatively large numbers due to some preserved forest habitats on the area.
Perennial herbaceous plants represent the main biological types of endemic plants (15 species or 75.0% of the total number of endemics of 20 species). Relatively large is the number of the trees, 3 species (15.0%). With a lower number of species, only by one, are represented shrubs and the transitional forms between the basic biological types (biennial- perennial). Relicts are mainly forest species (18 species; 42.86% of the total number of relics of 42 species). Next are the groups of annual herbaceous plants and shrubs, 11 species (26.19%) each of them. With a lower number, 2 species, is represented the transitional form shrub-trees (4.76%).

Table 2. Classification of plant species based on the growth form (biological type)

Growth form	Species number	Rate (%)
Biennial - perennial (b-p)	1	1.75
Perennial (p)	24	42.11
Shrubs (sh)	12	21.05
Shrub or tree (sh-t)	2	3.51
Tree (t)	18	31.58
Total	57	100

The study of plant life forms is important because it provides the basic structural components of vegetation stands; it is indicative of habitat conditions and is widely used as a criterion for describing it (Milani et al., 2017). The plant life form is a genetic attribute that reflect the degree of adaptation of plant to specific climatic conditions and provide useful information on the habitat climate. The range of life forms found in the flora of a certain area indicates not only how adapted these plants are to climatic conditions, but also provides an indication of the possible stressors and their impacts on the studied ecosystem (Nikolić et al., 2011).

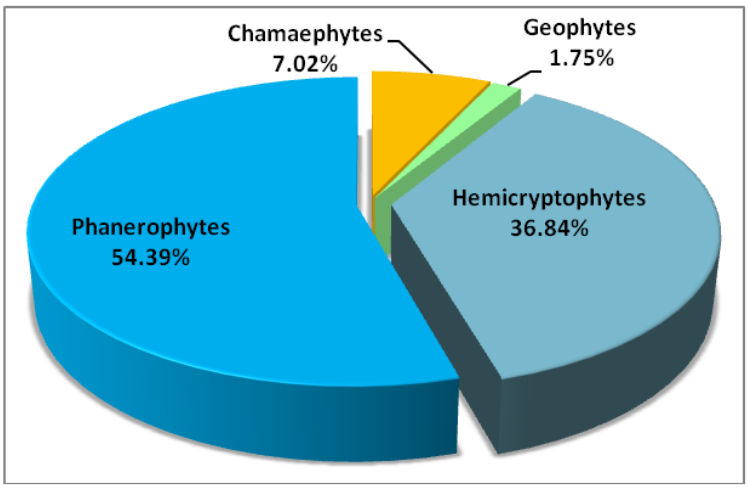

Figure. 4. Life form spectrum of studied flora of Drenova – Nikolica IPA

Phanerophytes are the most dominant life form with 31 species (54.39%) among the endemic and relict plants species, followed by hemicryptophytes, 21 species (36.84%) (Fig. 4). This can explained by the study area's location in the temperate climatic zone and significant contribution of forest habitats. Another reason for the high phanerophytes is that the study has been conducted mainly at the low altitude of the study area (not in subalpine ecosystems) which prevents extreme cold winters. The occurrence of a high proportion of hemicryptophytes in Ramsar is typical of a temperate climate. The remaining life forms include a lower number of species, 4 species (7.02%) are chamaephytes and one is geophytes (1.75%).

The studied flora of the investigated territory is a combination of 21 different phytogeographical elements (Figure 5). Distribution of chorological types of different origin confirms the diversity of conditions in the studied territory. Chorological analysis revealed that Europen-Asian and Balkan (8 species, 14.04% each of them), Sub-Mediterranean (5 species, 8.77%, and the European, European-Mediterranean and subBoreal (4 specie, 7.02% each of them) chorotypes constitute the main bulk (56.15%) of the total flora of the studied area.

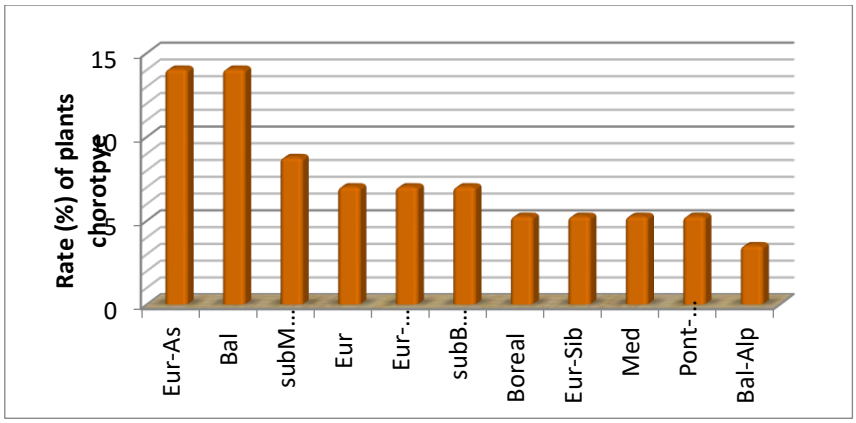

Fig. 5. Rate (%) of main chorotypes of plants studied

The following groups of chorological types have equal representation by 3 species each (5.26%): Boreal, European-Siberian, Mediterranean and Pontic- Mediterranean (Fig.5). With 2 species (3.51%) represented Balkan-Alpin element, and 10 remaining chorological types are presented by one species (1.75%)

The grouping of South origin chorological types (Balkan, Sub-Balkan, Mediterranean, Oriental-Turanian, Pontic, etc.) amounts to 49.14% of the total elements. The grouping of North origin elements (European, Europe-Asiatic, Boreale, Siberian, etc.) has 50.86%. These values indicate that Drenova-Nikolica IPA lies on the border of the Mediterranean and Middle Central European regions and has equal northern and southern influence.

4. CONCLUSIONS

Drenova-Nikolica IPA site is one of the Important Plant Areas of the Albania. The study showed that there are 57 endemic and relict from 46 genera and 33 families. From the floristic point of view, this area is particularly important due to the outstanding diversity of its endemic and relict flora. Endemism of studied IPA ranges from local (Albanian) to Balkan and Apenine-Balkan. Among these plants most are the phanerophytes, perennial herbaceous plants and the species of European-Asian, Balkan and Sub-Mediterranean origin.

The local endemics *Acantholimon albanicum*, *Festucopsis serpentini*, the subendemic *Campanula hawkinsina* and some Balkan endemics such as *Halacsya sendtneri*, *Sedum serpentini* etc, was recorded on the serpentine area. The high number of endemics indicates the importance of serpentine habitats as a centre for floristic differentiation. Serpentine areas also appear to be important refuge for many endemic and relict species.

The results of this work will support the protection activities of the relict and endemic flora as well as will provide support for conservation the high diversity of ecosystems. The obtained data can be used as a basis for comparison with data of the flora of different IPAs in other floristic region in Albania. The preliminary results will open avenues for further research on this Important Plant Area.

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