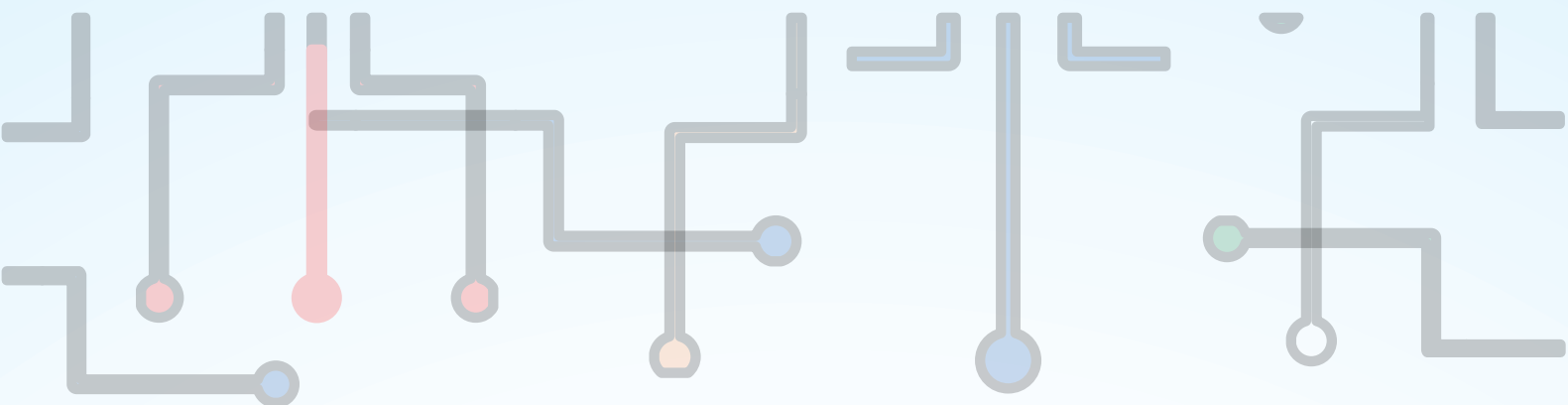




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POST COVID-19 URBANISM: ESTABLISHING MODULAR DIMENSIONS WHEN DESIGNING NEW URBAN SPACES

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Abstract. *Because of the global pandemic caused by the COVID-19 virus, many countries around the world are facing the negative consequences of this virus on the health of people. Apart from healthcare, the negative consequences also affect the overall economic and social aspects of the life in the cities. Proposed measures to prevent the spread of the virus include restricting the movement of people in the cities, personal protection and social and physical distancing between people. All this leads to a change in the way cities function as urban centers, the use of buildings and public space. Urbanism and architecture, at the time of the corona virus, have the primary task of organizing the functioning of cities as well as the buildings and spaces in them. This is a challenge for future city planning in order to provide a quality and safe way of life for the residents of the city and the emergence of a new "post COVID-19" urbanism. This paper will present possible solutions for the transformation of urban architectural conditions when designing a given space, specifically through a project for a new modular tourist camp. The solution of the project before the onset of the pandemic will be subject to analysis from the aspect of new dimensioning caused by the recommendations for protection of people. The aim of this paper is to offer modular models in the design of tourist camps by re-dimensioning the micro-urban elements of the camp in the existing dimensioned space. The expected results of this paper will provide an opportunity to apply new modular dimensions of open spaces in order to enable the health safety of citizens and enable the proper functioning of urban spaces.*

Keywords: COVID-19, Module, Urbanism

1. INTRODUCTION

On 11th Mart 2020, WHO characterizes COVID-19 as a pandemic (WHO, 2020). Countries around the world are facing the negative effects of this virus on the health of people of all ages, from all over the world, from the smallest village to the largest metropolis. Apart from health, the negative consequences also affect the overall economic and social aspects of the states, and thus the life in the cities.

Proposed measures to prevent the spread of the virus include restricting people's movement in cities, personal protection, and social and physical distancing between people (MH-RNM, 2020). All this leads to a change in the way cities function as urban centers, the use of buildings and public space. If at the moment, medical institutions around the world are working to find a vaccine against the virus, we urban planners need to find a module that will be functional and applicable to the transformation of existing and new spaces in the new post-covid19 urbanism.

The shore of Lake Ohrid, with its natural characteristics has very favorable conditions for the development of tourist facilities. Apart from the numerous hotels and resorts along the shores of the lake from the Ohrid and Struga side, from the beginning of the 60s until the 90s, several auto camps were developed: "Autocamp Sv. Naum", "Gradishte", "Eleshec", "Andon Dukov", "Daljan", "AS", "Livadishte" and "Radozda". Since the 1990s, with the beginning of the system's transition, all camps have experienced setbacks and closures. The ownership structure has also changed, but still no development is achieved in that part of tourism. In recent years, there have been initiatives to open small campsites, but they are in a small space and without urban architectural standards.

As the interests of foreign tourists are in the direction of camping, the task is set, to improve the old campsites and build new ones, which will be able to meet all tourist norms.

In this paper, based on the research, a model of a tourist camp is presented that can be adjusted according to the size and shape of the terrain along the entire shore of Lake Ohrid, even on both sides of the lake - the Republic of North Macedonia and the Republic of Albania.

2. CONCEPT OF MODULAR MOBILE TOURIST CAMP

The model of the mobile tourist camp is planned to be used in the newly envisaged urban blocks planned for tourism in accordance with the urbanistic plans in RNM. The models are modularly designed with a sized module 6.30 / 6.30 m. for individual residential buildings, and a yard with the same module 6.30 / 6.30. For the module, when designing the model of the mobile tourist camp, is used the dimension of a ship's container with dimensions of 6.06 / 2.44 m. The difference of 24 cm. on the module from 6.06 to 6.30 is used for manipulation when placing the container. In the module from 6.30 / 6.30, 2 containers will be placed - $2 \times 2.44 = 4.88$, the difference from 1.42 to 6.30 is used for external porch for both containers. In this module, another types of accommodation can be provided - a bungalow of solid construction, a trailer or a tent. The other module 6.30 / 6.30 is provided for the same tourist mobile unit and will be used as a yard (Fig.1)

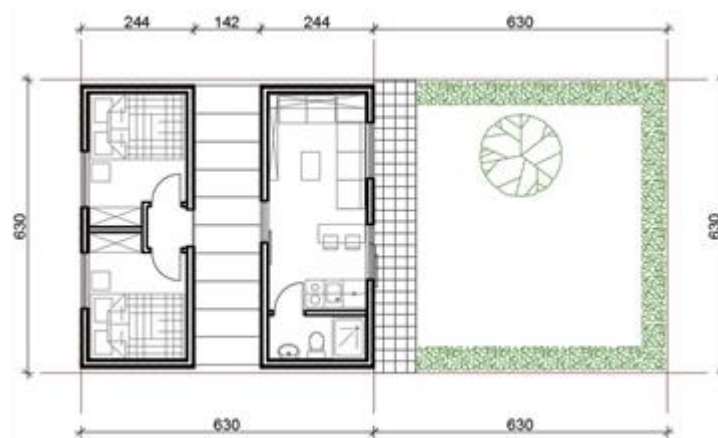


Figure 1 Basic layout of one mobile unit

The individual housing model consists of 2 urban segments. Urban segment 1 is a connecting model in which public space and facilities of the class of purposes B1 - small commercial and business units and public institutions are designed. Urban segment 2 is a model of individual housing of purpose class A1 - family housing in residential houses (Fig.2, 3).

Selected modules:

630/630 cm - object and 630/630 cm - yard

270/630 x N - pedestrian path

900 (630 + 270) / 900 (270 + 630) x N - public space

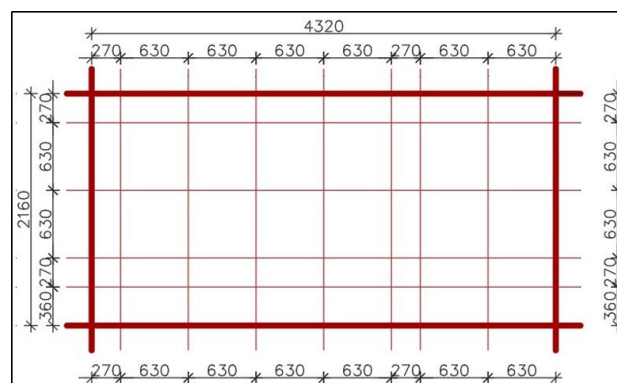


Figure 2 Urban segment 1

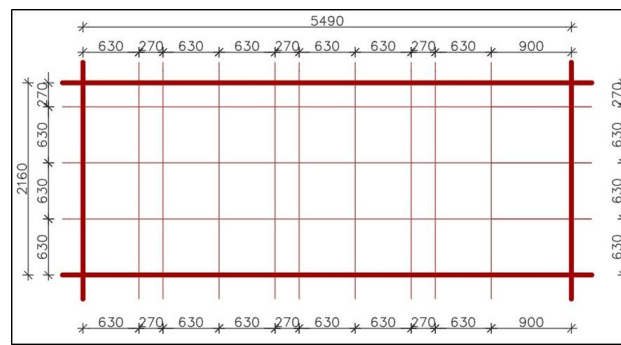


Figure 3 Urban segment 2

The model of a mobile tourist settlement - type of temporary individual housing consists of 6 modules, interconnected. When schematically displacing and setting the two main modules, 3 modules are obtained in a ratio of 2: 1: 2 which are placed horizontally. The other 3 modules are connected and obtained from the main modules by their redistribution and rotation of their functions (Fig.4).

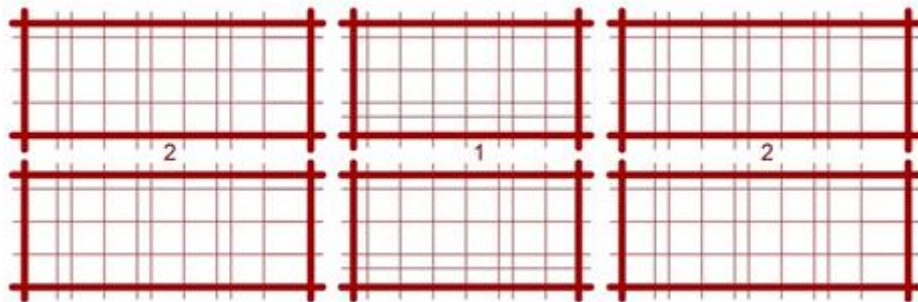


Figure 4 Schematically displacing of modules

Before designing the project, several conditions were set:

1. The yard should function as an outdoor room, 2. Two adjacent buildings should not be connected to each other, 3. The yard should be connected to the living room, 4. Protective public greenery, 5. Pedestrian access to each building, 6. Designing a street with a special traffic regime, 7. Common parking

Selected modules (Fig.5):

630 / 630 cm – **object**, 630 / 630 cm – **yard**, 270 / 630 x N – pedestrian path

900 (630 + 270) / 900 (270 + 630) x N – **public space**

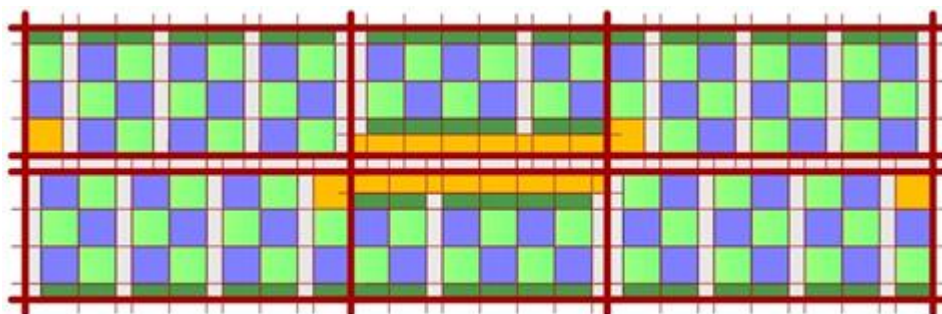


Figure 5 Schematically displacing of modules

The common area where the public and commercial functions are located is envisaged as a gravitational point for the tourists from the settlement and equipped with urban equipment, greenery and water surfaces, so that the tourists will use that space during the day and in the evening on vacation. The shared parking is divided into two parts located on both sides of the camp, and the space along the camp is intended for a service street for the needs of the camp. This solution also offers the ability to multiply the camp modules on both sides (Fig.6):



Figure 6 Project solution

3. NEW MODULAR SOLUTIONS FOR TOURIST CAMP BY RESPECTING COVID-19 VIRUS PROTECTION MEASURES

The concept of the modular solution of the tourist camp remains the same:

- The basic accommodation module - 630/630 cm
- Using your own yard - 630/630 cm
- Module distribution scheme 2: 1: 2
- The dimensions of the camp remain the same - 232/45 m.

The new modular solutions emerge from the prescribed measures to protect against the virus from a minimum distance of 2 m between people, using: pedestrian paths, public areas and parking lots (Fig. 7-10).

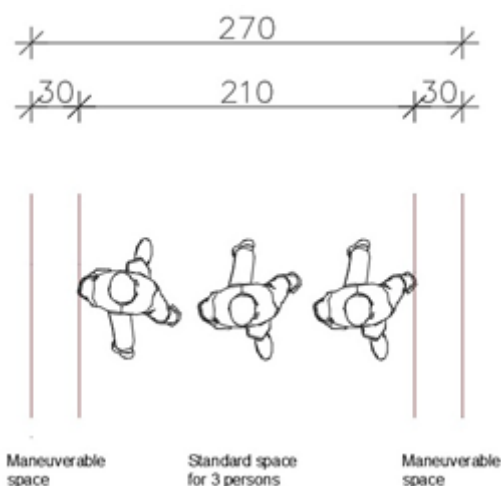


Figure 7 Old dimensions of pedestrian path (before Covid-19)¹

¹ In this paper, all the dimensions of the urban elements shown are in accordance with Neufert's guidelines

According to prof. Ashraf M. Salama, “Social distancing measures are a vital part of mitigating pandemics. They complement other measures in decreasing the prospect of the spread of disease. The current body of knowledge points out that social distancing is not a new measure to mitigate the spread but has been introduced and practiced during the past several decades” (Salama AM, 2020). At this time, social distancing measures were introduced by the World Health Organization in response to the initially gradual and then exponentially global spread of coronavirus.

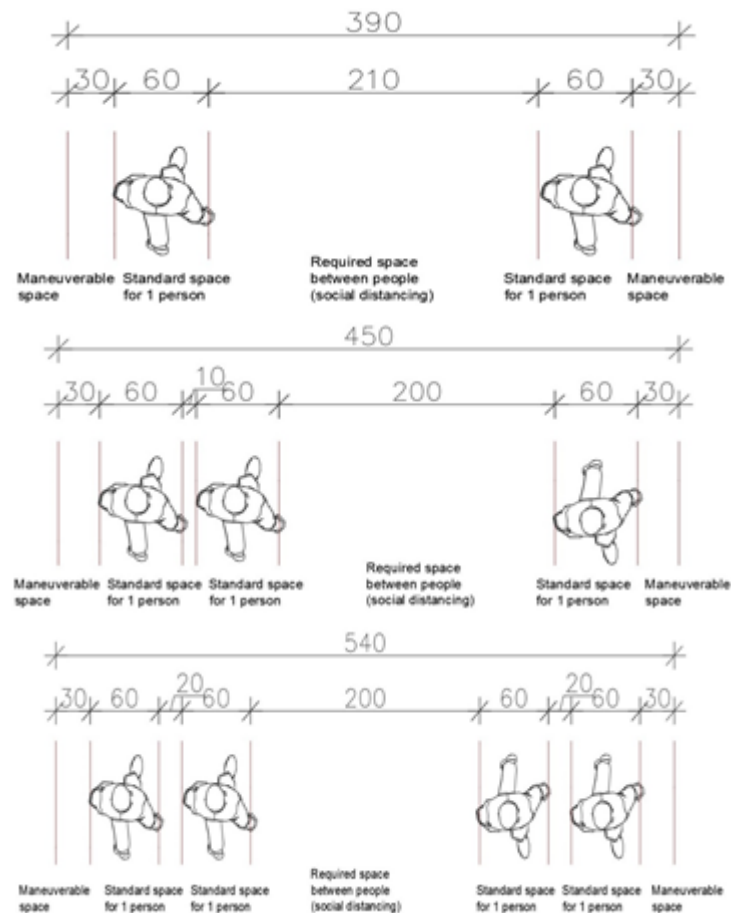


Figure 8,9,10 New dimensions of pedestrian paths (during COVID-19)

In the previous modular solution for urban segment 1, the dimensions of the pedestrian modules are 270 cm wide, while in the new solution, they are 450 cm wide. The urban segment 1, in the previous solution contains 12 accommodation and yard modules, while in the new solution, 10 modules can be accommodated on the same area because larger dimensions are allocated for the public space.

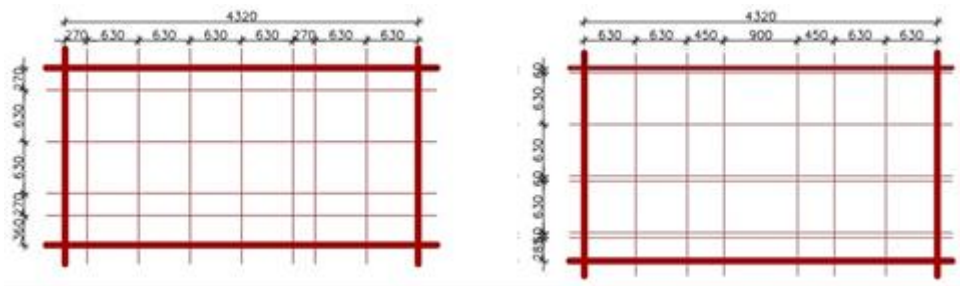


Figure 11 Old dimensions of modules (left) and New dimensions of modules (right)

In the previous modular solution for urban segment 2, the dimensions of the pedestrian path modules are 270 cm wide, while in the new solution, they are 390 and 540 cm wide. The urban segment 2, in the previous solution contains 21 modules for accommodation and yard, while in the new solution, 18 modules can be placed on the same surface because larger dimensions are allocated for the public space (Fig.12).

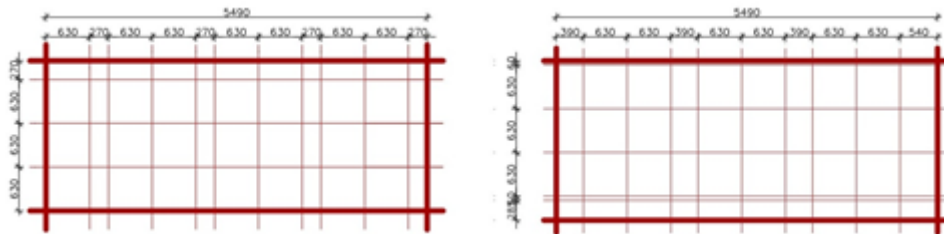


Figure 12 Old dimensions of modules (left) and New dimensions of modules (right)

The previous solution on parking space provided for 50 parking spaces. With the new solution, the distance measures between people from 2 meters are respected in the same space. Therefore, that distance between parked vehicles is maintained. The new parking space envisages 22 parking spaces on the ground floor and 14 on the level of +3.90 m. of steel construction (Fig.13).

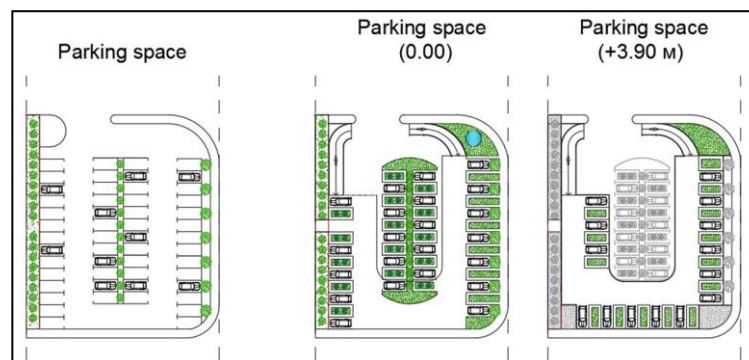


Figure 13 Old (left) and new (right) dimensions of parking space

According to the corona protection measures, at the same dimensioned space for a tourist camp are established new modular dimensions for models in the design of this type of facilities. The new modular dimensions provide 36 accommodation units and 12 public and commercial facilities for the needs of camp users. The reduction of

accommodation units results from the increased dimensioning of the public space with the pedestrian and access paths that enable the protection of the people during its use (Fig.14).

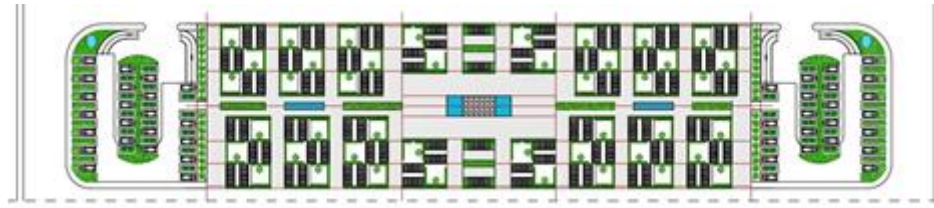


Figure 14 Final project solution

4. CONCLUSION AND FUTURE DIRECTION: POST COVID-19 URBANISM

The current pandemic raises important questions for future research and practice in our fields of study. Therefore, the development of healthy environments must be central to architecture and urbanism in the future.

This type of modular solutions provide an opportunity for the new design of tourism facilities. Regarding the existing tourist camps, in order to protect the users, an analysis should be made of the possibilities for expansion of the free public areas, the pedestrian paths and the parking lots. If there is no space for expansion, the possibility of designing free areas should be foreseen on the second level (+4.20 m) for the benefit of visitors in order to increase the physical distance between people (Fig.15).

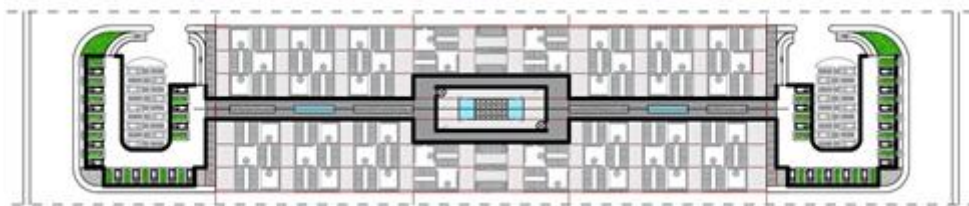


Figure 15 Second level of the final project solution

The implemented measures for protection of people in this project are through a series of ways for distancing between people for their protection, BUT WITHOUT CAUSING restrictiveness, selectivity and alienation. Therefore, we transform the PHYSICAL and SOCIAL DISTANCE into a HUMAN DISTANCE.

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NEW POSSIBILITIES IN THE POST PANDEMIC ERA IN THE DESIGN OF PUBLIC SPACES

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Abstract. We are the witnesses of extraordinary pandemic crisis due to COVID-19 virus in the whole planet. One of the most important measures to protect from this invisible enemy is creating bigger social distance. Also, increasing of usage of individual eco transport options like bicycles or electric scooters will diminish the usage of common public transportation which represents bigger risk for public health. Our task as urbanists is to propose several possible options in order to increase the space for pedestrian communication, to stretch the width of bicycle lanes and to create new zones and paths for its users. The lessons that we have learned during this crisis could be used not only as a temporary planning solution. The changes in urban landscape should be implemented as permanent urban improvements. The process of pedestrianization and car banning in centers of towns was already started in more developed countries decades ago. But now, even these countries are reconsidering the public space in order to make it even more cars free and more pedestrian and bicycle friendly. The challenging question that is imposing nowadays considering Macedonian towns is related to capability of our authorities to enable this urban necessity into our car congested and air polluted cities in order not only to defend ourselves from COVID-19, but also to provide much more sustainable prosperity of our towns.

Keywords: pedestrian, urban, transport, sustainable, COVID-19

1. GLOBAL URBAN CHALLENGES DURING AND AFTER THE COVID-19 PANDEMIC CRISES

Car congestion is one of the most common issue is almost all Macedonian cities. We are not talking only about the pollution aspect due to the omnipresence of vehicles. The occupation of immense territories serving as open parkings, multilevel car garages buildings and the invading road infrastructure are simply limiting the possibilities of the improvement of public space in general. Sidewalks are used more for car parking zone then space for pedestrians. Instead of increasing its pedestrian zones, Skopje is struggling by constant attack of cars within the promenades of river Vardar or in the very few car free areas.



Figure 1 Car congestion

Nowadays there is another challenge that should be integrated in the contemporary approach of town planning. One of the most important recommendations from WHO against COVID-19 is to provide 1.5 meters minimum distance between people. This measure means that we should adapt our cities in order to serve to this health protocol during the crises.

Is it possible to improve our cities making them less polluted but also safer regarding the COVID-19 crises in the same time? How the world important towns act and react in order to enable safer public space? There are some answers that will illustrate the contemporary tendencies in the town planning called "Tactical Urbanism":

1.1. READAPTING THE STREETS IN ORDER TO INCREASE THE WIDTH OF THE PEDESTRIAN AND BICYCLE LANES IN EVERY PART OF THE CITY. (POP-UP BIKE LANES)

Introducing of Pop-up bike lanes is part of the Tactical Urbanism that by definition means short term and not expensive interventions in the cities in order to improve and increase its public space. Pop-up lanes are created by simple preadaptation of the current car roads switching its users from motorcars to bicycles and electric scooters. This change is easy, cheap and fast to implement in the majority parts of the cities. Therefore, this preadaptation was wide world implemented regardless the economic power of the town.

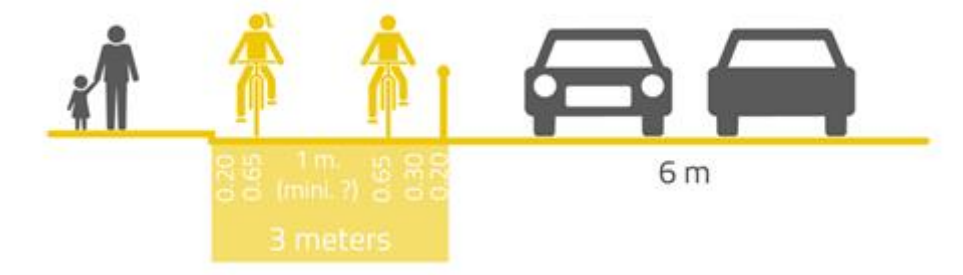


Figure 2 Pop-up bike lane profile dimensions



Figure 3 Pop-up bike line: implementation

1.2. PREADAPTATION OF CURRENT PUBLIC OPEN SPACE IN ORDER TO ENABLE COVID-19 PROTOCOLS

There are several examples in Europe when the common public spaces like squares, pedestrian zones are becoming part of the open dining area or lounge area of bars. For instance, Lithuania's capital, Vilnius, has borrowed its public space to bar and restaurant owners so they can put their tables outdoors keeping physical distancing rules.



Figure 4 Vilnius gives public space to bars and cafes to allow physical distancing

Other example regarding these pop-up urban transformations is coming from the United States of America. In San Francisco, in the park called “Dolores” the authorities have painted circles of 2 meters diameter arrayed on the lawn creating “human parking lots” that will keep the safe distance between people and enabling them to enjoy the nature in the same time. The whole idea of adapting to the new pandemic protocols is that the people will not lose their usual habits but they will just remodel them.

1.3 BANNING CARS IN THE CENTERS OF TOWNS

The worldwide tendency of banning cars in the center of towns is not decreasing its developing curve. Being commenced since the second part of the 20th century, this act of liberating main city squares from car invasion is just more accelerating during these pandemic times. These urban transformations are basically not completely forbidding flow of vehicles. The point is to redefine, sometimes redirect, and “repack” that flow in to the public transport and to individual transportations (bicycles, electric scooters etc.), all with ecological character. That will allow more green area as well in the center of the towns, and in the same time it will give them more human character, cleaner air, more flexibility of urban design in general. The arguments for pedestrianization and increasing the bike network so far were connected with ecological factors, public health reasons, and aesthetics reasons.

Most of the developed and smart countries, are already implemented not only these methods of inner city's traffic improvements, but in Netherlands and Germany there are constructed bike highways between two cities.

“Paris en Commun's” 15-minute city concept is certainly part of this movement in urbanism. The whole idea is that Parisians should be able to meet their essential needs within a short walk or bike ride. Developed by Deputy Mayor of Paris, Christophe Najdovski (Macedonian origin), “Paris in 15 minutes” in which citizens' basic needs, such as work, shopping, health, or culture, should be available within 15 min of their home. This concept has started before the COVID-19 crises but “Paris in 15 minutes” is perfectly suitable for the current safety protocols encouraging the citizens of the capital of France to use their bikes or to walk. This new healthy habit represents not just temporary measures against the pandemic, and if the Parisians will prefer bicycle instead of car in the future, they will have not just cleaner and safer city, but much prettier as well.



Figure 5 Paris en Commun's 15-min city concept. From the top, clockwise, the headings read: Learn, Work, Share and Re-Use, Get Supplies, Take the Air, Self-Develop and Connect, Look After Yourself, Get Around, Spend, and Eat Well.

2. MACEDONIAN CAPITAL AND ITS PUBLIC SPACE DURING THE PANDEMIC CRISES

The diagnostics of current appearance of public space in Skopje before COVID-19 represents a typical car-centric town, constantly losing its free public space especially during its last decades. The consequence of unstoppable eagerness for more comfort of each citizen regarding the number of cars per family is a congested city with no awareness of ecological or sustainable prosperity.

Speaking of awareness, there is also lacking of acceptance from the majority of Macedonians about the new COVID-19 context. On the other hand, parts of the citizens during the first lockdowns have decided to use bicycles instead of public transport avoiding risks of being infected. The tendency of purchasing bikes is rapidly increasing during the pandemic.

The biggest question that is imposing is: why the Macedonian society, the Macedonian authorities and the Macedonians them self are not implementing none of the urban measures for improvement of public spaces elaborated in the previous chapter. There are no pop-up bike lanes, no additional public space in service for the coffee bars and restaurants, no bigger pedestrian zones, no car banning in the center of the town etc.

Therefore, we are proposing several possible methods to response to current urban challenges divided in three categories: short term, mid-term and long-term measures.

2.1 SHORT-TERMS MEASURES POSSIBLE METHODS TO RESPONSE TO CURRENT URBAN CHALLENGES

- Pop-up bike lanes in Skopje, as immediate traffic modifications all around the city.
- Readapting the current public open spaces in order to enable enough space for social distancing
- Instant (pop-up) pedestrianization of critical parts of the town

2.2. MID-TERMS MEASURES POSSIBLE METHODS TO RESPONSE TO CURRENT URBAN CHALLENGES

- Massif campaign organized by central and local authorities endorsing car banning in centers of towns, widening of bike lanes, increasing the infrastructure for bicycles and electric scooters penetrating in every part of the city...

- Public media and social networks should endorse the authorities with aggressive promotions of those measures.

2.3. LONG-TERMS MEASURES AND POSSIBLE METHODS IN ORDER TO RESPONSE TO CURRENT URBAN CHALLENGES

- Reforms in the education system in Macedonia in all ages and all levels of learning processes (starting with pre-schools and finishing with universities).
- These reforms should provide the best education professionals and best paid teachers and professors in Macedonia.
- What will be the main goal of those radical reforms? The point is to establish new educational methods which will implement new way of thinking about the towns, to learn the kids how to respect the green spaces, the nature, to understand that the common space is for all and that we should all take care of our towns. The final goal is to create new generations starting with the youngest ages that will know what are the benefits from the car free zones, bigger pedestrian areas and the sustainable towns in general. Because if we are promoting and implementing instantly those measures before teaching the younger generations of the benefits of car free towns, the feedback could be discouraging, and the people will not be willing to give up from their cars.

3. OUR ROLE AS PROFESSORS REGARDING THE CURRENT CHALLENGES IN PUBLIC URBAN SPACE

What is our role as professors regarding the implementation of those long-term measures?

We should reconsider the lectures and the courses related with Urbanism, Urban Planning and Urban Design in order to respond with the current challenges in modern towns. Our responsibility, as professors of urbanism has significant impact for the future planners of the town.

The scholars that taught us before more than two decades ago, were proclaiming towns dedicated for cars, and not for pedestrians. All the standards and rules for urban planning were serving the space of car and vehicle's infrastructure was the first priority, and not the pedestrian. For example, public city bus was not part of the infrastructure network in the local streets. This urban standard, (still a current standard in urban planning) is only discouraging all the citizens to use public transport, because if the bus station is close only to the main city roads, that will provide less interest of using the public transport. On the contrary, if we provide the bus station that will be up to three minutes walking distance from the citizen's home, it means that the bus line will penetrate in all part of the city. In that case we can say that people will reconsider the car option in the favor of public transport.

Second example of car centric urban planning standard is the radius of street curve. We, as students have been taught that the optimal turning radius for the curve in the city road infrastructure is 6 meters. What does it mean? It means that when the car turns, it will reduce its speed, but not enough to be safe for the pedestrians in the crossroad. Contemporary western towns are promoting 4 meters radius in order to reduce more the speed of cars and to increase the safety for the pedestrians.

Also, about the standard for number of parking spaces for public buildings should be reconsidered. If we are providing huge amount of parking spaces serving some sport's public building, or a concert hall, then we will invite all the people to use their cars and not the public transport or eco individual transport (bicycles or electric scooters) in order to reach those edifices.

Urban standards of town planning should be considered as parameters that should be adaptable to the new needs of their citizens. So, as professors of urbanism we should embrace those positive changes in order to create future architects and city planners that will respond in a much appropriate way to the current and future challenges of our cities.

The most recent challenge is how to react in the public space due to the current COVID-19 pandemics regarding the need for more free space between people keeping the safe physical distance of 1.5 meters. We believe that the improvements of public space, switching the role of the car and the pedestrian regarding its priority, enlarging the pedestrian and bike space and diminishing the role of the car in the city etc. will be compatible with the current requirements for social distancing and promoting safer public space.

4. SUMMARY

One of the most important goals of this paper is to propose possibilities how to act as urbanists in order to establish safer public spaces due to Covid19 Pandemic.

Therefore, we proposed some short, mid and long term measures how to implement some urban transformations in order to provide safer public space, not only during the COVID 19 pandemic crises, but also to create open public spaces that will introduce sustainable environment in any part of the cities.

At the end, we would like to finish with some open questions that will serve to continue the research for safer and better open public space in our towns:

- Can Cities Become Car-Free After the Covid19 Pandemic?
- Could we use the pop-up bike lanes as a permanent solution in our towns?
- Do the Covid19 crises could boost our authorities to accept the Tactical Urban

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“CONTEMPORARY TENDATIONS IN INTERNATIONAL RESIDENTIAL BUILDINGS”

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Abstract. *Architectural design of contemporary residential buildings is one of the most interesting part of architectural design. Contemporary residential buildings contribute to the urban character, context and vitality of the cities. They need to be integrated with their architectural design to the urban context, local character, size and development in order to create architectural design responses in strategic level and form the urban identities of the cities of tomorrow. Designing of contemporary residential building focuses on specific analysis of the building form, layout, functionality, landscape design, environmental performance and residential amenity. Architects have a responsibility to the future generations to enrich and design the contemporary residential buildings, to understand the significance of a place and respond to it. Contemporary residential buildings should create a response to their cultural, social, historical, political, economic and physical environments. Specific attention in this research will be given to analysis of contemporary tendations and different design approaches in residential apartment buildings with consideration of their urban context, adequate public access and architectural space. The expected outcome results in this scientific paper is to identify the contemporary design approaches in residential buildings and create application at the international education processes.*

Keywords: *architectural design, typology, contemporary residential buildings*

1. RESIDENTIAL BUILDINGS (INTRODUCTION, CHARACTERISTICS)

Contemporary residential buildings contribute to the context, urban character and vitality of the cities. They need to be integrated with their architectural design to the urban context, local character, size and development in order to create architectural design responses in strategic level and form the urban identities of the cities of tomorrow. Residential buildings correspond to the natural and built features, social, economic and environmental factors. Designing of contemporary residential building focuses on specific analysis of the building form, layout, functionality, landscape design, environmental performance and residential amenity.

Principles for designing residential buildings are:

1. Urban Context and character
2. Built form and scale
3. Density
4. Sustainability
5. Landscape design
6. Amenities
7. Safety
8. Housing diversity and social interaction
9. Aesthetics

2. LOCAL URBAN CONTEXT (CONNECTION BETWEEN URBAN CONTEXT AND SHAPE OF THE FASADE AND BUILD ENVELOPE)

Architectural Residential Buildings respond and contribute to the urban context and local character. Urban context comprises the key natural and built features of the specific location, which includes social, economic and environmental factors.

The desired future character of the residential building can vary from:

- preserving the existing look of the urban development area or
- establish new character based on different uses, street patterns, subdivisions, densities and typologies. (Fig 1)



Figure 1 The urban context and location of residential flat buildings is determined by factors, such as neighborhood character, accessibility to transport, jobs and services and environmental considerations

Analysis of the urban context and surrounding area is one of the crucial defining and shaping elements of residential buildings. Analysis of the location of the residential building and site is very important, particularly for the elements of daylight distribution and possibility of solar potential of the facades of the buildings, because the surrounding buildings can create shadow on other buildings and effect the solar PV potential of the facades of the building. (Fig 2)

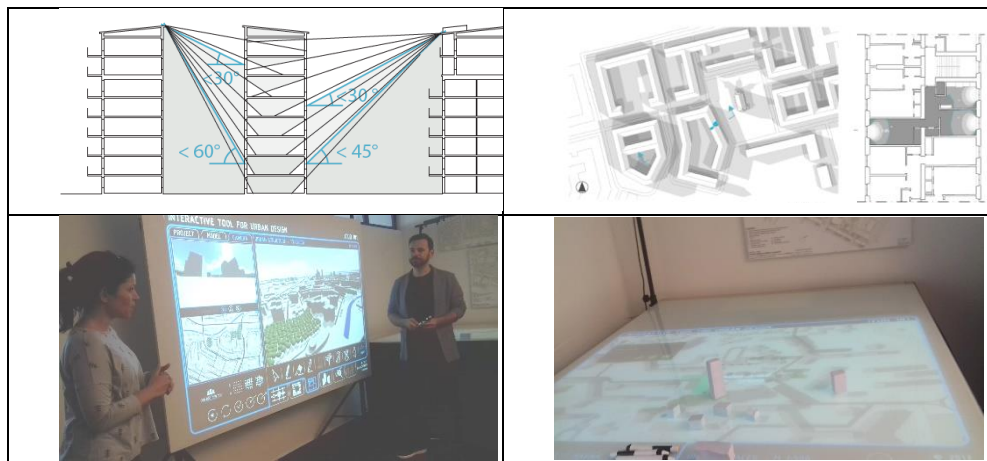


Figure 2 Interactive Tool for Urban Design, Bratislava, Slovakia 2018

The location of residential buildings is determined by urban context and character. Density of residential area should correspond to the density appropriate to the site and its context, according to projected population, infrastructure, public transport, community facilities and the environment.

3. CONTEMPORARY TENDATIONS OF INTERNATIONAL REFERENCE BUILDINGS

3.1 Contemporary aesthetics of built form and scale

- Contemporary use of colors, shape and form
- Contemporary use of modern materials and textures

3.2 Contemporary tendations in apartment's interior design

3.3 Sustainable building's development design solutions and tendations

3.4 Contemporary residential complexes

3.1. CONTEMPORARY AESTHETICS OF BUILT FORM AND SCALE

Residential buildings should have built form appropriate to the existing or desired future character of the streets-capes and surrounding buildings.

Good Building Form should have good proportions, balanced composition of elements, layout and structure. variety of colors, materials and textures, corresponding to the urban local context. (Fig 3)



Figure 3 Aesthetics of international examples of Residential Buildings

Design Aesthetics of facades of larger Residential buildings includes:

- Organization of principal building mass by dividing a large form into several smaller forms to minimize visual impact,
 - Organizing building's mass into base and top in order to express different vertical elements,
 - Using horizontal emphasis on a tall building and vertical emphasis on wide buildings to balance the overall size.
- (Fig 4, Fig 5, Fig 6)

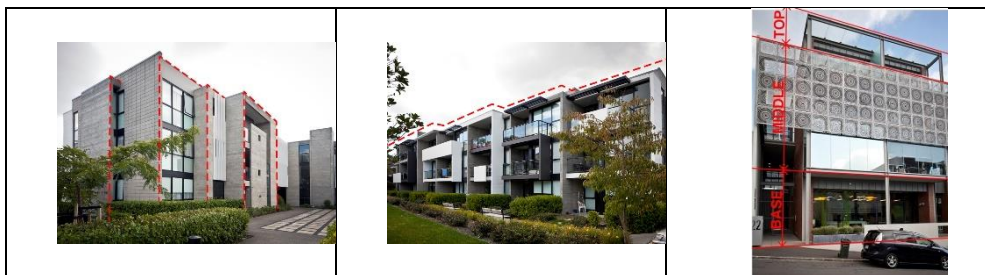


Figure 4 Analysis of the Design Aesthetics of facades of larger Residential buildings

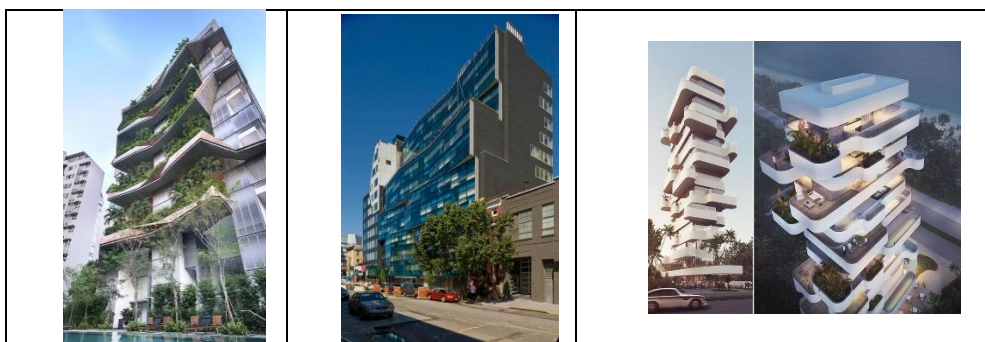


Figure 5 Design Aesthetic of the facades in Residential buildings using different shapes and volumes, as well as combination of different materials



Figure 6 Design aesthetics of buildings facades using different colors and contract shapes and materials

3.2 CONTEMPORARY TENDATIONS IN RESIDENTIAL BUILDING 'S APARTMENT INTERIOR DESIGN

Architects are defining various segments open-space interior design in order to designate different living or working zones, which can be accomplished by incorporating different changing floor levels, shifts in surface colors and textures, islands for kitchen separation, furniture groupings, and lighting to improve the visual organization of space. (Fig 7)



Figure 7 Contemporary Tendencies of Interior Design in Residential buildings

3.3. SUSTAINABLE BUILDING DEVELOPMENT DESIGN SOLUTIONS AND TENDATIONS

Contemporary Residential Buildings correspond to sustainable design: energy efficiency, heating and cooling systems reducing correlation on technology, natural cross ventilation and sunlight, renewable technologies, recycling and reuse of materials and waste, use of sustainable materials, etc. (Fig 8, Fig 9)



Figure 8 Sustainable green building design in International Residential Buildings



Figure 9 Sustainable green building design in International Residential Buildings

3.4 CONTEMPORARY RESIDENTIAL COMPLEXES (MIXED-USE DEVELOPMENT, CONTEMPORARY COMPLEX OF RESIDENTIAL BUILDINGS, LANDSCAPE DESIGN DEVELOPMENT, SECURITY AND SAFETY SOLUTIONS, CONTEMPORARY AMENITIES)

Residence Complexes often use functions with mixed-use development. Mixed use development includes multiple uses and function in one building. In apartment buildings this is usually achieved vertically with different uses stacked above one another. In Fig 10, there is schematic presentation of mixed-use development of residential buildings, which include: residential, commercial, retail:cafe and restaurants and underground parking. (Fig 11)



Figure 9 Residential complexes mixed-use development

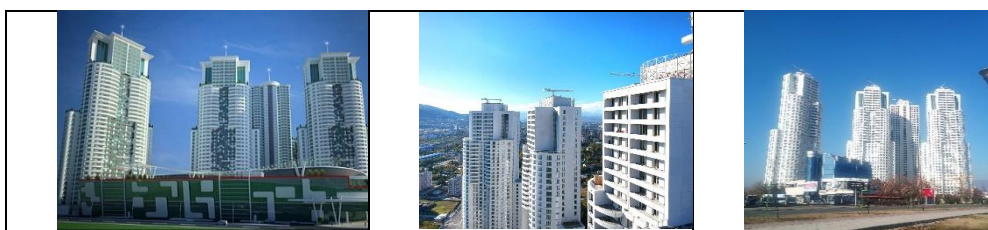


Figure 10 International example of Cevahir Residential buildings in Skopje

Residence complexes often have mix-use functions, which include: retail- cafe and restaurants, commercial areas, parking, sport areas: fitness, pools, residential areas, relaxation amenities, landscape organization with parks, pools, green development, which give character and modern contemporary development of the residential complex. (Fig 12, Fig 13)



Figure 11 International example of mix-use Residence Complex



Figure 12 International example of mix-use Residence Complex

3.5. LANDSCAPE DESIGN IN RESIDENTIAL COMPLEXES

Architectural design of Contemporary Residence Complexes has an integrated and sustainable system between the buildings and attractive landscape design of the property. (Fig 14, Fig 15)



Figure 13 International Contemporary Residential Complex and landscape design



Figure 14 International Contemporary Residential Complex and landscape design

3.6. SAFETY IN RESIDENTIAL COMPLEXES

Good design should optimize safety and security, and provide quality public and private spaces with clearly defined secure access. Each apartment has planned security and safety design. (Fig 16)



Figure 15 International example of apartments with applied security and interior design

3.7. CONTEMPORARY AMENITIES IN RESIDENTIAL COMPLEXES

Architectural design of Contemporary Residential Buildings corresponds positively with the living environment with efficient layouts of amenity area, retail area, commercial area, swimming indoor and outdoor pools, relaxation amenities, sport facilities. (Fig 17)

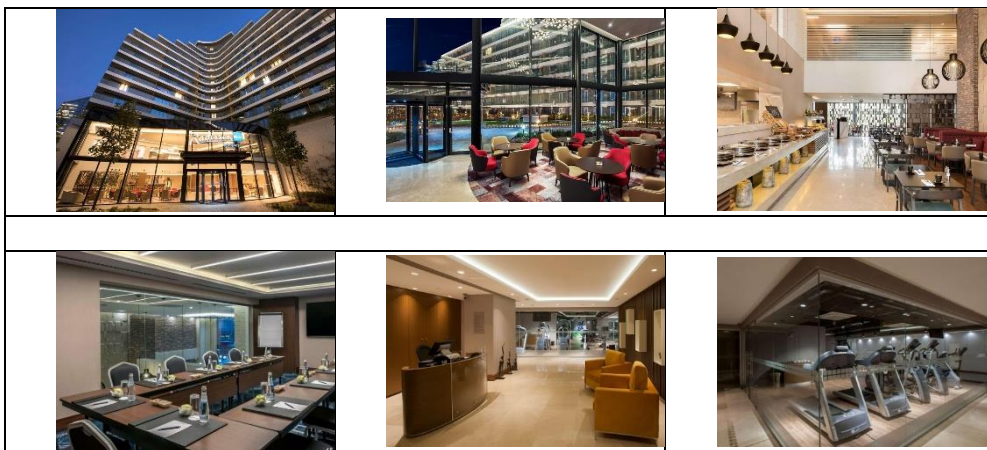


Figure 16 International example of Residential complex and combinations of different types of amenities: retail area, commercial area, fitness center, hotel, conference halls

4. CONCLUSION

Contemporary tendencies in architectural design of International Residential buildings require integrated approach in many aspects:

1. Contemporary design corresponding to the urban context
2. Contemporary build shape and form
3. Contemporary apartments with modern open plan organization and interior design
4. Sustainable design - integration of the buildings with green technologies development
5. Landscape architecture with corresponding organization with parks and green development
6. Contemporary style of Residence complexes with organization of mix-use development and amenities: retail centers, restaurants, commercial areas, sport areas: fitness, pools, residential areas, relaxation amenities development.

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FLOOD PREDICTION MODEL IN MALAYSIA: A REVIEW PAPER

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Abstract. *Flood is among the deadliest natural disaster in many countries, including Malaysia. Annually, flood happens in Malaysia at two different states, which is either in the form of a flash flood or seasonal flood. One way of understanding or forecasting incoming floods is by designing a reliable flood prediction model with an extended forecast period. Existing of the flood prediction model, the emergency response team has sufficient time to respond. This main paper contribution is to present a state-of-the-art flood prediction model. Researchers in Malaysia have been studying four significant forms of flood prediction models in recent years, which will be addressed in this paper too. These models are the Autoregressive Integrated Moving Average (ARIMA), Seasonal ARIMA (SARIMA), machine learning, and Nonlinear Autoregressive Exogenous Artificial Neural Network (NARX). The accuracy and efficiency of the flood prediction model are essential, and these few factors need to be considered, Root Mean Square Error (RMSE), model best fit, and R-squared (R^2). This paper thus proposes the most ambitious model of flood prediction to be used in Malaysia. This study can be used as a guideline to choose the proper flood prediction model for predicting floods.*

Keywords: *flood, forecast, prediction, Malaysia*

1. INTRODUCTION

A flood happens around the globe, and for Malaysia, it is a crucial problem. It is a natural disaster that becomes an annual event in Malaysia. Floods can no longer be seen and viewed as an isolated event, as they are closely linked to problems such as disease outbreaks, food insecurity, and deterioration of climate. Flood still happens in Malaysia, although the government had executed multiple plans with a large budget, such as the enlargement of drainage[1].

Hundreds of lives have been lost due to floods in the past decades, directly or indirectly. Besides, flood presents the most widespread natural threat to life today, as compared to all the other natural hazards. Based on the 2014 & 2015 data from the Water Resources Management and Hydrology Division, there are a total of 381 flood cases occurred in Malaysia[2]. It is a common situation where the government buildings or schools to be converted as the Evacuation Centre since these locations can shelter many people or flood victims at the same time. These places also need to have essential basic such as drinking water supply. But some of these shelters cause people to feel trapped, hence it is crucial to have the geographic information to let the authority know which is the best location for evacuation and as Evacuation Centre[3].

It is important to forecast flood because of continuous heavy rainfall that caused flood is challenging to avoid in countries that receive high rainfall rates annually, especially in countries like Malaysia. Flood forecasting also became a discussion among world researchers to get the best prediction of flood occurrence.

Flood forecasting is among the most complex to model, but this research needed for risk reduction due to flood. Flood not only damage properties, but it also may take the lives of people. Flood forecasting has become increasingly important. It involves high accuracy and statistical modeling, such as trend analysis. Those modelings are essential to help the local authority to manage and identify the flood trends and patterns as well as the capacity of the flood to harming the current safety.

On 1st December 2019 at Melaka, Malaysia, continuous 2 hours heavy rainfall caused the flash flood, and 20 vehicles were sunk in the water. At the same time, another 30 cars stuck in the car park buildings and unable to move out while waiting for the water to recede[4]. Heavily rain, which falls since 5.30 pm, caused the water to overflow in areas of Lebuhraya Tun Razak, Bukit Katil, Batu Berendam, and Ayer Keroh. Fig. 1 shows the vehicle sunk in the flood in this disaster.



Figure 1 Vehicle Sunk in the Flood

While on 7th July 2019 at Melaka, Malaysia, a flash flood caused 1096 peoples to be displaced. The flash flood occurred in Alor Gajah and Melaka Tengah caused by the run-off rainwater from storms in Negeri Sembilan, which then overflowed downstream in the state of Melaka. State Disaster Management Committee secretariat head Effendy Ali said as of 5:00 pm, and there were 1021 victims from 229 families in Alor Gajah and another 75 from 18 families in Melaka Tengah[5]. Fig. 2 show the victims evacuate to the evacuation centre after their home had flooded.



Figure 2 Victims at Evacuation Centers

In Malaysia, flash floods and seasonal floods often occur. Flash floods typically happen in the high population area, such as Kuala Lumpur or Melaka. Meanwhile, the seasonal flood occurs when there is a monsoon and have a specified period for the flood to occur. A seasonal flood happens according to a particular time and month. Seasonal floods mainly occur in the southern part of Peninsular Malaysia, including the areas of Melaka and Johor, from December until January due to Northeast Monsoon[3].

The occurrence of flash floods has a strong relationship with rainfall and geography. Rainfall with high intensity in a short period and complex orography tend to have a high frequency of flash flood[6]. Flash flood also occurred due to unplanned building development, which could lead to a poor drainage problem in the city. When there is heavy rain, rainwater could not adequately drain out of the town, which then causes a flash flood. Besides, drastic land use planning and development at river basins could increase the impermeable of land surrounding the river basin, thus increases the volume and peak discharge of hydrograph generated by the river basin[7].

This paper aims to identify various forms of the model for flood prediction. Each type of flood prediction model has different prediction accuracy, and this exactitude also affects the prediction duration of the incoming flood. By discussing

the different kinds of flood prediction models, opinions and suggestions to choose the best model will then given to suit and serve the main purpose of predicting flood.

2. FLOOD PREDICTION MODEL

It is essential to have a flood prediction model to forecast the occurrence of floods. wThe flood prediction model needs to be as accurate as possible to provide precise information for the rescue team to respond to the incoming disaster. There is four main flood predictions model discussed in this paper which are ARIMA, SARIMA, machine learning, and NARX.

2.1. ARIMA TIME SERIES

The Autoregressive Integrated Moving Average (ARIMA) was introduced in 1976 by Box and Jenkins. It has since become the most popular model for forecasting data from the univariate time series. The root of the model is from the Moving Average (MA) model and Autoregressive (AR) model. Both of these models, AR and MA, also have a combination called ARMA model. There are three stages in the Box-Jenkins step to construct an ARIMA model, model identification, model estimation, and model checking. These steps are essential for the time-series data to identify the best ARIMA model[8]. Equ. 1 shows the equation of the ARIMA model with the parameter of ARIMA (p, d, q).

AR (p) = Auto regression order of model;
I (d) = Degree of differencing
MA (q) = Moving average of the model

The equation to define the above notation is:

$$y_t = \sum_{i=1}^p \phi_i y_{t-i} + \sum_{j=1}^q \theta_j e_{t-j} + \epsilon_t + C \quad (1)$$

ϕ = Autoregressive model's parameters,
 θ = Moving average model's parameters.
c = Constant,
 ϵ = Error terms (white noise).

Where ϵ_t is the error term at time t, ϕ_i for the variance stabilizing, i represent the parameter number of i-th autoregressive and θ_j represent the parameter number the j-th moving average. ARIMA models used in various applications ranging from medical, economic, and engineering. The application of ARIMA include in the cases such as stock market prediction, electric power consumption, COVID-19 cases, or various of data with sufficient measurement that can represent by time series to be used to be model[9]

The differencing approach will use in the Box-Jenkins methodology to make the original data stationary. The autocorrelation function (ACF) and partial autocorrelation function (PACF) parameter used to decide the term for autoregressive and moving average variable, which to apply in the ARIMA model.[10]. According to [11], the ARIMA model is the most accurate method compare with other prediction techniques in [12].

2.2. SARIMA

Seasonal ARIMA (SARIMA) model is where seasonal components included in the ARIMA model. A combination of the seasonal term in the ARIMA model formed the seasonal ARIMA. Fig. 3 shows an example of the SARIMA equation.

Based on the equation, parameter m = number of observations per year. In this equation, the lowercase notation is for the non-seasonal parts of the model, and uppercase notation used for the seasonal components of the model[13].

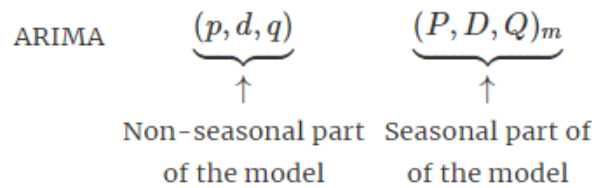


Figure 3 Combination of ARIMA with Seasonal Part

2.3. MACHINE LEARNING

Machine learning is to give the ability for the system to learn and improve from the previous experience without using the programme by the application of Artificial Intelligence (AI). During the past two decades, there are lots of complex mathematical calculations processes of floods. Machine learning (ML) methods give a high contribution to the improvement of flood prediction systems by providing cost-effective and high performance. For that purpose, the individual data sets are being trained, validated, verified, and tested on basic flow to construct a machine learning model described in Fig. 4.

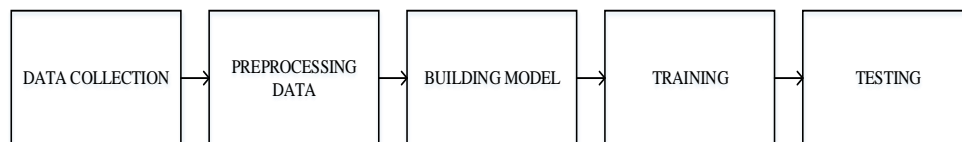


Figure 4 Flow for Building the Machine Learning

2.4. NARX

The Nonlinear Autoregressive Exogenous Artificial Neural Network (NARX) model is a type of dynamically driven recurrent artificial neural network (ANN). Recurrent networks have one or more loops of feedback which can be local or global. Global loops reduce the requirements of computational memory. There are two necessary uses for the recurrent network, which are associative memory and input-output mapping networks. Two applications of input-output are prediction in the form of time series and signal modeling.

The most apparent advantage of NARX models is those different models made up of the same structure, and thus have a fair cost of computation. Therefore, whenever a NARX network uses a period forecast as an input for subsequent periods compared to a feedforward network, degrees of freedom will be achieved. These will allow summary information on exogenous variables to be included as well as a smaller number of residuals, thereby reducing the number of parameters to be estimated[9].

3. METHOD

In this study, the methods and models used for predicting flood prediction identified through the review of journal articles in a similar subject field.

These studies had few variable parameters to consider, which are the location, flood resource variable, time interval of data, root mean square error (RMSE), R^2 or best-fit percentage, type of floods, prediction duration, data obtained, and software used.

The search query for this review includes two main search terms. The first main term of the search is the flood prediction model (flood prediction model). The second main term consists of the four search terms that often used in flood prediction, such as “prediction,” “forecast,” “Malaysia,” and “Estimation.”

Table 1 present the summary of the flood prediction model that had been studied and compiled on the table. The parameter considered in this study are the location, flood resource variable, RMSE, and MSE, R squared and best fit, model types, types of the flood, and prediction duration.

Table 1 Flood Prediction Models

Types of Forecast	Location	Flood Resource Variable	RMSE and MSE	R ² and Best Fit	Model types	Types of Flood	Prediction Duration
SARIMA [14]	Dungun, Terengganu, Malaysia	Water Level	MSE 0.01246		(0,1,1) (0,1,1) ₁ 2	Seasonal	Monthly
ARIMA [15]	Segamat River	Rainfall		0.9895	(0,1,2)		
ANN[14]	Dungun, Terengganu, Malaysia	Water Level	MSE 0.00674		4-6-1	Seasonal	Monthly
BPNN (Backpropagation Neural Network)[16]	Dungun, Terengganu, Malaysia	Water Level	MSE 0.0016		5-8-1	Seasonal	Monthly
NARX (Neural Network Autoregressive with Exogenous Input)[16]	Dungun, Terengganu, Malaysia	Water Level	MSE 0.0008		NARX 5-10-1 d= 4	Seasonal	Monthly
NARX[17]	Sungai Besut, Terengganu Sungai Dungun	Water Level	0.0220	85.47		Flash	5 hours
NNARX (Neural Network Autoregressive with Exogenous Input) [18]	Muda River, Kedah	Water Level	0.0067	95.29	[4,10,1]	Flash	7 hours
ENN (Elman Neural Network) [19]	Kedah	Water Level	0.008	93.6249	[4,10,1]	Flash	
NARX[19]	Kedah	Rainfall, Water Level	0.0203	85.7319	[4,10,1]	Flash	
NNARX[20]	Klang River	Water Level	0.017			Flash	
Multiple-Input Single-Output (MISO) Autoregressive with Exogenous Input (ARX)[21]	Pahang River, Temerloh, Pahang	Water Level	0.01869	50.41	ARX 441	Flash	7 hours

MISO Autoregressive Moving Average with Exogenous Input (ARMAX) [22]	Pahang River, Temerloh, Pahang	Water Level	0.00947	63.06	RMX 2221	Flash	7 hours
Non-linear Auto Regressive Exogenous Neural Network (NARXNN) [22]	Kelantan	Water Level	0.0842	85.56	NARX-NN	Flash	7 hours

4. DISCUSSION

There are different types of flood prediction models with different purpose and accuracy. It also depends on how long the prediction duration. The longer the prediction duration, the percentage of best fit also will decrease, and this will reduce the flood prediction model accuracy. The most accurate model to use for flood prediction is by using machine learning such as NARX. This finding matches the finding from [22].

When deciding on the model to be used, it is crucial to know the purpose of the flood prediction model. There are two purposes in the flood prediction model, which is to predict the flash flood and to predict seasonal flash flood. Multiple types of flood resource variables can use for flood forecastings, such as rainfall, streamflow, and water level.

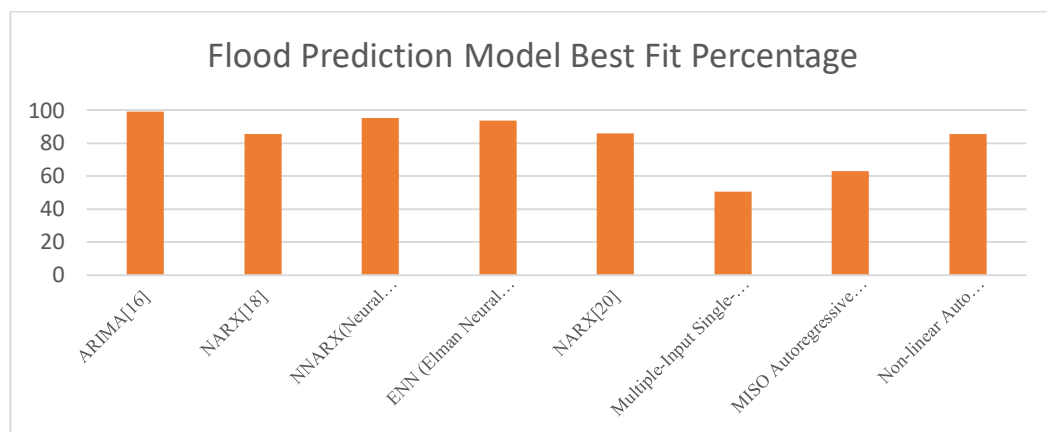


Figure 5 Flood Prediction Model Best Fit Percentage

Fig 5 and Fig 6 shows the result of flood prediction model accuracy based on the model best fit, Mean Square Error (MSE), and Root Mean Square Error (RMSE). The model with a high percentage of best fit and R^2 means that a particular model had a high accuracy of prediction.

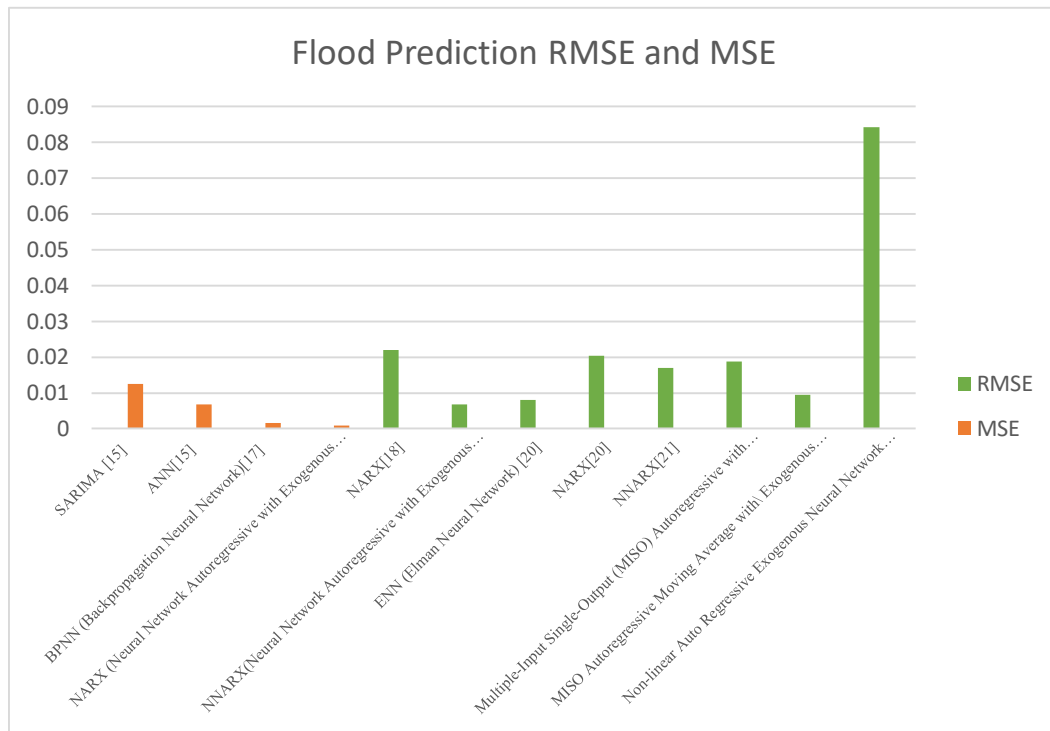


Figure 6 Flood Prediction RMSE and MSE

This situation difference compares to RMSE and MSE. The lower the value of RMSE and MSE mean the model is significant because smaller RMSE and MSE shows that the prediction graph is near to the mean, which indicates that the model is more accurate.

When deciding on the model to be used, it is crucial to know the purpose of the flood prediction model. There are two purposes in the flood prediction model, which is to predict the flash flood or seasonal flash flood. Multiple types of flood resource variables can use for flood forecasting, too, such as rainfall, streamflow, and water level.

There are different types of flood prediction models with different purpose and accuracy. It can observe that the most accurate model to be used is by using machine learning such as NARX. Different flood prediction models had different accuracy. Besides, it also depends on how long the prediction duration. The longer the prediction duration, the percentage of best fit also will decrease, and this will reduce the flood prediction model accuracy. This finding match with the finding from [22].

5. CONCLUSION

Based on the survey, the most accurate model to predict flash flood is by using Neural Network Autoregressive with Exogenous Input (NNARX), which can predict 7 hours of the incoming flood with the best fit of 95.29%. While for seasonal flood, the best flood prediction model to be used is also by NNARX, which has small MSE, as shown in Table 1. As the prediction duration increase, the best fit or accuracy of the prediction will decrease. This paper can be the guideline for researchers to find the most suitable flood prediction model. For future research, the scope of the survey may not be limited to Malaysia but also other flood-prone countries.

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COMPATIBILITY BETWEEN KNOWLEDGE MANAGEMENT AND ORGANIZATIONAL DESIGN

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Abstract. *Constant changes in the business environment, business processes or products, are forcing organizations to reorganize, to search for new organizational forms, but also to establish clever market positioning that creates a competitive advantage. Organizational design becomes important in order to find the most effective structure, which would cope with ever-changing business environment; and knowledge management maximizes the utilization of knowledge as one of the main sources of competitive advantage in the market. The purpose of the paper is to explore the importance of compatibility between knowledge management and organizational design. Knowledge management is recognized as an essential element of business, and extensive efforts are being made to build and develop this process. Numerous improvements are possible in the area of organizational design, such as redesigning existing models and developing new ones so that knowledge management practices can be applied as easily as possible. The research findings would most benefit managers, who can analyze their businesses and determine areas where change is needed, regarding organizational design and knowledge management, which influences business performances.*

Keywords: *business organization, organizational design, organizational structure, knowledge management*

1. INTRODUCTION

The importance of knowledge as a resource and a factor for organizational success was highlighted at the end of 20th century, by the intensive development of information and communication technologies. Changes in social and technological environment of organizations have led to an increased importance of intangible resources, especially knowledge as a strategic element. Knowledge management can be defined as a business concept that aims to create organizational knowledge (Mihajlovic, 2014).

Organizational knowledge management is a modern technique of developing organizational strategy for successful market competition (Al-Laham, 2003). Knowledge management is a business concept that enables organizational success and strong competitive advantage (Al-Laham, 2003). Knowledge as organizational resource should build the foundations of long-term sustainable competitive advantage.

In recent years, the field of knowledge management has been intensively researched by many authors, considering new market trends and new technologies that are greatly changing organizations. Based on this, the concept of a new organizational design is the learning organization. Knowledge management requires an organizational design that is flexible, shallower than traditional bureaucratic design, and at the same time able to provide the necessary level of control to keep the most important knowledge within the organization.

Thus, although there is no common conclusion of researches conducted so far, creating organizational forms that will be able to support knowledge management and technology development, is the future challenge. The implementation of knowledge management as a business concept will become necessary for almost all organizations, regardless of their activity and size, to develop and maintain their business in the changing market conditions.

2. CREATING ORGANIZATIONAL DESIGN

Organization design, as opposed to organizational theory (Galbraith, 2014) is a set of prescribed knowledge. Organizational design largely determines the organizational success. In today's extremely dynamic environment and rapidly changing conditions, the survival of organization is conditioned by its design. Therefore, complex environmental conditions are transferred to organizational solutions, thus creating complex organizational structures, which enable quick adaptation to market conditions.

Organizational design is a fundamental and a continuous decision-making process on a range of issues related to the shape, overall system and characteristics of organization (Galbraith, 2014). Managers must constantly review it and strive for the best way of organizing, which is their continuous and enduring task. Organizational design must provide the rational use of all organizational resources (Sikavica & Hernaus, 2011). Apart from being a process, organizational design can also be viewed as a state, ie. the result of the organizing process. Every organization is created, maintained and innovated in the process of organizing. Organizational design can be defined as the result of shaping and aligning all elements of organization, in order to accomplish an established mission (Hernaus, 2009). It is an extremely important process, and should be considered in all parts of organization, in every organizational unit (Hernaus, 2009).

The biggest question when designing organizations is where to start. Strategy affects the structure of organization that defines key people and their key processes. Key people are assigned roles and responsibilities. An information system is needed to provide people with the right information at the right time, so that they can do their jobs well. Incentive measures and a reward system are established to make the organization successful and training and development offer employees the opportunity to develop and to see their career paths.

Today, two groups of organizational models stand out in particular: traditional models (often referred to as bureaucratic) and organic (adaptive) models. Jay Galbraith's Star Model and the McKinsey 7S Framework are of interest, as representatives of the most widespread models of organizational design, and representatives of new ways of organizational design.

3. KNOWLEDGE MANAGEMENT

Knowledge management is a term that denotes organizational business philosophy, which recognizes knowledge as an important resource, well managed in order to have organizational benefit (Sabri, 2005). Knowledge management is a group of tools and approaches aimed at collecting, using and preserving knowledge (Jennex, 2007). Nowadays, it is obvious that one of the most important organizational resources is knowledge, as a source of organizational competitive advantage. Research and application of knowledge management is a large complex area, which is in constant development.

Knowledge management is an approach to adding or creating value by more actively fostering and assessing know-how, whether it is located within organizations or outside it (Carlucci et al, 2004). Lee and Yang (2000) offer a definition of knowledge management theory as access to all information within an institution, which allows individuals to apply relevant information to existing knowledge in order to create knowledge. Knowledge management is the explicit and systematic management of key knowledge and the processes of its creation, collection, organization, diffusion, use and exploitation (Anand & Singh, 2011). Chuickha (2016) in her paper defines knowledge management as a process consisting of five interdependent activities, which operate in a circle: acquisition, transfer, application and creation of new knowledge.

This discipline of management is only a little over a quarter of a century old, and is used in several different areas, so it is difficult to classify it entirely in one of the traditional divisions of management. Due to the growing importance of knowledge as a resource, the interest of scientists in this field is growing, so further development of this discipline is expected.

There are four key factors in knowledge management that Omotayo (2015) highlights: knowledge, people, processes, and technology. Knowledge is a basic prerequisite for knowledge management because without the knowledge that will be managed, there would be no knowledge management. Knowledge is generally understood as the collection and/or construction of information and is available in the form of theories, processes, systems or in the form of opinions, ideas and analyses. People or employees are another factor on which the entire knowledge management depends, because they are the ones who create the process of knowledge management from start to finish, participate in it and implement it. Processes, as the third component of knowledge management, are defined as mechanical and logical instructions for doing work in organization. Technology is a key driver and fundamental element of the knowledge management plan. With the development of information and communication technologies, knowledge management is realized through various technological solutions that greatly help the processes of storage, sharing and research of knowledge.

Applying knowledge is the first process that can bring improvements to an organization's business. Unfortunately, there is always a gap between what organizations know and what they do. There are several reasons why the acquired knowledge is not applied. It can be the lack of reliability in knowledge sources; lack of time to use new knowledge, or risk aversion (increased risk of error) (Gray & Meister, 2004).

4. THE RELATIONSHIP BETWEEN ORGANIZATIONAL DESIGN AND KNOWLEDGE MANAGEMENT

When implementing knowledge management, the organization is constantly redesigned and reshaped. Flexible organizational structure is necessary. People should be open to change at all levels, especially leadership. Emerging strategy should be ready to respond to new conditions, quality-oriented processes, enable testing, implementing change, and a compensation system that encourages innovation, the development of new ideas and knowledge.

Knowledge management practices lead to the need for organizational design change, which must be evolving. The increased knowledge and the impact of new knowledge lead to a constant organizational transformation. Hierarchies are perceived as barriers to the transfer and development of knowledge, but on the other hand the need for coordination and control increases. It should start with the removal of hierarchical levels; creating shallow organizational structures that enable better two-way communication, then changing the chain of command and implementing the process of employee empowerment. After that, it is desirable to create a compensation system that will encourage entrepreneurship and innovation of employees. The communication structure must also be redesigned to allow horizontal communication. The whole process of reshaping should be constant and self-renewing.

The N-shape of the organization is often mentioned in the literature as a new form of organization compared to the traditional M-shape. The N-shape is characterized by (Hedlund, 1994, Soderlund&Tell, 2009):

- Merging activities, combinations instead of division.
- Temporary set of people or units instead of permanent structures.
- The importance of staff at „lower“ levels in inter-functional, intra division and international dialogue instead of coordination exclusively through „managers“ at the top.
- Lateral communication and dialogue instead of vertical communication.
- Top management as a catalyst, architect of communication (technical and human) infrastructure and protector of knowledge investment instead of supervisor and resource allocator.

A comparison of M and N organizational shape is shown in Table 1. Only the most primitive organisms develop by division, so it can be drawn analogously that the M-shape is the most primitive organizational shape that is not suitable for new business needs.

Table 1 Comparison between N and M organizational shape

	N-Shape	M-Shape
Technological interdependence	Combination	Division
Human interdependence	Temporary relationships, between same group of people	Permanent structures, changeable group of people
Critical organizational level	Middle	Top
Network communication	Lateral	Vertical
The top management role	Catalyst, architect, protector	Supervisor, allocator
Competitive area	Focusing, depth economy, combined pieces	Diversification, economies of scale and scope, semi-independent parts
Basis organizational form	Heterarchy	Hierarchy

Source: Based on Hedlund, G. (1994). A Model of Knowledge Management and the N-Form Corporation, Strategic Management Journal, 15, Summer 1994, 73-90, p.83, adapted by author

The strengths of M-shape and the weaknesses of N-shape are shown in Table 2.

Table 2 Strengths of M-shape and the weaknesses of N-shape

N-Shape weaknesses	M-Shape strengths
Fundamental, radical innovations that have not been realized only by (re)combination and experimenting	Radical innovations through specialization, abstract articulation and investments outside current competences
Long time to acquire new fundamental knowledge because of restrictions on old recruitment and acquisitions	Rapid infusion and diffusion of drastic new perspectives through people, acquisitions and separations
Difficulties in coordination of huge projects because of relieving to small groups	Ability to design large systems through complex articulation and tightly controlled complexity
“Competitive traps” through overly limited development paths	Risk management through “competitiveness portfolio”
Prejudices for the internal exploitation of ideas	Freedom of using the most effective ways, intern or extern
Difficulties in changing the overall vision due to internal managerial promotion	Change of basic direction and culture through external competences of top management
Strategic vulnerability due to strong focus and internal connections	Strategic robustness because of quasi-independent parts

Source: Based on Hedlund, G. (1994). A Model of Knowledge Management and the N-Form Corporation, Strategic Management Journal, 15, Summer 1994, 73-90, p.83, adapted by author

In the newly formed organizational shapes that are suitable for the development of knowledge management, teams that bring together people from different departments play an important role, which gives them a better insight into the overall situation in organization. A special feature is that these teams are self-forming and self-managing: they come together depending on existing needs and do not have a clear leader. These characteristics allow them to take responsibility for performing special tasks and to be adequately rewarded for it. The middle level of management is most important in these forms because it coordinates the performance of work, due to greater responsibility they take on.

Organizational culture, although not an element of organizational design or knowledge management, has a crucial impact on the capabilities and performance of organizations, especially in the implementation of knowledge management.

5. CONCLUSION

Knowledge management as a phenomenon of modern business is a relatively new concept that has aroused the interest of scientists and researchers in the last thirty years, and there has been a constant growth of interest in this topic. The turbulent business environment requires the use of all available resources for the most effective market struggle. It is the frequent changes in the environment and business processes or products that force organizations to frequently reorganize and search for new forms of organization. Therefore, the concepts of organizational design and knowledge management come into focus: organizational design becomes important to search for the most optimal design of organization that will be ready to deal with frequent and sudden changes in the environment, and knowledge management for the most optimal use of knowledge as one of the main resources, a possible source of competitive advantage.

Thus, although there is no unique conclusion of the research conducted so far, the fact is that there is a need for contemporary organizations to introduce knowledge management and adapt their organizational design to it. The most common changes that occur in the formation of organizations are reflected in changing organizational structure, hiring people who are willing to learn, improve, work as a team and share knowledge, redesigning processes that become automated, creating an emerging strategy involving employees at all levels, and change a compensation system that promotes entrepreneurship and employee accountability. The harmony of elements is of the utmost importance when designing an organization, because organizational success depends on it. These emerging forms of organizations must simultaneously achieve two key criteria — be deprived of unnecessary hierarchical levels to allow for unhindered lateral communication, but at the same time allow for a sufficient level of control. The role of teams is becoming increasingly important and teams are becoming self-forming and self-managing. Due to these changes in all elements of organizational design, new organizational forms are created that are individual, because they differ in many ways and cannot be viewed collectively like traditional organizational forms that were universal and easier to apply.

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USER MODELING APPROACHES IN ADAPTIVE LEARNING SYSTEMS

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Abstract. *Adaptive learning systems have potential for accommodating student differences in a diverse population. Adaptive learning can be used both in blended learning settings and flexible learning methods by adjusting to the pace of student, allowing the flexibility in learning styles, different sequence of curriculum and customized presentation. Adaptive system architecture consists of three essential parts; user model, domain model and interaction/adaptation model. As one important feature of any adaptive system is the user model that represents information about each user/student, this paper focuses on user model by overviewing the existing approaches in user modeling in terms of used data types, model initializing methods and implementation of the models.*

Keywords: *Adaptive learning systems (ALS), adaptive eLearning, user modeling, learner model*

1. INTRODUCTION

The popularity of novel technologies such as mobile devices and Internet connections among people from all ages drives the researchers to focus, among other things, on usability of technology in the education. Technology can be integrated into face-to-face teaching, blended teaching, virtual teaching and distance education. Technology Enhanced learning (TEL) can be used to provide flexibility in the mode of learning for both formal and informal settings. It can be used as a tool in the classroom, by utilizing smart boards, media and games, and as support for learning outside the classroom, in form of web applications, mobile applications and games.

The “One-size-fits-all” approach is not appropriate when each user has unique cognitive processes and abilities. Adaptive learning systems address demographic variability of the learners by customizing course content or presentation according to differences in student skills [11]. They may provide individualized learning in a flexible environment and content for the learners, with the support of learning analytics [18]. An adaptive learning environment facilitates the learning process dynamically by monitoring the activities of the users; interprets them to create basic domain-specific models; considering the user requirements and preferences out of the interpreted activities, represents these in associated models; and acts upon the available knowledge on the users and the subject. [38]

The studies in the literature contain many examples of adaptive learning systems also with different names i.e. Intelligent Tutoring Systems (ITS)[46], Adaptive Intelligent Learning Environments (AILE) [23], Adaptive Educational Hypermedia Systems (AEHS)[10] or Personalized Learning Environments (PLE) [14]. Generally, all of them can be called as adaptive learning systems as they all have adaptation according to the learner characteristics.

Early computer aided adaptive learning systems developed for teaching purposes were Intelligent Tutoring Systems (ITS) which are closer to a tutor-centered paradigm[47]. Traditional ITSs provide adaptive sequencing of curricula and support through adaptive feedback and scaffolding. With the development of the web, adaptive hypermedia techniques have become more popular [5]. ELM-ART- an interactive textbook with adaptive curriculum sequencing, tests and exercises for programming in LISP [22, 45] and AHA! (Adaptive Hypermedia Architecture) [8] could be given as examples of early web based adaptive learning systems. In the 90's, server-based www applications were not interactive enough to support following the student actions and provide online help. After the support of real interactivity; online behavior can be monitored and used for evaluation of their performance and providing help. Later on, many adaptive learning systems are proposed considering different user characteristics such as AEHS-LS (Adaptive E-Learning Hypermedia System based on Learning Style) [19] which determines the learning styles of the users and adopts the system accordingly.

Adaptive system architecture consists of three essential parts; the user model, domain model and the interaction/adaptation model. The user model that represents information about each user/learner is an important feature

of any adaptive system. The aim of this paper is to overview existing methods utilized for user modelling in adaptive learning systems and to provide a survey on current research in this field. The paper is organized as follows; the second section of the paper explains the user model and its importance by giving user characteristics and model initialization techniques, while the third section explains user knowledge models. The Fourth section analysis recent research for each of the different ways of user modelling in case of uncertainty containing machine learning methods, and finally the fifth and sixth sections give a discussion and conclusion respectively.

1.1. USER MODEL

Adaptive systems mainly consist of three essential components; the user model, domain model and the interaction/adaptation model.

The User Model describes the information about each user; such as knowledge level, preferences, learning style etc. Upon the evaluation of data collected from the user, the system draws conclusions on the user characteristics and acts accordingly.

The Domain Model represents the domain concepts and provides a structure for the representation of the user domain knowledge. In different adaptive learning systems, these concepts can have different functions, weights and meanings. Commonly, each concept is connected or related with other concepts.

The Adaptation/Interaction Model represents and defines the interaction between the user and the system. It includes evaluation, adaptation and inference mechanisms as the data stored in the Adaptation/Interaction Model is used to infer user characteristics with the objective of updating and validating the user model.

According to [32], adaptation can be implemented in an e-learning system by using four elements; content aggregation, presentation, navigation and collaboration support. Adaptive content aggregation means, depending on the learning and teaching style or domain background knowledge the system could offer different types of content, in terms of different background domains, levels of detail or in different multimedia formats. In adaptive presentation, the content can be adopted with additional, prerequisite, comparative explanations and sorting content units regarding criteria like relevance to background knowledge, knowledge level, etc. Adaptive navigation is the adaptation of global or local guidance. An e-learning environment could offer direct guidance as well as link sorting, link hiding, link disabling and link annotating [11]. A network-based educational system that uses the system's knowledge about learners to form a collaborating group can offer this support and suggest communication with the other learners to provide adaptive collaboration support.

The user model is also referred as student model or learner model in different studies. The user model is required in an adaptive system because it can adopt aspects of the system according to given, or inferred, user characteristics. The model can be separated by the system from the rest of its knowledge and contains explicit assumptions about the user. The current trend favors user centric approaches instead of tutor centric approaches.

Koch in [39], gives seven key features of the user models which are user-centric:

- Assisting the user during the learning of a specific subject.
- Providing information to adjust the user.
- Adapting the interface to the user.
- Helping users find information.
- Giving immediate feedback to the user on his level of knowledge.
- Supporting collaborative work.
- Assisting the user during the use of the system.

In user modelling there are two basic questions to be addressed; the first one is how to initialize the new user model and the second is how this model will be updated. Generally, this process involves diagnosis, classification, and control of the user parameters or characteristics. To diagnose the new user, firstly significance of the user characteristics should be evaluated.

1.2. USER CHARACTERISTICS

In adaptive/ personalized learning systems, student's individual characteristics have a more significant role than in the traditional learning and can become a reason of student's success or failure. In different adaptive learning systems different user characteristics are taken into consideration. What characteristics of the user should be considered to create a user model, to provide a successful and pleasant learning experience?

Novel adaptive learning systems introduce the new development and deployment of adaptive mechanisms by using different attributes for user modelling. The structure of the user models constantly changes over time. Some of them

consider learning styles [17, 19, 20, 33, 40, 43] and some use hybrid models [2] to present user characteristics. Even the same authors over the years recommend different sets of user model attributes; as an example [11] and [22]. In [34] authors selected 22 user model attributes from the research performed in between 2001-2013. The given set of variables includes: age, gender, cognitive abilities (perceptual speed, processing speed, working memory capacity, reasoning ability, verbal ability, spatial ability and other cognitive abilities), meta-cognitive abilities, psychomotor skills, personality, anxiety, emotions and affect, cognitive styles, learning styles, experience, background knowledge, motivation, expectations, preferences, and interaction styles. Other user characteristics in a user model can be objectives/goals/tasks, personality traits, stereotypes, geographic data, demographic data, behavior, social/ group, environment/ work.

Data used in user modelling is categorized in two main classes; Domain Independent Data and Domain Dependent Data. Domain Dependent Data or Domain-specific information model is referred to as the student knowledge model. It describes the students' knowledge level, their understanding of domain knowledge or curriculum elements, the errors that the students made, the students' knowledge development process, records of learning behaviors, records of evaluation or assessment, and so forth.

The domain-independent information is information about the skills of students, so it is based on their behavior. It may include learning goals and objectives to compare with the learners' achievements, cognitive capabilities such as inductive reasoning skill and associative learning skill, motivational states, background and experience, and preferences.

The data collected from users can be categorized like in [2], as demographical data through the registration process, explicit ratings for a subset of the available items, and implicit data from the user's online behavior.

The users' engagement level, motivation state, study time and study habits can be discovered by examining system usage data and online behavior. This information would help the system discover which user is about to quit, and to prevent this; the system could send reminders or offer different content to keep their progress.

Requirements on User Profiling given in [32] are defining static and dynamic information attributes about the users, providing management (like storage, deletion or update) of attributes in real-time and supporting learner tracking (e.g. observing the learning process, the paths through the courses, all learning objects viewed)

1.3. INITIALIZATION OF THE USER MODEL

A common feature of various adaptive Web systems is the application of user models (also known as profiles) to adapt the systems' behavior to individual users. User models are essential part of adaptive learning systems which represent the information about users.

In [1], three approaches are explained for initializing the student model.

1. The system may assume that a new user knows nothing about the domain.
2. The user's prior knowledge may be discovered by using a pre-test during the registration process to the system.
3. The system may use patterns among students in order to group similar students into categories.

The first approach can be preferred for the simplicity, but it is not reliable as it assumes the user knows nothing about the domain, although the user may already have some initial knowledge. A great number of educational systems initialize the models of new students by assuming that they know nothing or that they have some standard prior knowledge of the domain being taught. This causes the boredom of the users which already have initial knowledge about the domain and decreases their motivation.

The second approach, applying a pre-test to measure the prior knowledge of the students is a more appropriate solution, but it contains a trade-off between the number of questions and accuracy. If the number of questions in the pre-test is too high it would frustrate the user and decrease the motivation from the starting point. On the other side not having enough number of questions couldn't give the real level of the user. To recover this trade-off, adaptive pre-test is suggested by [5], which can select the next question according to previous answers.

The third initialization way does not require a pre-test, it groups similar users into the same categories, in other words stereotypes. Stereotypes allow the system to start the customized interaction in a quicker way, often based upon a short initial interaction with the user or a short period observing the user. A system might ask the user just a few questions or it might set the student an initial task to assess their level. From this small base of information, the system estimates the values of a large number of components of the student model.[26]

2. USER KNOWLEDGE MODELS

A knowledge model represents a reflection of the student's state and level of knowledge and skills in term of a particular subject domain [11]. User knowledge models can be categorized according to their coverage as Overlay models and Perturbation models.

Overlay models keep the user/student knowledge only a subset of the entire domain knowledge and do not allow representing the incorrect knowledge that the student acquired or the misconceptions. This solution demands great flexibility in the student knowledge model for each topic [22]. Many researchers have adopted overlay student models to represent the learner's knowledge for each concept independently, focusing on the comparison between the student model and the expert domain knowledge as in [12]-[36]. A certain measure is assigned to each curriculum element based on the estimated student's understanding on that element. The measure can be a scalar (an integer, or probability measure, or a flag such as initial acquisition/assimilation/mastery) or a vector estimate.

Stereotypic inference also can be used in any modeling method. Users can be categorized i.e. as novices, intermediates, experts and others [26]. The stereotype and overlay techniques of student modeling are often combined in adaptive systems for education. The disadvantage of this technique is that it does not consider incorrect behavior of the user or the reason of that behavior.

Perturbation models assume one or more perturbations (misconceptions) exist for each knowledge domain element. Incorrect user behavior may be caused by the application of one of misconceptions in place of the related correct knowledge element. Therefore the student knowledge is represented by a union of a subset of the domain model and another subset of the misconception set with all misconceptions that the learner may have [9]. Keeping the misconceptions or the errors in the students' knowledge is a more realistic way for a better learning.

3. UNCERTAINTY BASED USER MODELS

In user modelling, there is often uncertain or imprecise information; rather it is not sure that the available information is absolutely true or the values are completely defined. In this case, several statistical prediction methods are used.

There are several Artificial Intelligence techniques used in adaptive educational systems for predicting missing information, such as Fuzzy Logic (FL), Decision Trees, Bayesian Networks (BN), Neural Networks, Genetic Algorithms and Markov Models.

3.1. FUZZY LOGIC

Fuzzy logic methods are used in many adaptive learning systems in user modelling taking into consideration many different user characteristics as in [2-4, 13, 41, 44, 48, 49]. In some studies fuzzy logic methods are commonly used for examining and assessing learning outcomes as in [44]. Learning and teaching behavior can be presented by the fuzzy rules in a human readable and linguistically interpretable manner.

Student modelling is performed by fuzzy models with a multi-agent approach in [48]. Profiling system stores the learning activities and interaction history of each student into the student profile database which is abstracted into a student model. Student model contains fuzzy values of the students' behaviors.

In[30], eight stereotypes for representing the knowledge level of a learner from novice to expert. In this study fuzzy sets are combined with user stereotypes and the overlay model to give appropriate domain concepts that correspond to the learner's knowledge level and educational needs.

The study [4] demonstrates the proposed zSlices type-2 fuzzy-logic-based system's capability for uncertainties produce better performance, in terms of student performance and improved success rates compared with interval type-2 fuzzy logic, type-1 fuzzy systems and non-adaptive systems.

In [3], system gathers input and output information of the user during the learning process including head pose direction and face expressions and the state of the e-learning environment. An interval type-2 fuzzy logic-based system that can learn different teacher's pedagogical decisions based on the content difficulty level as well as the students' average level of engagements and the variation between the engagements in a dynamic real online teaching environment.

3.2. DECISION TREES

Decision trees are commonly used for gaining information for decision making. A decision tree is a tree structure such that each branch node represents a choice between a number of alternatives, and each leaf node represents decision.

Decision tree starts with a root node and users split each node recursively according to decision tree learning algorithm. The final result is a decision tree where each branch represents a scenario of decision and its outcome. [27]

One of the methods for user categorization is proposed in [1] is CLARISSE. It identifies the categories among students for an ITS for teaching of quantum information processing. CLARISSE generates an adaptive pre-test to identify the learner's category after very few questions by using decision tree and classify new students according to their cognitive level.

3.3. BAYESIAN NETWORKS

Bayesian Networks (BN) are a probabilistic graphical model in which each node represents a random variable and each link represents probabilistic dependencies among the corresponding random variables [7]. BNs have been widely used for the purpose of modelling learner skills as they offer probability computations of unobserved nodes from evidence of observed nodes. [16]

In [21] Bayesian Networks is used to detect the learning style of a student in a Web-based education system. The system models perception, processing and understanding of the students by evaluating their participation in forums, chats, mail systems and access patterns. Participation in forums, chats, and mail systems is used to detect whether the student prefers to work alone or in groups. Access patterns to information determine how students understand, sequentially or not.

Dynamic Bayesian Networks (DBNs) have the potential to increase the representational power of the student model and increase prediction accuracy [25], by modelling skill hierarchies. Hierarchical models improve prediction accuracy significantly. A domain expert employing a more detailed skill topology and more complex constraint sets could probably obtain an even higher accuracy on data sets.

The study [35] proposes a user modeling system named Zebra which manipulates students' characteristics by a Triangular Learner Model which is consist of knowledge, learning style and learning history sub-models. Zebra has two engines: mining engine (ME) and belief network engine (BNE). Mining engine (ME) is responsible for collecting learners' data, monitoring their actions, structuring and updating the model while Belief network engine (BNE) is responsible for inferring new personal traits by using Bayesian network and hidden Markov model into inference mechanism.

3.4. NEURAL NETWORKS

Artificial neural networks are one of the main machine learning methods designed for finding patterns in data. They are brain-inspired systems which are intended to replicate the way that humans learn. They are used for classification, clustering and prediction.

SQL-Tutor is one of the Intelligent Tutoring Systems (ITS), which was developed to teach university students SQL using an Artificial Neural Network (ANN) for decision-making. Inputs of the system were time needed to solve the problem, the level of help provided to the student, the complexity of the problem and the knowledge level of the student. In the output, the ANN attempted to predict the number of errors or constraints violations committed by the student. The system employs this prediction to make the next teaching decision such as selecting the next problem from the problem database. [31]

Another study [40] uses 32 different attributes which can be used to infer the learning style and preferred learning mode of the learner in accordance with Gardner's theory of multiple intelligences by using two different feedforward-backpropagation neural networks, one for the learning style and another for preferred learning mode.

3.5. LEARNING ANALYTICS AND EDUCATIONAL DATA MINING TECHNIQUES

Currently, data mining techniques and learning analytics techniques such as clustering, classification, collaborative filtering and association rule mining are used in e-learning platforms [6, 15, 24, 28–30, 37, 42]. In recent studies these methods are more often used.

Learning analytics is the automatic analysis of educational data to enhance the learning experience.

In [42], authors proposed an Adaptive web-based English tutor which uses an online pre-questionnaire to model each student's learning style according to pre-defined Jackson learning styles. At the end, system classifies students according to the learning styles by using k-means clustering.

In the study [37], behavior mining techniques were used to extract the students' access patterns, preferences, learning styles to discover a method for delivering suitable and personalized contents to students based on their special characteristics. FP-Tree association rule mining technique was used for exploring the relationships between characteristics.

4. DISCUSSION

In an e-learning system it is crucial to consider the individual traits to take the attention of the user and increase the engagement level. Adaptive learning systems contain a user model which represents the essential information about the user. This information is used to adapt the system's behavior according to individual traits of the users. E-learning systems may successfully retrieve different learning material and resources that technically match a specific goal. Recent systems are designed in a more user-centric way, allowing users having more choices or more flexibility.

The user modelling is one of the key factors for the success of the e-learning system. Users' achievements will depend to a large extent on the user models to represent the users' actual interests and characteristics. In the literature, the number and type of user characteristics to adapt depending on the design of each system, but relevantly cognitive skills, learning styles and student knowledge are used more commonly as adaptation criteria. The first step in user model design should be defining static and dynamic data attributes about the users. Attributes such as user demographic data (i.e., gender, age), academic background etc. can be entered by the user through the registration process of the system. The system gathers the dynamic data from the user's interactions and online behavior. For unknown information of the user, prediction methods are used. Machine learning and data mining methods are also widely used in recent studies to discover the patterns in user data rather than classic rule-based adaptation methods. Techniques that capture dynamic changes in user information and available user data can increase the adaptivity of user model, so the system can have better performance in individualization.

Student model initialization using patterns among students in order to group similar students into categories seems more practical than assuming that a new user knows nothing about the domain or applying an exhaustive pre-test during the registration process. This allows the system to start the customized interaction in a quicker way. If the assumptions for the user are missing or incorrect, the system should update the user stereotype or change the user group upon the recent data.

Adaptive environments also can adapt to support collaborative and group learning, not just to a single learner. User models are often developed using a combination of methods. For example, when user/student model initialization can be done by machine learning methods (i.e. Bayesian Networks), user model adaptation and prediction can be done by the help of educational data mining techniques such as clustering, classification etc.

5. CONCLUSION

In this paper we tried to answer the following questions: Which user characteristics are used in adaptive learning systems? Which way of user model initialization is more proper? Which adaptation methods are used? What are the pros and cons of adaptation methods?

In the traditional face to face teaching-learning interaction; teacher/tutor is the center and student is supposed to adopt himself for the different attitudes or teaching methods of teachers. Also, in human tutoring, teacher can notice the students who are not learning well, which mistakes are done by the group of students, what are the misconceptions, what are the different learning styles in the group. In e-learning systems these kinds of knowledge should be extracted from the system. This is where the user modeling becomes critical for the enhancement of learning effectiveness of web-based educational systems. The purpose of user modeling is to understand the user and diagnose the characteristics of the user to be able to perform adaptation accordingly. As it can be seen from the existing studies, all methods employed to predict uncertainty in user modeling are dealing with different aspects of user characteristics. There is no model to take the student as a whole to evaluate all aspects of learning process. Furthermore, extracting data not only from the learning system but from users' other interactions with other systems, web pages etc. to get a proper knowledge of real interests of the user can help improving the adaptation. When user modeling is done with more parameters, in other terms, using more data would increase the accuracy, but on the other side it could cause higher complexity and additional processing time. There is a

tradeoff between the amount of data and complexity which should be well balanced. This is why user characteristics or user data should be selected very precisely.

In many researches one of the main problems are defined as the lack of standardization for the design of user models. Existing studies show that each method captures different elements of user characteristics by using different pedagogical theories. Combination of different techniques, in other words, hybrid systems could be the future of user models. The user model can be divided into sub-models such as knowledge model, interaction model, pedagogical model etc. This would contribute to the modularity of the systems or the easier combination of the different methods; such as using different algorithms for different sub-models, combining different machine learning or data mining methods.

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SOLVING TRIGONOMETRIC EQUATIONS IN PRIMARY SCHOOL?

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Abstract. *Trigonometry is a subject taught at high school and university level. Since the basic trigonometric relations are first introduced in a right triangle, which is sufficiently studied in primary school, with an emphasis on the Pythagorean theorem, certain trigonometric problems can be solved by primary school students if they only know the definitions of the trigonometric functions in a right triangle as well as their values for characteristic acute angles (30° , 45° and 60°). We give a few examples of trigonometric equations that can be solved with basic knowledge of the trigonometric relations in a right triangle and using the geometric tools that the students in the upper grades of primary school already have. Everything is done in order to promote the creative teaching of mathematics, especially in the work with talented students, and to make the classes more interesting and fun. The objectives are to improve the math knowledge of the students, to develop their math skills and to motivate them to do independent research.*

Keywords: *trigonometry, trigonometric identities, trigonometric equations*

1. INTRODUCTION

Trigonometry is a subject taught at high school and university level. Few decades ago, trigonometric functions of an acute angle were taught in the eighth grade of primary education [1]. In recent years, this topic has been studied by the students in the second year of secondary education. Trigonometry studies the relationships involving side lengths and angles of triangles, so knowledge of geometry is very helpful in dealing with trigonometric problems. Since the basic trigonometric relations are first introduced in a right triangle, which is sufficiently studied in primary school, with an emphasis on the Pythagorean theorem, certain trigonometric problems can be solved by ninth-grade students if they only know the definitions of the trigonometric functions in a right triangle as well as their values for characteristic angles (30° , 45° and 60°). Many countries, such as Romania and North Korea, introduce basic trigonometry in middle school (grades 5-9). Vajiac in [6] concludes that basic trigonometric concepts are within reach of six graders. According to him, the schools may start with introducing elementary trigonometry in sixth-grade honors classes. It could be done with minimum effort and it would change the children attitude toward learning mathematics.

This idea of finding relationships between the angles and the sides in a right triangle is to motivate elementary school students to "discover" certain trigonometric identities on their own and then use them to solve some trigonometric equations. In the Macedonian educational system, the trigonometric equations are introduced to the students in the third year of secondary school. We give a few examples of trigonometric equations that can be solved with basic knowledge of the trigonometric relations in a right triangle and using the geometric tools that the students in ninth grade already have. Everything is done in order to promote the creative teaching of mathematics, especially in the work with talented students, and to make the classes more interesting and fun. The objectives are to improve the math knowledge of the students, to develop their math skills and to motivate them to do independent research.

At the beginning we present some results that we apply in our further work. Using elementary geometry and the definitions of the trigonometric functions in a right triangle and the unit circle, we compute the values of sine and cosine functions at 30° , 45° , 60° and give proofs of some trigonometric identities. These results can be found in many books (see the references). Then we consider a few trigonometric equations and solve them for acute angles ($0 < x < 90^\circ$).

2. THE SINE AND COSINE FUNCTIONS OF 30° , 45° AND 60° .

In this section we present some well-known results which can be found in many textbooks. Namely, the trigonometric ratios of 30° , 45° and 60° angles can be easily derived from $30^\circ - 60^\circ - 90^\circ$ and $45^\circ - 45^\circ - 90^\circ$ right triangles, “with the help” of the Pythagorean theorem.

Let ABC be an equilateral triangle with side length 1 and AD be the height of the triangle through the vertex A .

Then ABD is right triangle and we have $\sin 60^\circ = \frac{\overline{AD}}{\overline{AB}} = \frac{\frac{\sqrt{3}}{2} \cdot 1}{1} = \frac{\sqrt{3}}{2}$, $\cos 60^\circ = \frac{\overline{BD}}{\overline{AB}} = \frac{\frac{1}{2} \cdot 1}{1} = \frac{1}{2}$.

Since $\angle BAD = 30^\circ$, we have $\sin 30^\circ = \frac{\overline{BD}}{\overline{AB}} = \frac{\frac{1}{2} \cdot 1}{1} = \frac{1}{2}$ and $\cos 30^\circ = \frac{\overline{AD}}{\overline{AB}} = \frac{\frac{\sqrt{3}}{2} \cdot 1}{1} = \frac{\sqrt{3}}{2}$.

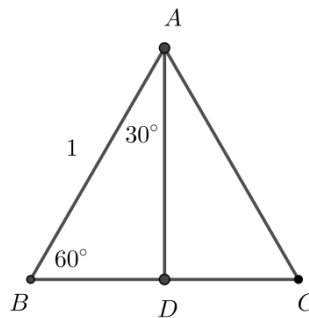


Figure 1

Let ABC be an isosceles right triangle with hypotenuse $\overline{AB}=1$. From the Pythagorean theorem we have

$\overline{BC} = \overline{AC} = a = \frac{\sqrt{2}}{2}$. Then, $\sin 45^\circ = \frac{\overline{BC}}{\overline{AB}} = \frac{\frac{\sqrt{2}}{2}}{1} = \frac{\sqrt{2}}{2}$ and $\cos 45^\circ = \frac{\overline{AC}}{\overline{AB}} = \frac{\frac{\sqrt{2}}{2}}{1} = \frac{\sqrt{2}}{2}$.

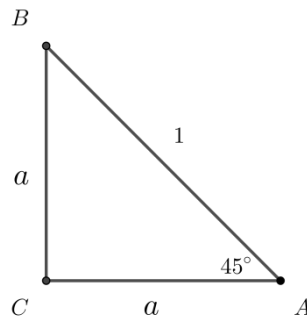


Figure 2

3. SOME BASIC TRIGONOMETRIC IDENTITIES

Next, we give geometric proofs of some trigonometric identities which are used for the trigonometric equations in the following section. The geometric proofs in the trigonometry are not complete proofs since they depend on the figures, but are very suitable for the ninth-grade students. In the literature, one can find many examples of geometric proofs of various trigonometric identities [2, Jarrett] and very often those proofs are given as *proofs without words* [5, Nelsen].

3.1 PROOF OF $\sin^2 x + \cos^2 x = 1$

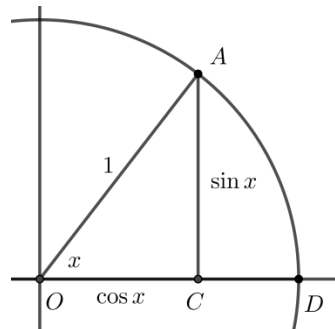


Figure 3

Let $\angle AOD = x$ and $C \in OD$, such that AC is perpendicular to OD . Then AOC is right triangle with the hypotenuse of length 1. We have $\sin x = \frac{\overline{AC}}{1}$, i.e., $\overline{AC} = \sin x$ and $\cos x = \frac{\overline{OC}}{1}$ i.e., $\overline{OC} = \cos x$. The Pythagorean theorem gives $\sin^2 x + \cos^2 x = 1$.

3.2 PROOFS OF $\sin^2 \frac{x}{2} = \frac{1-\cos x}{2}$ AND $\cos^2 \frac{x}{2} = \frac{1+\cos x}{2}$

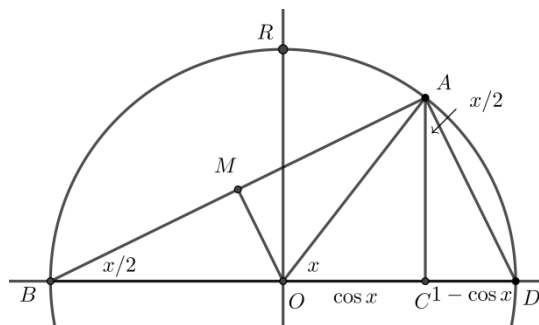


Figure 4

Let $\angle AOD = x$. Then $\angle ABD = \frac{x}{2}$ and $\angle BAD = 90^\circ$. If M is the midpoint of the circle chord AB , then OM and AB are perpendicular to each other. From the right triangle OMB we obtain $\sin \frac{x}{2} = \frac{\overline{OM}}{1}$, i.e., $\overline{OM} = \sin \frac{x}{2}$ and

$\cos \frac{x}{2} = \frac{\overline{BM}}{1}$ i.e., $\overline{BM} = \cos \frac{x}{2}$. Since OM is a midsegment in the triangle ABD , it follows that $\overline{AD} = 2 \sin \frac{x}{2}$, and since M is the midpoint of the segment AB , we have $\overline{AB} = 2 \cos \frac{x}{2}$.

The triangles ABD and CAD are similar (both are right triangles and they have one common acute angle), so $\angle CAD = \frac{x}{2}$. Then, from the right triangle ACD we have $\sin \frac{x}{2} = \frac{\overline{CD}}{\overline{AD}} = \frac{1 - \cos x}{2 \sin \frac{x}{2}}$. Hence, $\sin^2 \frac{x}{2} = \frac{1 - \cos x}{2}$.

From the right triangle ABC we have $\cos \frac{x}{2} = \frac{\overline{BC}}{\overline{AB}} = \frac{1 + \cos x}{2 \cos \frac{x}{2}}$. Hence, $\cos^2 \frac{x}{2} = \frac{1 + \cos x}{2}$.

4. SOLVING TRIGONOMETRIC EQUATIONS

In this section, using elementary geometric tool, the definitions of trigonometric ratios and the results given above, we solve some trigonometric equations for acute angles ($0 < x < 90^\circ$).

4.1) $\sin x = \cos \frac{x}{2}$, $0 < x < 90^\circ$

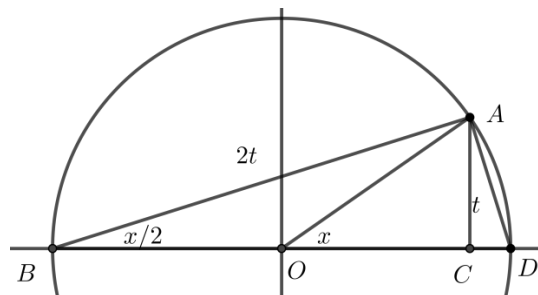


Figure 5

Let $\sin x = t$. From $\sin x = \cos \frac{x}{2}$, it follows that $\cos \frac{x}{2} = t$. From the right triangle ABC we obtain $\sin \frac{x}{2} = \frac{t}{2t} = \frac{1}{2}$. Hence, $\frac{x}{2} = 30^\circ$, i.e., $x = 60^\circ$.

$$4.2) \cos x - \cos \frac{x}{2} + 1 = 0, \quad 0 < x < 90^\circ$$

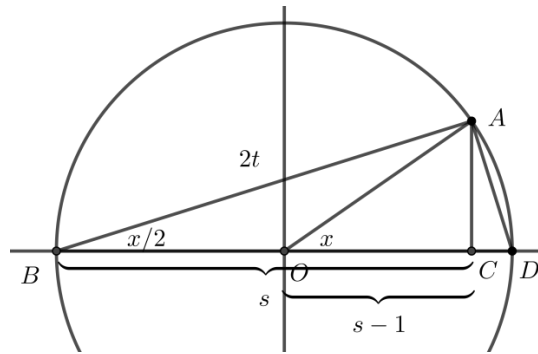


Figure 6

Let $\cos \frac{x}{2} = t$ and $1 + \cos x = s$. Then, $\cos x - \cos \frac{x}{2} + 1 = 0$ converts to $s - t = 0$. From the right triangles ABC and AOC , we obtain $\overline{AC}^2 = (2t)^2 - s^2$ and $\overline{AC}^2 = 1^2 - (1-s)^2$, respectively. Then, $(2t)^2 - s^2 = 1^2 - (1-s)^2$, $4t^2 - s^2 = 1 - 1 + 2s - s^2$, $4t^2 = 2s = 2t$. The last equation is equivalent to $t(2t - 1) = 0$. Hence, $t = 0$ or $t = \frac{1}{2}$.

Since $t > 0$, it follows that $\cos \frac{x}{2} = \frac{1}{2}$. So $\frac{x}{2} = 60^\circ$, i.e., $x = 120^\circ$. Since we solve for $0 < x < 90^\circ$, it follows that this equation has no solution.

$$4.3) \sin x = \sqrt{3} \sin \frac{x}{2}, \quad 0 < x < 90^\circ$$

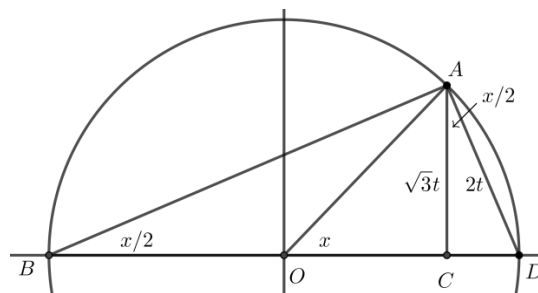


Figure 7

Let $\sin \frac{x}{2} = t$. Then $\overline{AD} = 2t$. From $\sin x = \sqrt{3} \sin \frac{x}{2}$ we obtain $\overline{AC} = \sin x = \sqrt{3}t$. It's clear that $\angle DAC = \frac{x}{2}$, so, from the right triangle ACD we have $\cos \frac{x}{2} = \frac{\sqrt{3}t}{2t} = \frac{\sqrt{3}}{2}$. Then, $\frac{x}{2} = 30^\circ$, i.e., $x = 60^\circ$.

$$4.4) \sin \frac{x}{2} + \cos x = 1, \quad 0 < x < 90^\circ$$

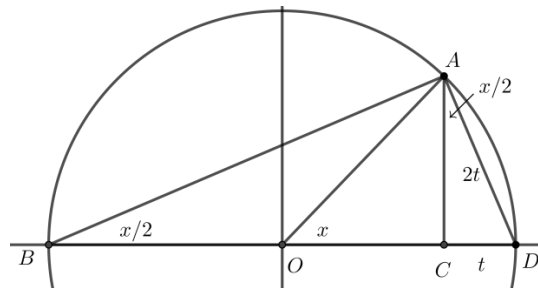


Figure 8

If $\sin \frac{x}{2} = t$ then $\overline{AD} = 2t$. From $\sin \frac{x}{2} + \cos x = 1$ we obtain $\overline{CD} = 1 - \cos x = t$. From the right triangle ACD we have $\sin \frac{x}{2} = \frac{t}{2t} = \frac{1}{2}$. Hence, $\frac{x}{2} = 30^\circ$, i.e., $x = 60^\circ$.

$$4.5) 2\sin^2 x - \cos x, \quad 0 < x < 90^\circ$$

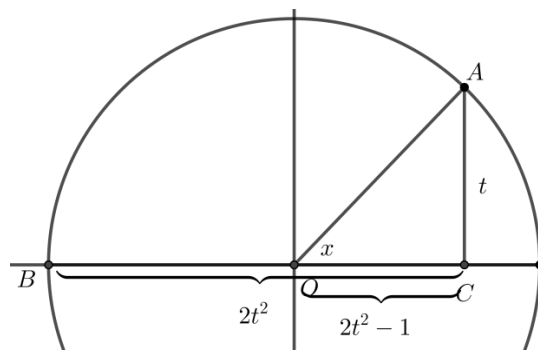


Figure 9

Let $\sin x = t$. Then $\overline{AC} = \sin x = t$ and $\overline{BC} = 1 + \cos x$. From $2\sin^2 x - \cos x = 1$, it follows that $\overline{BC} = 1 + \cos x = 2\sin^2 x = 2t^2$. Hence, $\overline{OC} = \cos x = \overline{BC} - 1 = 2t^2 - 1$. From the right triangle AOC we obtain $t^2 + (2t^2 - 1)^2 = 1^2$, i.e., $4t^4 - 3t^2 = 0$. The last equation is equivalent to $t^2(4t^2 - 3) = 0$. Hence, $t^2 = 0$ or $t^2 = \frac{3}{4}$. Since $t > 0$, it follows that $t = \frac{\sqrt{3}}{2}$, i.e., $\sin x = \frac{\sqrt{3}}{2}$. Finally, $x = 60^\circ$.

4.6) $\operatorname{tg} x = \sqrt{2} \sin x$, $0 < x < 90^\circ$

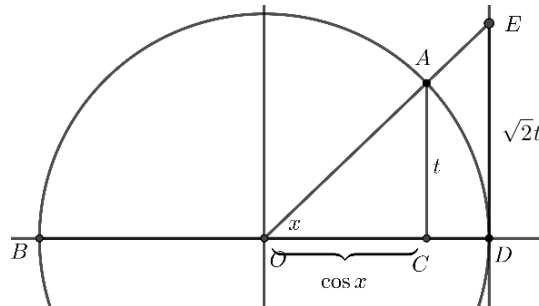


Figure 10

Let $\sin x = t$. From $\operatorname{tg} x = \sqrt{2} \sin x$ we have $\overline{ED} = \operatorname{tg} x = \sqrt{2}t$. Since the triangles AOC and EOD are similar, it follows that $\frac{\cos x}{1} = \frac{t}{\sqrt{2}t}$, i.e., $\cos x = \frac{1}{\sqrt{2}} = \frac{\sqrt{2}}{2}$. Hence, $x = 45^\circ$.

4.7) $\cos x = \sin \frac{x}{2}$, $0 < x < 90^\circ$

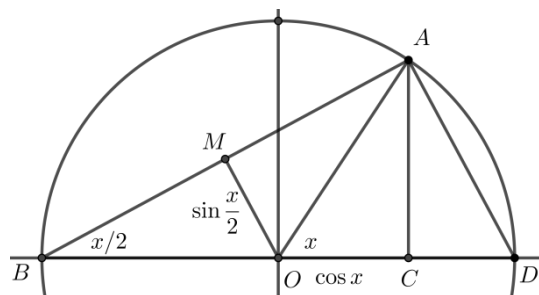


Figure 11

Let M be the midpoint of AB . Then, $\angle OMB = 90^\circ$ and $\sin \frac{x}{2} = \frac{\overline{OM}}{\overline{OB}} = \frac{\overline{OM}}{1}$, so $\overline{OM} = \sin \frac{x}{2}$. From $\cos x = \sin \frac{x}{2}$ we have that $\overline{OM} = \overline{OC}$. It follows that the right triangles AMO and ACO are congruent (they have common hypotenuse and one equal leg). Therefore, $\angle AOM = \angle AOC = x$. Since $\angle AOM = \angle BOM$, it follows that $x + \frac{x}{2} = 90^\circ$, i.e., $3x = 180^\circ$. Hence, $x = 60^\circ$.

$$4.8) \sqrt{3}(1 - \cos x) = \sin x, 0 < x < 90^\circ$$

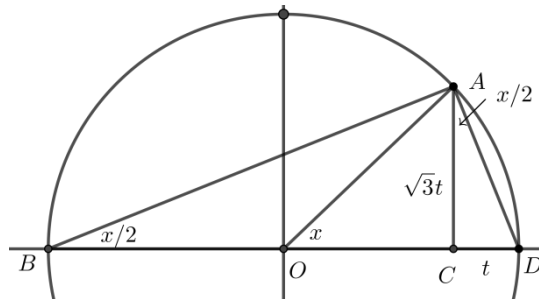


Figure 12

Let $\overline{CD} = 1 - \cos x = t$. Then, the equation $\sqrt{3}(1 - \cos x) = \sin x$ implies $\overline{AC} = \sqrt{3}t$. From the right triangle ACD we have $\operatorname{tg} \frac{x}{2} = \frac{t}{\sqrt{3}t} = \frac{1}{\sqrt{3}}$. Hence, $\frac{x}{2} = 30^\circ$, i.e., $x = 60^\circ$.

$$4.9) 3 \operatorname{tg}^2 x = \frac{2}{\cos^2 x} + 1, 0 < x < 90^\circ$$

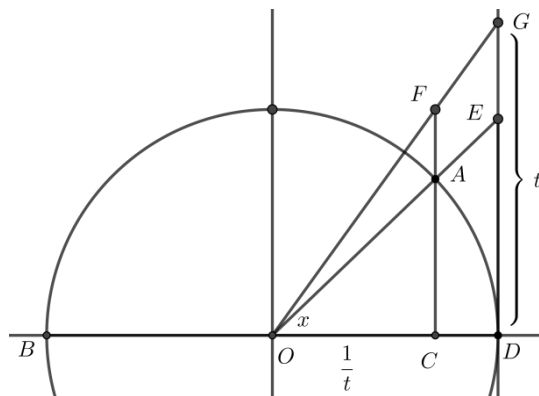


Figure 13

Let F be a point on the line AC , such that $\overline{FC} = 1$. Let OF intersect the tangent of the circle at D , at the point G . The triangles OCF and ODG are similar and therefore $\frac{\overline{FC}}{\overline{OC}} = \frac{\overline{GD}}{\overline{OD}}$, i.e. $\frac{1}{\cos x} = \frac{\overline{GD}}{1}$. Hence, $\overline{GD} = \frac{1}{\cos x}$.

Let $t = \frac{1}{\cos x}$. Then $\overline{OC} = \frac{1}{t}$ and $\sin x = \overline{AC} = \sqrt{1 - \frac{1}{t^2}}$, i.e., $\sin^2 x = 1 - \frac{1}{t^2}$... (1) The triangles AOC and EOD are similar and therefore $\frac{\overline{AC}}{\overline{OC}} = \frac{\overline{ED}}{\overline{OD}}$ i.e., $\frac{\sin x}{\frac{1}{t}} = \frac{\operatorname{tg} x}{1}$. Hence, $t = \frac{\operatorname{tg} x}{\sin x}$, i.e. $t^2 = \frac{\operatorname{tg}^2 x}{\sin^2 x}$... (2) From (1) and (2) we obtain

$tg^2x = t^2 \sin^2 x = t^2 \left(1 - \frac{1}{t^2}\right) = t^2 - 1 \dots (3)$ From the initial equation $3tg^2x = \frac{2}{\cos^2 x} + 1$ and (3) we obtain $3(t^2 - 1) = 2t^2 + 1$, which is equivalent to $t^2 = 4$. Since $t > 0$, it follows that $t = 2$, i.e., $\cos x = \frac{1}{2}$. Hence, $x = 60^\circ$.

$$4.10) \quad 2\sin^2 x + \sin x - 1 = 0, \quad 0 < x < 90^\circ$$

The given equation is equivalent to $2(1 - \sin^2 x) = 1 + \sin x$. Hence, $2\cos^2 x = 1 + \sin x \dots (1)$. From the right triangles AQP and RPA we have $\cos^2 x + (1 + \sin x)^2 = b^2 \dots (2)$ and $a^2 + b^2 = 4 \dots (3)$, respectively. The triangles RPA and RAQ are similar. Therefore, $\frac{b}{2} = \frac{\cos x}{a}$, i.e., $a = \frac{2\cos x}{b} \dots (4)$. Putting (4) in (3) we obtain $\frac{4\cos^2 x}{b^2} + b^2 = 4$. Hence, $\cos^2 x = \frac{4b^2 - b^4}{4} \dots (5)$. From (1) and (2), it follows that $\cos^2 x + (2\cos^2 x)^2 = b^2 \dots (6)$. If we put (5) in (6), we obtain $\frac{4b^2 - b^4}{4} + (2\frac{4b^2 - b^4}{4})^2 = b^2$. Hence, $(4b^2 - b^4)^2 = b^4$, i.e. $b^4(4 - b^2)^2 = b^4$. Since $b^4 \neq 0$, it follows that $(4 - b^2)^2 = 1$. Then $4 - b^2 = 1$ or $4 - b^2 = -1$, i.e., $b^2 = 3$ or $b^2 = 5$. If we substitute the last results in (5), we obtain $\cos^2 x = \frac{3}{4}$ or $\cos^2 x = \frac{-5}{4}$ (the second result is not possible). Since $0 < x < 90^\circ$, it follows that $\cos x = \frac{\sqrt{3}}{2}$. Hence, $x = 30^\circ$.

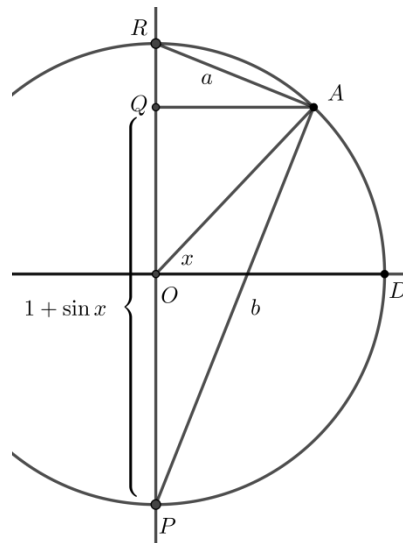


Figure 14

5. CONCLUSION

The purpose of this work is not to introduce the topic *Trigonometric equations* in regular classes which are realized according to a previously determined plan and program. The idea is to show that the elementary school students can derive trigonometric properties and solve some trigonometric equations with the knowledge they already have. They just need to be motivated to research and guided through the process. It could be done in honors classes or in the workshops for talented students. This approach makes the teaching mathematics more creative and interesting.

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DISTORTION PERFORMANCE OF UNDERWATER ACOUSTIC MIMO MOBILE NETWORKS

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Abstract. *The paper considers the distortion performance of underwater acoustic MIMO mobile networks for an independent identically distributed (i.i.d.) Gaussian source. Such networks are appealing due to the need to perform sensing and surveying of underwater areas. Underwater acoustic communication is subject to attenuation, or path loss, that depends not only on the distance between the transmitter and the receiver, but also on the operating carrier frequency. Each transmission experiences frequency dependent path loss and fading. The information is conveyed across the network by transmitting it from one mobile to another across the multihop route. The mobility is based on the direction persistent mobility model. Numerical examples are presented to illustrate the distortion performance of the underwater acoustic MIMO mobile network.*

Keywords: *underwater acoustic, mobility fading, distortion*

1. INTRODUCTION

The field of underwater acoustic networks has been the focus of a number of studies recently [1–4]. The motivation for these studies has been the need to perform sensing and surveying of underwater areas. The reasons are varied and include environmental, scientific and commercial needs. In particular, there are general oceanographic needs [5], observations of marine biology and/or fisheries [6], environmental, including pollution monitoring [7], monitoring of off shore oil and gas fields [8], submarine detection, and so on. Underwater mobile networks represent an appealing choice in this context [9]. Related to the sensing task are additional tasks, such as, computing, transmission and reception of information. The transmission task is in particular strenuous since underwater acoustic communication experiences attenuation, or path loss, that depends not only on the distance between the transmitter and the receiver, but also on the operating carrier frequency [10]. This means that the careful choice of the operating carrier frequency is of great importance for efficient underwater communications. In addition, as the attenuation increases with the increase in the carrier frequency, it effectively limits the range of choices for the operating carrier frequencies. Moreover, as underwater communication is established by the transmission of acoustic signals, the low speed with which sound propagates underwater introduces transmission delays.

The paper focuses on the average distortion performance of underwater acoustic MIMO mobile networks. The multihop routing is done by utilizing a modified version of the reserve listen and go transmission protocol [11] which includes request-to-send (RTS) and clear-to-send (CTS) messages [12]. The mobility model is direction persistent. Each mobile-to-mobile transmission is subject to frequency dependent path loss and independent Ricean fading.

The paper is organized as follows. The underwater acoustic propagation is highlighted in Section 2. The average distortion performance of a multihop route for the MIMO mobile underwater acoustic network is evaluated in Section 3. Section 4 presents numerical examples. Section 5 concludes the paper.

2. UNDERWATER ACOUSTIC PROPAGATION

Underwater acoustic transmission is subject to attenuation, that is, path loss. For a signal that is transmitted on a frequency, f , the attenuation is [10]

$$A(d, f) = A_0 d^k a(f)^d \quad (1)$$

where A_0 is a unit-normalizing constant that includes fixed losses, d is the distance between the transmitter and the receiver, $a(f)$ is the absorption coefficient, and k is the spreading factor. For practical spreading $k = 1.5$,

($1 \leq k \leq 2$). The absorption coefficient is given by Thorp's formula that provides $a(f)$ in dB/km for f in kHz as [10]

$$10 \log a(f) = \frac{0.11f^2}{1+f^2} + \frac{44f^2}{4100+f^2} + \frac{2.75f^2}{10^4} + 0.003. \quad (2)$$

This formula, appropriate for frequencies above few hundred Hz, is illustrated in Figure 1.

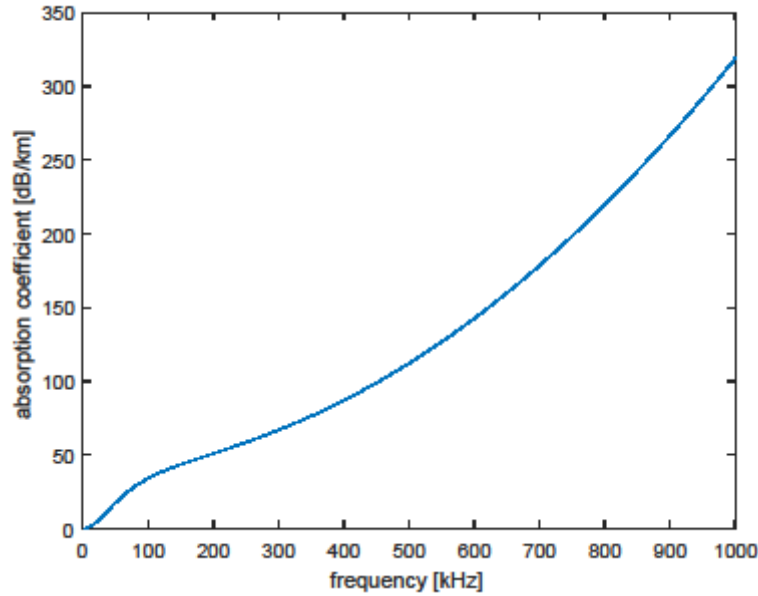


Figure 1 The absorption coefficient $a(f)$

The ambient ocean noise consists of: turbulence, shipping, waves and thermal noise. It can be described by Gaussian statistics and continuous power spectral density (p.s.d.). The overall p.s.d. of the ocean ambient noise is [10]

$$N(f) = N_t(f) + N_s(f) + N_w(f) + N_{th}(f). \quad (3)$$

3. DISTORTION PERFORMANCE

3.1 TRANSMISSION PROTOCOL

The transmission protocol that facilitates the transmission of information along the multihop route from the source mobile to the receiving mobile [11–16] is based on the modified version of the reserve listen and go protocol [12]. According to the reserve listen and go protocol, the source mobile first senses the channel, and starts the transmission only if the channel is idle. If the channel is busy, the transmission is delayed. A careful graphical study, nonetheless, showed that the reserve listen and go protocol is still vulnerable to interference for a range of different distances between the interferers and the receiving mobile [11]. The reserve listen and go protocol has therefore been modified to include an exchange of request to send (RTS) and clear to send (CTS) messages before the start of the transmission [12]. The transmission may still be subject to interference if the distance from the interferers to the receiving mobile is greater than the distance between the source mobile and the receiving mobile [11–16]. Assuming constant p.s.d. S for all interferers, the interference can be described by

$$I(f) \approx \frac{cS}{A(d_1, f)} \quad (4)$$

where d_1 is the distance between the receiving mobile and the interferers and c is a constant indicating the number of interferers (we let, $c = 6$). Due to the multiple interferers, the interference is modeled as Gaussian with p.s.d. $I(f)$.

3.2 MOBILITY MODEL

We consider N mobiles within a network with a circular area \mathcal{A} . The density of mobiles is $\rho = N/\mathcal{A}$. The mobiles do not enter or leave the network. The network density is therefore constant. The mobility is described by the mobile speeds and the direction angles. The direction persistent mobility model considers that the direction and the speed of the mobiles are constant for a certain duration, T , and vary independently from one hop to another [11]. In other words, the mobiles mobility status at packet reception is independent from the mobility status at packet transmission on the next hop along the route. Without the loss of generality, we consider the scenario where the distance between the mobiles at time t is d as illustrated in Figure 2. Mobile a moves with speed v_a at an angle θ_a . Mobile b moves with speed v_b at an angle θ_b . At time $t + T$, as illustrated in Figure 3, the distance between the mobiles is [11]

$$d_e = \sqrt{d^2 + T^2(v_a^2 + v_b^2) - 2T^2v_av_b \cos(\theta_a - \theta_b) + 2dT[v_a \cos(\theta_a) - v_b \cos(\theta_b)]} \quad (5)$$

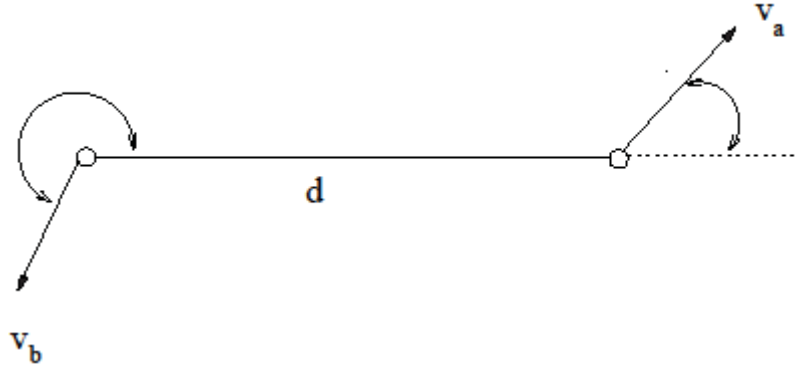


Figure 2 Mobiles: time = t

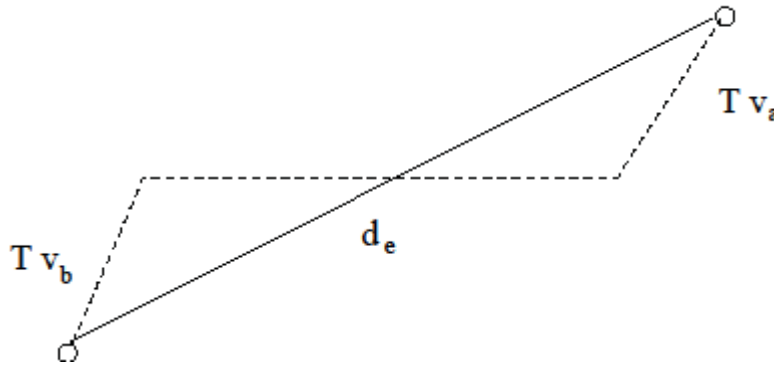


Figure 3 Mobiles: time = t + T

Note that $T = L/R_b + d/c$, where L is the number of bits per packet, R_b is the bit rate in bits per second, and $c = 1500$ m/s is the speed of sound underwater. The average distance between mobiles is $\bar{d} = (d + d_e)/2$.

3.3 AVERAGE ROUTE DISTORTION

The mobiles use a decode and forward relaying strategy. The route frame error probability (FEP) is $\text{FEP}_{\text{route}} = 1 - \prod_{i=1}^{n_h} (1 - p_{b_i})^L$, where p_b is the bit error probability (BEP) for a mobile-to-mobile link and n_h is the number of hops in the multihop route. For a large number of realizations over (v, θ) , the ensemble average route frame error probability which can be evaluated via Monte Carlo simulation is $\overline{\text{FEP}}_{\text{route}} = \frac{1}{M} \sum_{m=1}^M \text{FEP}_{\text{route}}$. The route distortion is

$$D_{\text{route}} = (1 - \overline{\text{FEP}}_{\text{route}})D + \overline{\text{FEP}}_{\text{route}}\sigma^2 \quad (6)$$

where $D = \sigma^2 2^{-2R}$ is the distortion for a sequence of i.i.d. Gaussian random variables with variance σ^2 encoded at a bit rate R by an optimal source coder [17]. The multihop route has an average number of hops $\bar{n}_h = \sqrt{N/\pi}$ [11].

Given perfect channel state information at the receiving mobile and flat Ricean fading for the mobile-to-mobile channel [18], the BEP is [19, 20]

$$p_b \lesssim \left(\frac{1+\mathcal{K}}{1+\mathcal{K}+\gamma(\bar{d},f)} \right)^{tr} \exp \left(-\frac{tr\mathcal{K}\gamma(\bar{d},f)}{1+\mathcal{K}+\gamma(\bar{d},f)} \right) \quad (7)$$

where γ is the signal to interference plus noise ratio (SINR). The Ricean fading parameter \mathcal{K} is the same for all mobile-to-mobile links. The achieved transmit diversity gain is t and the achieved receive diversity gain is r . The attenuation and noise are considered to be constant over the operational bandwidth, therefore for transmit power P and bandwidth B in kHz, the SINR is

$$\gamma(\bar{d}, f_o) = \frac{P}{A(\bar{d}, f_o)[N(f_o) + I(f_o)]B}. \quad (8)$$

4. NUMERICAL EXAMPLES

We consider numerical examples that illustrate the average distortion performance of a multihop route with an average number of hops. It is assumed that the variance of the i.i.d. Gaussian random variables is $\sigma^2 = 1$. The distortion is averaged over $M = 1000$ realizations. The network area is $\mathcal{A} = 1000 \text{ km}^2$. Independent Ricean fading for each MIMO mobile-to-mobile link with $\mathcal{K} = 10$ is assumed. The bandwidth is $B = 4 \text{ kHz}$. The frame size is $L = 1000$ bits. The bit rate is $R_b = 1 \text{ kbps}$. The mobiles move at a speed of $v = 1 \text{ m/s}$ and operate with the same transmit power level. It is also assumed that given the number of transmitters and receivers, full transmit and receive diversity in the MIMO mobile-to-mobile channel is achieved. Fixed losses are neglected. The spreading factor is $\kappa = 1.5$, the shipping activity factor is $s = 0.5$, and the wind speed is $w = 0$.

Figure 4 presents the average route distortion for 2×2 MIMO mobile-to-mobile link. The transmit power is $P = 110 \text{ dB re } \mu\text{Pa}$. The rate is $R = 4$ bits per description, that is, $D = 6.25 \times 10^{-2}$. In the case when the interferers are at a distance $d_1 = 2d$, the average route distortion is close to optimum. When the distance to the interferers decreases to $d_1 = 1.75d$, there is a graceful degradation in the average route distortion performance. As the distance to the interferers decreases to $d_1 = 1.5d$, there is a significant degradation in the average route distortion performance.

Figure 5 similarly illustrates the average route distortion for 3×3 MIMO mobile-to-mobile link. The transmit power is reduced to $P = 100 \text{ dB re } \mu\text{Pa}$ due to the higher degree of diversity. The rate is still $R = 4$ bits per description, that is, $D = 6.25 \times 10^{-2}$. In the case when the interferers are at a distance $d_1 = 2d$, the average route distortion is close to optimum. When the distance to the interferers decreases to $d_1 = 1.75d$, there is a graceful degradation in the average route distortion performance. As the distance to the interferers decreases to $d_1 = 1.5d$, again a significant degradation in the average route distortion performance can be observed.

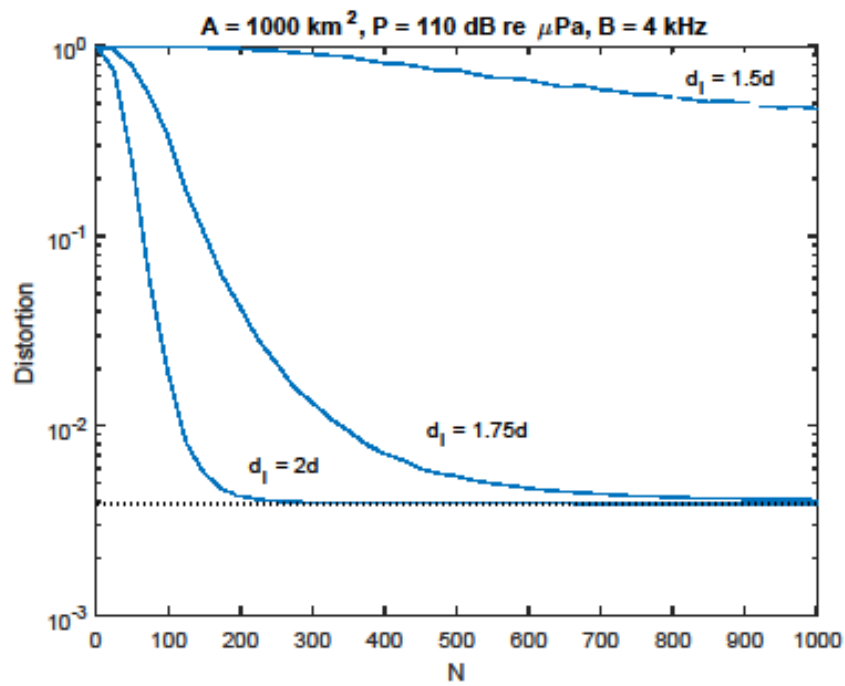


Figure 4 Distortion 2X2 MIMO mobile channels for R=4 bits per description

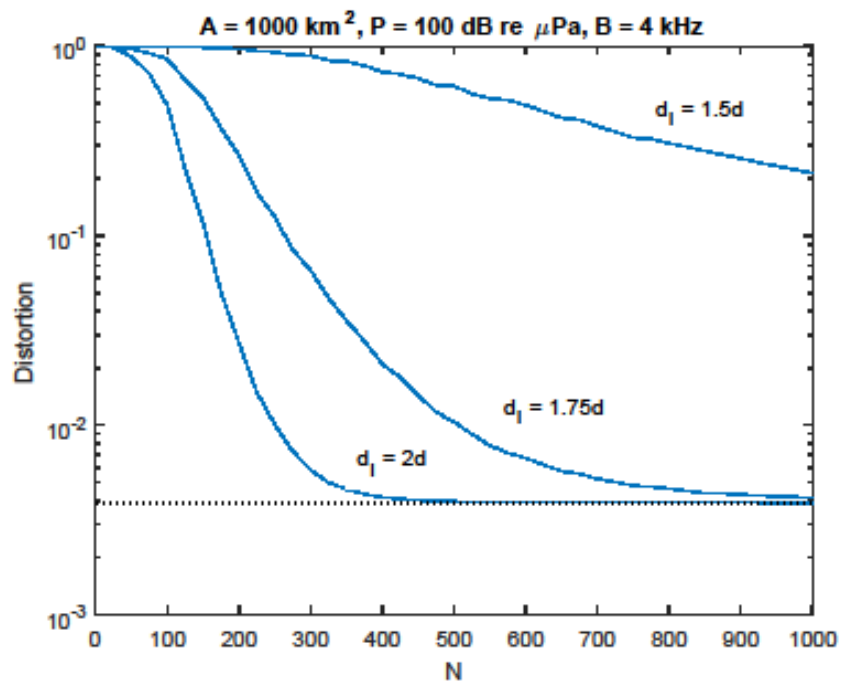


Figure 5 Distortion for 3X3 MIMO mobile channels for R=4 bits per description

5. CONCLUSION

The paper evaluated the average distortion performance of underwater acoustic MIMO mobile networks in the context of a direction persistent mobility model and the modified reserve listen and go transmission protocol that incorporated and exchange of RTS/CTS messages before the start of the transmission. The mobiles used decode and forward relaying. An i.i.d. Gaussian source was considered. The average distortion performance was illustrated through numerical examples. It was found that the impact of interference strongly depends on the distance between the receiving mobile and the interferers. The average route distortion performance deteriorates as the distance to the interferers decreases. On the other hand, the increase in the mobile's number of transmitters and receivers lead to performance improvements due to the increased diversity level.

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HIGHER EDUCATION IN AN ONLINE ENVIRONMENT - A BRIEF OVERVIEW OF THE EXPERIENCE OF INTERNATIONAL BALKAN UNIVERSITY

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Abstract. *The crisis caused by the SARS-CoV-2 virus has disrupted lives, economics and education around the world rapidly and beyond a scope that one could imagine. International Balkan University (IBU) quickly adapted to the “new normal” and replaced classical classrooms with the online synchronous online mode of education with a real-time video-conferencing and interactive teaching, using Zoom platform. The university used the online management system Hello for online class sessions. The university has opened an Online Learning Centre to allow real-time lectures, but also e-conferences, webinars, defence of graduate and master's theses, etc. Exam.net platform was used by most instructors 80% in the realization of the exams, in combination with Zoom service for monitoring the students and preventing cheating. An attempt was made to relate the initial observations about the content of IBU students regarding online teaching and examination with the success of students' cohort. The pandemic affected the internationalization of the university, however it hasn't had any negative influence on the research activities of the academic staff. This preliminary study attempts to start further analysis directed toward the determination of the effectiveness of the online teaching and learning process at IBU.*

Keywords: *online teaching, higher education, COVID-19 pandemic, International Balkan University*

1. INTRODUCTION

COVID-19 crises forced the global lockdowns and abrupt restrictions of all aspects of life [1, 2] including conversion of conventional face-to-face instruction to the online format [3, 4]. Schools and universities all over the world met with the challenges about the way to proceed with teaching and learning activities, and how to “save” the academic year, but at the same time, caring about the public health and minimizing the risk of the spreading the virus [3]. In March 2020, over 1.5 billion students and pupils all over the world have been affected by universities and schools' closures due to the COVID-19 pandemic, while in December 2020 due to partial reopening of the schools, the number dropped to 314 million learners or 18% of the total number of enrolled learners [4]. Virtual classrooms have become a significant part of the education, requiring the immediate transition of the face-to-face classes to the online mode. On the other hand, the academic staff was provided only with deficient information consisting mainly of technological help [5], without paying attention about the pedagogical issues, considered as most suitable in virtual classrooms to maintain the quality in education [6,7]. Also, the application of digital technologies in the online settlement increased, and thus the need for raising the awareness of teachers about the application of digital tools in the improvement of the teaching efficiency. A lot of studies advocated the different role that teachers have in online instructions compared with the teaching in the traditional classroom settlements [8, 9]. The new role of instructors requires training and institutional support [10].

Some universities have already established some model of remote teaching and learning, introducing distance learning or online teaching or a hybrid teaching and learning models (a combination of traditional face-to-face teaching and distance learning) before the start of the world health crisis [11, 12]. The successful realization of the online study programs relies on the provision of suitable tools supporting online teaching and assessment arrangements [13]. It shows online teaching to be suitable for learners with full-time employment and those having families. Increased number of learners with full-time employments, elder students with families and long-life learners, increase the demand in the orientation of the universities toward online teaching and learning [14].

The study carried out by the European University Association [11] showed that over 80% of the universities (Fig. 1) implemented online learning and teaching modes before the global health crisis, and they have established learning centres that support academic staff using digital tools in the improvement of teaching and learning in their courses.

The rapid interest in online education increased with the closure of the universities, although many professors and students had never experienced this model of teaching. It was found [11] that over 70% of the academic staff in Ireland had never delivered classes online, and the situation was similar in most European countries. But, the situation dramatically changed with the beginning of the pandemic, there has never been so big number of universities experiencing online teaching and learning [11].

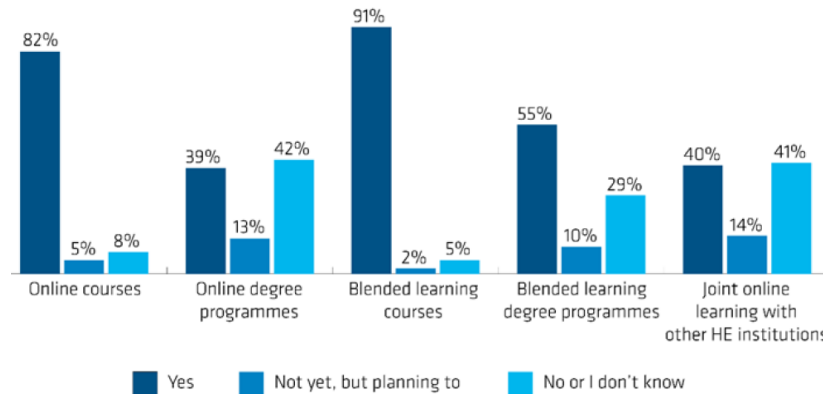


Figure 1 Types of e-learning offered by institutions. Source [11]

Some surveys indicated satisfaction of both, the students and the staff with implementing online education [11], but some data showed that students prefer more classical face-to-face teaching, particularly in learning difficult concepts [15] and those accepting a deep level of learning [16].

The transition from traditional on-site to an online education requires longer planning and preparation, involving the teacher's familiarity with digital learning and instruction tools, as well as the application of the suitable pedagogical approach. So, the emerged adaptation toward online teaching format is recognized as remote teaching. An additional concern is the minimization of plagiarism and cheating during exams. Therefore, the creation of the system for fair and generally accepted assessment approaches in the virtual environment is quite challenging [17, 18].

1.1. ABOUT STRENGTHS AND WEAKNESSES OF ONLINE EDUCATION

Some countries recognized online teaching as the opportunity for the learners who once felt difficulties to reach some higher education institution, particularly if it was located out of the region. The number of online programs increased, particularly in the United States of America, because of the financial aid offered by the country, recognizing an online education as the possibility to increase the number of well-educated people in the country [19, 20]. Costs of developing and starting-up online teaching are high and include the provision of hardware and software platforms for courses delivering, training, but, on the other hand, online courses may attract new students resulting in the profit increase [21, 22]. Online learners don't travel to a certain location, they can join the classes from home and, at the same time, online teaching can reach a bigger number of students [21]. The suitable teaching methodologies the teachers implement can help students in adaptation and experience as a part of the community. Some concerns arisen about the application of pedagogical practices, suitable for an online classroom have been a concern of the provision of an efficient realization of engineering education in the virtual environment [23]. Applied pedagogies supporting critical and creative thinking, collaboration and interaction are oriented toward project-based, hands-on concepts, interactive labs, data analysis, scientific simulations [24], active learning [25], flipped classroom [23, 26], problem-solving approach [27] and project-based learning [28]. Including discussions with students during online classes increase students' success. It was shown that the students feel more comfortable and freer during online discussions and have more time to focus and form their opinions and ideas, leading to better integration in the online classrooms. Often as a measure of the student-instructor interaction and the level of teacher's interest and care for them, one is using the feedback of the instructors on the students' performance [29].

Institutions offering online courses were more concerned about the rate of successful completion of the courses and not only in the number of enrolled students. Some studies showed that effective teaching, the commitment of the teachers and students and their self-discipline can improve the achievements of students.

Providing quality in the online teaching requires a combination of the following segments teaching and learning techniques, methods for the evaluation of the gained students' knowledge and skills; application of technology that makes the planned things feasible; human and material resources needed for the realization of the selected methods. The question is how to measure the quality of online education?

Indicators of quality in teaching and learning are learning outcomes, interactions between the participants in the education process (student-students, student-content and student-academic staff), their satisfaction and the motivation, Fig. 2 [23]. An interaction is hard to be achieved when the online teaching is prepared quickly, i.e., when the material is delivered by the teaching staff and later used by students to work and study.

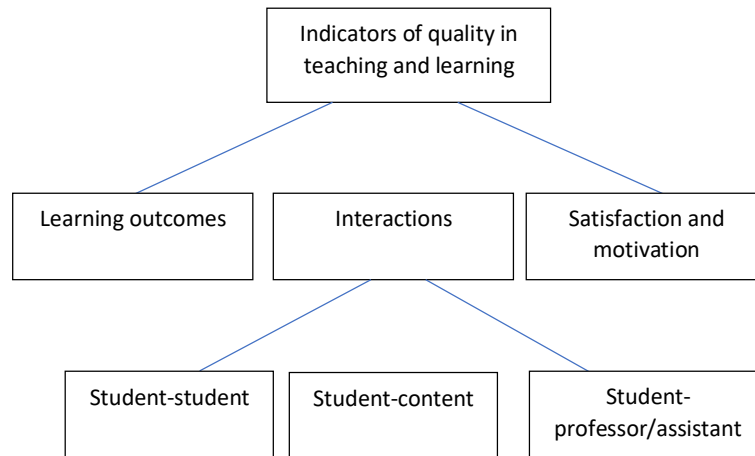


Figure 2 Indicators of teaching and learning. Source [23]

The first step in the quality assurance of the study program is its accreditation by the national and international authorities. Many programs that substituted classical teaching and learning to the online format with the start of the World health COVID-19 crisis, haven't been accredited for this mode of education [23]. Social interactions and communication approaches are not included in the design of classical programs while being critical for the online environment [30]. Design of the curriculum, the course content and the course material need to facilitate the three types of interactions student-material, student-students, and teacher-learner, Fig. 2 [23]. Studies focused on the interactions confirmed that in online education they are difficult to be achieved. Factors showing unsuccessful online teaching include isolation - when students cannot interact with their peers; lack of computer skills, frequent technical difficulties and educational deficiencies [30]. Yet, if the interactions are planned and integrated well, their realization and how they are achieved may increase the learning outcomes. Online teaching recognizes learning as both, a social and a cognitive process, not merely a matter of information transmission [31].

Internet connections and other technical problems obstruct effective online teaching. Organization offering online education needs to provide technical assistance for students and academic staff [20].

An additional drawback for the online settings is the ethical problems such as lack of honesty, integrity and reliability among the students. Some perceptions are that there are more opportunities for cheating, plagiarism and dishonest practices. The education institutions develop policies, procedures and guidelines to minimize or eliminate these ethical issues.

There is a general perception that the quality of education in an online environment is lower than the education performed in onsite settings. Some organizations, while they are not qualified, attempt to gain profit offering online education. This is considered as a reason for the negative attitude toward online teaching and learning [32].

This study tries to give a brief overview of the adjustment of the teaching process from traditional in Campus education with the online mode, in the case of the International Balkan University.

2. SOURCE OF DATA

Course Success Report, submitted by the instructors of the International Balkan University at the end of every semester, was used for the calculation of the percentage of students that failed in the exams and need to retake courses for spring semesters in the academic years 2018/2019 and 2019/2020. The percentage of failed students per study year was calculated. The analysis includes only courses with data given for both academic years. Thus, the same courses have been taken into account.

Information related to the research activities of the academic staff has been taken from the Academic Yearly Evaluation Report that the academic staff submits at the end of the academic year.

Statistics about the number of realized incoming and outgoing mobilities for both staff and students within Erasmus+ program have been given by the International Relations Office of the International Balkan University.

3. EXPERIENCE AT INTERNATIONAL BALKAN UNIVERSITY

At the beginning of March 2020, because of the risk of spread of the virus SARS-CoV-2, the Government of the Republic of North Macedonia introduced the state of emergency (No. 44-2147/1) and the lockdown of the country, restricting work, schools, travel, leisure, and other aspects of life for more than its 2 million citizens.

The experience of the higher education institutions in North Macedonia in the time of pandemic confirmed the EUA experience showing that the comprehensive institutions have more difficulties to establish an institutional approach of remote teaching comparing to the smaller ones. Another important issue in the rapid shift to the e-teaching is the extent of implementing the digital provisions in the education process in a particular institution [11].

In the eve of the health crisis, except the application of the information and communication technologies in the enhancement of the quality of teaching and learning in all levels of the education, the online teaching style in the higher education was used only in a few cases for delivering the lectures to the students of so-called dispersed study programs. Furthermore, the online/distance teaching format was not recognized by the Ministry of Education and Science of the R. North Macedonia, i.e., it was not regulated by law.

At the beginning of March 2020 with the appearance of the first cases of COVID -19 in the country, the Government of the Republic of North Macedonia adopted several measures and recommendations to prevent the progress of the virus SARS-CoV-2. Among them was the interruption of the educational process for 14 days in all levels of the education system. Having the numbers of newly infected persons continuously increasing, it was decided the schools and universities to stay locked and the teaching process to continue remotely during academic 2018/2019. Thus, the Government enforced regulation for the application of the Law in Higher education at the time of emergency (No.4-2447/1, 23 March 2020) designating the transition of the classical education to an online format.

International Balkan University (IBU) was among the first universities in the country that adopted synchronous online mode of teaching, applying a real-time video-conferencing and interactive teaching, using Zoom platform. IBU developed his own Online University Management System (Hello Online System) in 2018, integrating all aspects of the university workflow, including modules for students, teaching staff, accounting and finance and the student affairs office, too. The access to the online classes has been provided from the links created in the Zoom platform integrated into the Hello Online System. The students and the academic staff needed to log in into their accounts in the Hello system to click on the link and to join the classes. Also, the course materials and the assignments for the students, for every course, have been uploaded in the Hello system. Moreover, the university has opened an Online Learning Hub, equipped with technical arrangements to provide real-time lectures, webinars, defence of graduate and master's theses, e-conferences, etc. Not only classrooms are transformed into virtual ones, but the whole communication was done virtually, using e-mails, Viber, WhatsApp, Facebook messaging, Instagram and other social media applications.

The exams were also performed online. As the university solution for the online examination, Exam.net service was offered, and 80% of the academic staff used it in their courses. The rest 20% of instructors used project-based, take-home exams, oral examinations, etc.

The online teaching and learning process for academic staff and students of IBU was unknown. In the beginning, both teachers and students were delighted about this model of education, but some preliminary survey done by the assistants of the Faculty of Engineering [33] presented on the 2nd International Conference of Applied Sciences and Mathematics indicated that most of the students of International Balkan University prefer the traditional face-to-face type of teaching and examination. The reason for such results was not given.

It was assumed that the reason for the dissatisfaction of the students with the online teaching may be the increased number of the failed courses in the spring semester 2019/2020 compared to the spring semester 2018/2019. Course success report has been prepared at the end of every semester, where the number and percentage of students passed and those that need to retake the course is shown. The data of the courses delivered in the spring semesters in 2018/2019 and 2019/2020 were taken to develop an opinion about the success of the cohort (study year). The percentage of the failed students per study year per faculty is given in Fig.3. The records were taken just for the courses with the available information for both academic years, while the courses with the lack of information for one of the years have been disregarded. Only five faculties have been included in the analysis since the other two faculties didn't submit their data.

At the first look of the graph in Fig. 3, it seems like the percentage of the students failed the courses decreased in the spring semester of the academic year 2019/2020. More careful observation shows that there are cases where the number

of failures increased in the spring semester of 2019/2020. This is noticed for the 1st and 2nd year of studies at the Faculty of Communication (FCOM), 2nd and the 3rd year at the Faculty of Humanities and Social Sciences (FHSS), and in the 3rd year of studies at the Faculty of Engineering (FENG). The reasons of these results may be various, e.g., different professors that deliver a given course in both academic years under consideration, teaching styles have been changed, the overall success of the cohort, diverse learning styles of the students, technical issues, etc. [34, 35]. To understand the reason for such an observation, detailed analysis is required to be done in some future studies.

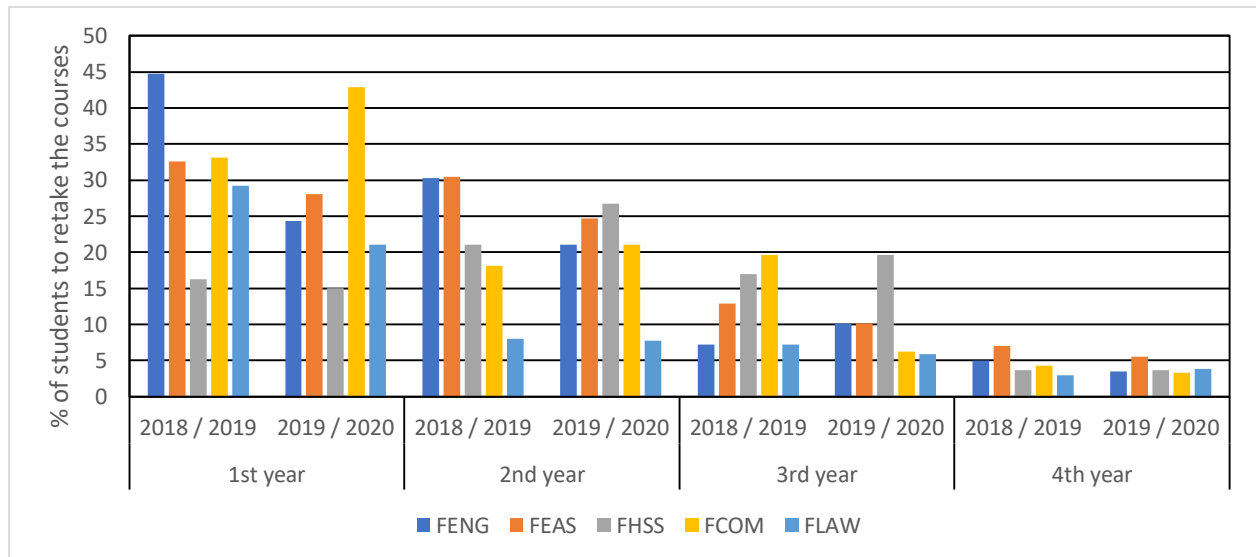


Figure. 3 Percentage of failed students per study year (cohort). The data concern spring semesters of the academic years 2018 / 2019 and 2019 / 2020.

Legend: Faculty of Engineering (FENG), Faculty of Economics and Administrative Sciences (FEAS), Faculty of Humanities and Social Sciences (FHSS); Faculty of Communication (FCOM), Faculty of Law (FLAW)

Table 1 Cancelled / postponed student and staff mobility

	Incoming Students	Outgoing Students	Incoming Staff		Outgoing Staff	
			Teaching	Training	Teaching	Training
Planned Mobility	21	20	22	20	7	5
Successfully Finished	7	20	0	0	1	2
Cancelled/ Postponed	14	0	22	20	6	3

Around 45% of the total number of students are international students from 10 different countries. Most of them returned to their countries and families at the first break of education, although at the beginning no one expected that such a situation would last that long. Also, Erasmus+ mobility program has been impacted by the worldwide health crisis. 67% of the incoming students and all incoming staff mobilities have been cancelled due to the COVID-19 pandemic and the cancellation of the International Staff Week in May 2020. A similar case was observed with the IBU outgoing staff, 75% of the planned mobilities were postponed, Table 1. This confirms the briefing report of the European University association elaborating that the first thing that suffered from the general lockdown was the internationalization and the mobility. It was interesting to observe that there wasn't single cancelling of the outgoing students' mobility that is different from the EAIE survey report demonstrated that 67% of their outgoing student mobility wasn't realized, while ESN survey report showed only 45% of cancellations [11].

It was shown [11] that COVID-19 pandemic interrupted the research activities, too. With the closure of the research labs, international research mobility was disrupted, changing the collaborations to the remote mode. With the risk of delays in the European Commission funds for the research projects, the additional obstacle has been in front of the research activities. Nevertheless, there is an opinion that research will continue online with increasing the interdisciplinarity and profound collaboration among universities [11].

Table 2 Part of the academic performance of the academic staff at International Balkan University in the academic 2018/2019 and 2019/2020.

Data available for five faculties: Faculty of Engineering (FENG), Faculty of Economics and Administrative Sciences (FEAS), Faculty of Education (FEDU), Faculty of Humanities and Social Sciences (FHSS), Faculty of Law (FLAW)

	Academic 2018 / 2019					Academic 2019 / 2020				
	FENG	FEAS	FEDU	FHSS	FLAW	FENG	FEAS	FEDU	FHSS	FLAW
Published articles										
(Original Scientific, Review, Short Scientific Professional and Popular Articles)	11	12	9	10	11	18	18	12	9	16
Participation to Conferences										
Contributions (paper)	21	7	9	9	4	28	9	4	7	5
Contributions (abstract)	7	9	7		12	20	2			1
National and International Project										
International	4	2	1	6	9	9	3	2	6	7
National	2	-	2	-	-	2	-	1	1	-

General observations on the performance of the academicians of the International Balkan University, presented in a form of the published articles, participation to the conferences and participation in national and international projects, Table 2, indicates that the lockdown due to the health crisis didn't decline the scientific contribution for the academic 2019/2020. An in-depth study on the impact on the research activities, some detailed and structured analysis needs to be done in the following studies.

To understand some initial perceptions, thorough research needs to be performed that would comprise studies related to the effectiveness of the online teaching and learning for every single course taking into consideration the different teaching methods implemented by the instructor. The analysis would involve the attitudes of the four stakeholders relevant for the education process: students, instructors, graduated students and representatives of the industry.

4. TOWARD BETTER ONLINE TEACHING ENVIRONMENT

Suggested strategies toward increased efficiency in online teaching are [20]:

- Some teaching platforms fit better given pedagogy. Thus, pedagogy advises technology and not vice versa.
- To understand the technical limitations, the students are facing.
- To allow students to design class model, how they will use their time. To decide whether they will read and watch pre-recorded lectures and they will use the classroom meetings for the consultation.
- Take some time of the class for socialization, promoting student-student interaction.
- Students to be informed on time about the things they need to do (homework, projects, discussions, etc.) for the successful accomplishment of the course.
- Application of the breakout sessions, particularly where group work is preferred, e.g., working on a project.
- Shorten the class hours to keep the student-focused, etc.

This preliminary study attempts to start further analysis directed toward the determination of the effectiveness of the online teaching and learning process at IBU, bringing the results of the survey into the practice.

5. CONCLUSIONS

Global lockdowns and unexpected limitations because of the COVID-19 pandemic forced the schools and universities to accept the online teaching model. Yet, in some countries, this model of teaching and learning hasn't been applied before the pandemic. As in the rest of the world, the teaching and learning process in the country has been switched from an old-style into a virtual format. International Balkan University quickly switched the onsite to online teaching. Real-time video-conferencing and interactive teaching and learning, using Zoom platform have been implemented. Virtual classrooms have been integrated into the University Online Management System, so-called Hello Online System. The students and the academic staff logged in into their accounts in the Hello system to access the link and to attend the lectures. The course materials and the assignments for the students for every course have been available in the Hello system, too. Besides, IBU has established an Online Learning Hub, allowing lecturing in the real-time defence of graduate and master's theses, e-conferences, webinars, etc. For the exams, mainly Exam.net together with the Zoom platforms has

been used for monitoring the students during the examination. This study aims to be a promoter for further in-depth studies about the outcome and the effectiveness of online teaching at International Balkan University.

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