

Proceedings of International Conference on
**Studies in Engineering,
Science, and Technology**

NOVEMBER 11-14, 2021 ANTALYA/TURKEY

PROCEEDING BOOK

EDITOR

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www.icsest.net



International Conference on Studies in
Engineering, Science, and Technology

www.icsest.net

Volume 1, Pages 1-122

Proceedings of International Conference on Studies in Engineering, Science, and Technology

© 2021 Published by the ISTES Organization

ISBN: 978-1-952092-26-8

Editors: Dr. Stephen Jackowicz & Dr. Maher Al-Jabari

Articles: 1-10

Conference: International Conference on Studies in Engineering, Science, and Technology (ICSEST)

Dates: November 11-14, 2021

Location: Antalya, Turkey

Conference Chair(s):

Stephen Jackowicz, University of Bridgeport, United States

Richard Thripp, University of Central Florida, United States

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Synaesthetic Scape: Methods of Creating a Virtual Architectural Experience

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Abstract: This research article draws attention to the sensory experience of architecture, whereby all different sensory aspects of the built environment work together to stimulate and communicate with the users' senses. The research disseminates a new term 'SynaestheticScape', which describes this experience. This term was introduced for the first time by the researcher in her PhD research. And it is also the title of the virtual landscape constructed as part of the Research by Design process. Architecture is understood in this article as the embodiment of human sensory interaction with an individual's environment through time and a way of holding users' stories of sensory interaction and perception. However, representations of architecture have tended to have been limited to expressing the visual interactions with the surrounding environment, ignoring the comprehensive effect of the sensory experience of users in understanding and perceiving their surroundings. The research article addresses this lacuna. The research aims to combine different concepts and methods that are not normally used in architecture to understand, describe and explore the process and potentialities of VR to produce ways of representing architecture that appeal to the senses and elicit memory and emotional engagement by developing a framework and a methodology outlining the foundation of a design process in creating sensory immersive spaces or 'SynaestheticScape' experiences which will eventually enhance the Iraqi pedagogy and design concept.

Keywords: Virtual reality, Architectural sensory experience, Synaesthesia

Introduction

In simple terms, synaesthesia means the union of the senses; '(Greek 'syn' = union/together + 'anaesthesia' = sensation/perception' [1] and it was first used in medical literature in 1860 [1]. In clinical terms, synaesthesia 'is a neurological condition in which the stimulation of one sense produces experiences in a totally different sense' [2]. Architectural theorist Marco Frascari introduced the term synaesthesia to architecture in his discussion of architect Carlo Scarpa's drawings (2003) and later in his book *Eleven Exercises in the Art of Architectural Drawing* (2011) [3]. Frascari emphasises that synaesthesia is not a neurological disorder, it is simply a different way to experience the world; subsequently, people with synaesthesia are referred to as 'synaesthetes' [4]. Frascari defines synaesthesia as the 'crossing of the senses' [4] and in *Eleven Exercises* he writes, 'It occurs

through the associations of two or more physical senses and other sense modalities' [3].

The experience of architecture is more about the multi-sensory interactions of our bodies with their surroundings, as opposed to reactions produced by the visual stimuli of design. Experience builds our memory of space and time; we are synaesthetes by instinct. However, we tend to lose this ability over time. Nonetheless, much of contemporary architecture seems to promote the visual aesthetics of spaces rather than seeking to deploy all of the senses that unite through the spatial experience. As a result, this research article responds to the need to draw our collective attention to all of the senses in the experience of architecture and explores the possibilities of creating a 'Synaesthetic Scape'. The article constructs the notion of 'Synaesthetic Scape' as a territory in which virtual perceptions are merged with other sensory associations, perceptions, and emotions (see figure 1).

For Frascari, sensory perception in synaesthesia transpires as an 'emotional state of affairs' that is difficult to describe:

'Synaesthetic inter-sensory associations are emotional states of affairs appreciating that there are ineffable things you hear, invisible things that you see, and impalpable things that you touch, that are describable but beyond words' [4]

Synaesthesia represents a condition which encompasses the cross-modality of the senses, something which differs from multi-modality [11] or a multi-channel communication concept. Multi-modality refers to the use of more than one channel or mode (media) of communication when it comes to introducing an idea or concept. The collection of these modes contributes to how multimodality increases an audience's reception of a concept or an idea; notably, these channels can be studied and detected separately (see Lexicon for full definition). In contrast to this conceptualization, this research article uses a proposed framework of 'Synaesthetic Scape' to explore the spatial experience contained within the understanding of synaesthesia as a 'cross-modality' of the senses.

Through exploring Carlo Scarpa's drawings as a key example, Frascari emphasised how the use of synaesthesia as a sensory experience influenced architectural representations. The architect Juhani Pallasmaa, on the other hand, has a slightly different perspective to this understanding. He warns that the sensory and spatial experience of architecture can become limited when focusing on the medium of graphical drawings or other symbolic, photographic, conceptual or intellectual representations. He argues that embracing these descriptive tools of architecture only serves to value the abstract and static value of building designs over the active essence of the human natural perceptual movement in and around those buildings and spaces.



Figure 1. Synaesthetic scape spatial explanation (design by the researcher in conjunction with frascari's concept of synaesthesia)

He is therefore critical of architecture which alienates us from our environment by displacing design, as a multi-sensory interaction, with static drawings that favour the visual sense. In particular, Pallasmaa is critical of computer imaging and suggests that,

‘computer imaging tends to flatten our magnificent, multi-sensory, simultaneous and synchronic capacities of imagination by turning the design process into a passive visual manipulation, a retinal journey. The computer creates a distance between the maker and the object, whereas drawing by hand as well as working with models put the designer in a haptic contact with the object, or space’ [6]

This research article builds on the ideas of Frascari and Pallasmaa in regard to architectural representation and experience. It contends with Pallasmaa’s theory that contemporary architecture is static and denies the real nature of human sensory perception. It further explores the potential of synaesthesia as a cross-sensory model for a virtual environment; an environment that allows for the sensory experiences of users when moving in and around virtual architecture.

The article introduces the term ‘Synaesthetic Scape’ as a framework for the design process. The term also describes, understands and reveals the potentials of the virtual environment which were created during the process of the research to elicit emotions and memory. The study investigates the potential of the ‘Synaesthetic Scape’ as a design tool which can create multi-sensory environments in order to enhance the experience of architecture and architectural pedagogy.

Etymology

Establishing the etymology of the ‘Synaesthetic Scape’

The etymology of my proposed ‘Synaesthetic Scape’ is explained in Figure 2. The suffix ‘scape’ has often been used in other words familiar to architectural design practice, such as landscape, soundscape and virtual scape, and is commonly used to describe a type of scenery. The combination of Synaesthetic and Scape thus suggests a cross-sensory spatial exploration.

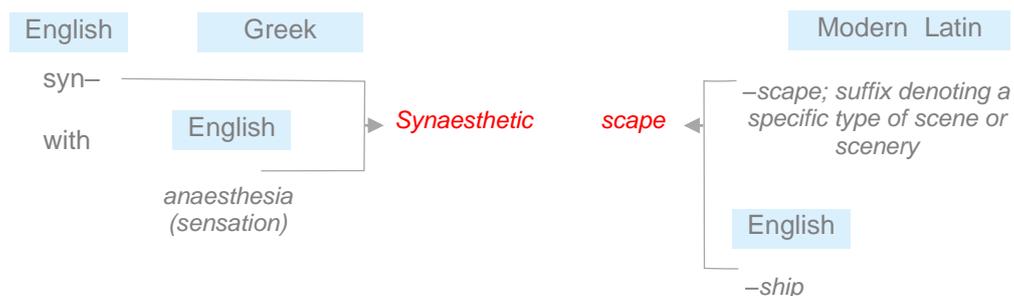


Figure 2. Proposed synaesthetic scape etymology (designed by the researcher)

Aims and Objectives

A three-stage framework was designed with the aim of designing in a synaesthetic way, the article uses an ‘Experimental inquiry’ Approach to achieve this aim. Briefly this approach involves a ‘process of generating and testing hypotheses for the purpose of understanding’ [7] and exploring the design process which produces the ‘Synaesthetic Scape’. Therefore, each stage has its own hypothesis, all of which are tested through a designed synaesthetic experiment, which, in turn, informed the subsequent stage.

The research aims to contribute to the design palette of architecture and the design process in general through the development of immersive VR tools for use in enhancing architecture as a sensory experience of place and subsequently the architectural pedagogy.

Thus, the objectives of this research can be summarised through two areas:

- To investigate the fields of synaesthesia and VR immersive environments in order to study the possibilities of designing in a synaesthetic way.
- To develop a co-produced design process for a ‘Synaesthetic Scape’ in which architects and users communicate and engage in the process of creating sensory immersive environments.

Methodology

The research developed a methodology which involved collecting, analyzing and deriving themes out of relevant data connecting to the virtual immersive experience. These themes were used to enhance the general design process of the ‘Synaesthetic Scape’.

The research is considered to be a narrative reflection of the researcher’s own research journey, whereby the aim of contributing to knowledge manifests through imparting both the methodology developed and the framework designed.

The research framework is designed around three accumulated experimental stages, all of which informed and led to one another (see figure 3). As stated previously, this framework uses an ‘experimental inquiry’ approach as a tool to operate the three experiments.

As made clear, each stage has its own hypothesis to test as well as individual questions to answer. This is completed through a designed synaesthetic methodology and test.

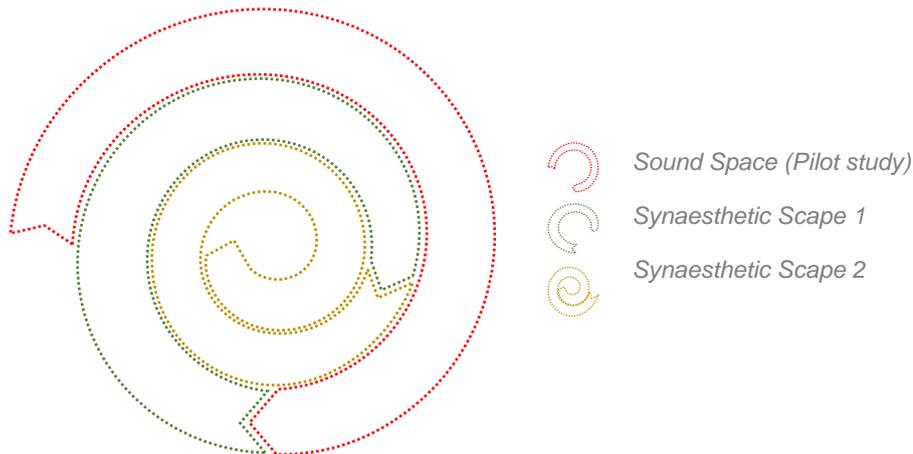


Figure 3. The three stages of a synaesthetic methodology (designed by the researcher)

‘Synaesthetic Scape’ is an experience of space where perception, sensory association and emotion are blended together in a virtual immersive medium. Thus, in order to test such an experience, the decision was made to design a synaesthetic methodology that identifies each of its three components and evaluates the results through the users’ experience of the space. This approach was carried out across every stage, with the results informing each subsequent stage. In order to identify and evaluate each component, the following actions were carried out:

Perception: users’ perceptions were identified by asking them to draw a map of the space as they perceive it (collecting artefacts).

Sensory association: In each stage, more than one sense was provoked. Users were asked to partake in a semi-structured interview to talk about their multi-sensational experience of the space.

Emotions: the users’ emotions were detected through every stage in consideration to each stage’s individual circumstances. Accordingly, they were evaluated by the participants within the semi-structured interview. Each stage had a distinctive methodology, as described below.

Stage One

Sound Space—Hypothesis and Questions

The initial stage in the design of the first ‘Synaesthetic Scape’, is referred to here as “Sound Space”

(four animated works of interior architecture. This project was my masters project which was submitted in 2002 for the MA Art & Space at Kingston University, London, UK. This pilot study tested “Sound Space” which represents an early example of the ‘Synaesthetic Scape’).

The hypothesis for this stage was:

A ‘Synaesthetic Scape’ experience can be achieved by tuning the design tools of lights, colours, textures and

materials (which are believed to influence the mood in the space emulating any real architectural experience’.

The subsequent two questions relate specifically to the sound space:

- What are the right levels of light, colour, materials and texture in influencing the emotional engagement of participants with the space?
- To what extent can music be used to provoke emotions in order to create the emotional aspect of the synaesthetic experience?

In the pilot study, a combination of quantitative and qualitative methods working together in two steps was proposed in light of the questions of the first stage (pilot study) and the hypothesis.

First step: Choose a method to identify emotions (quantitative method).

Second step: Focus group and semi-structured interviews with participants (qualitative method).

Nature of Data Collected

Facial video
recordings



- Tables of each individual’s raw data
- Excel Diagrams of emotional engagement
- Video Clips of emotional engagement (animated scenes)

Audio
recordings



Transcripts and themes

1. Facial video recordings were taken in three different situations:
 - Only listening to music in order to evaluate the level of music–emotion engagement.
 - Only watching the animated work (without the music) in order to evaluate the level of emotion–design engagement.
 - Watching the whole animation (with music) to identify the level of emotional engagement with the animated work as a synaesthetic experience.
2. An audio recording for the focus group
3. Audio recordings for the semi structured interviews

Nature of the Data in the Analysis Stage

This stage contains the visualized data in the form of tables and diagrams. All were made available to the participants, so that they could discuss in the focus group stage and later during the one-to-one semi structured interviews (see figures 4).

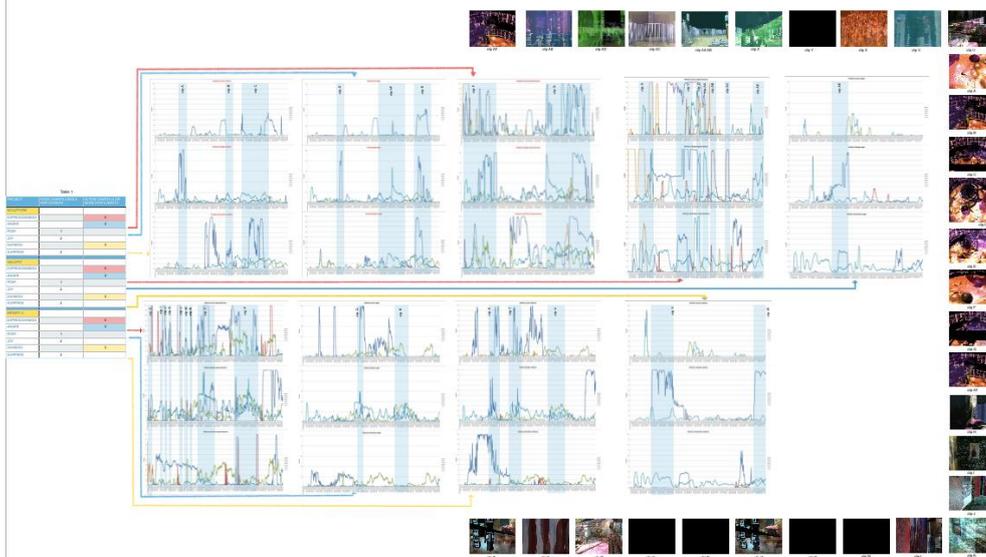
Stage Two

Synaesthetic Scape 1—Hypothesis and Questions

‘Using the virtual immersive technology will give users’ perceptions a sense of reality of the space, and its immersive qualities will help achieve the ‘Synaesthetic Scape’ experience’.

- Will neutralising the effects of the design tools (light, colour, materials and textures), allow other qualities of the virtual reality design to be present? Will this improve the quality of the synaesthetic experience? What might those qualities be?
- Can the virtual reality design share the same design tools as real architectural spaces?
- Music was used to provoke emotions in this scape; will it also provide room for the participants’

TimeStamp(msec)	angerct_emotion	attentionct_u	au01ct_linear	au02ct_nonlinear	au04ct_nonlinear	au09ct_linear_ca	au10ct_linear_ca	au15ct_linear_cau
0	0.00468622521	98.6196518	1.05828643	0.0690648109	0.00171960983	0.00450356631	0.00553352106	0.000592968834
71.4285736	0.00472830003	98.6852036	0.999735355	0.0649187043	0.00329321297	0.00454092957	0.00362603646	0.00152507098
142.857147	0.00475018751	98.5888596	1.17846727	0.0756969005	0.00604805816	0.0030355202	0.00337910419	0.00270185224
214.285721	0.00474529667	98.5906754	1.53991365	0.0819433481	0.0102025289	0.00395967253	0.00324276625	0.00335744023
285.714294	0.00475111417	98.516571	1.9756335	0.0922861919	0.0126793822	0.0040999013	0.00261972379	0.00365565345
357.142853	0.00474735256	98.690918	2.0633986	0.0850818753	0.0157473832	0.00316832354	0.00259625819	0.00413082354
428.571442	0.00474235322	98.7073746	2.0989418	0.0742011368	0.0175942387	0.00464760326	0.00294370158	0.0027452535
500	0.00475220988	98.633812	1.9408803	0.071747914	0.0176803544	0.00558160897	0.00312222214	0.0027004627
571.428589	0.00474391272	98.5016479	2.05222225	0.0701288134	0.0183979347	0.00357476622	0.00333795766	0.00279384293
642.857117	0.00474555371	98.5291672	2.10622001	0.069057785	0.0196945667	0.00252713775	0.00325023825	0.00229877746
714.285706	0.00477311667	98.5589828	1.90073156	0.0634146482	0.0220843088	0.00248452555	0.00318309152	0.00209183339
785.714294	0.00481270207	98.4271927	1.65690112	0.0594197661	0.0233397707	0.00370725244	0.00325796334	0.00221761758
857.142883	0.0048288051	98.3196182	1.61153746	0.0627619475	0.0231024139	0.00379317719	0.00317612523	0.00219958485
928.571411	0.00480855443	98.6448364	1.56864774	0.0681726038	0.0225412473	0.00417458033	0.00305591081	0.00196888228



imaginative understanding of the ‘Synaesthetic Scape’? (as in the first stage of experiments).

For this experiment, a combination of quantitative and qualitative methods were used in order to test the primary ‘Synaesthetic Scape’ environment. The experiment consisted of only one stage, unlike the first Sound Space experiment which consisted of two stages.

The Quantitative Method (E4 wristband)

The participants will wear an oculus kit (virtual reality kit to be worn on the eyes). The oculus kit will cover half of the participants’ faces, which makes it impossible to detect their emotions from their facial reactions. Thus, there was a need to change the ‘emotion as a service’ method used in the experiment; the electro dermal activity detection device, known as the E4 wristband, will be used (see figure 5).

This technology provides real-time data of the participants’ arousal levels in order to derive features related to stress, engagement and excitement. For more information about how this technology works see: <https://www.empatica.com/research/science/>.

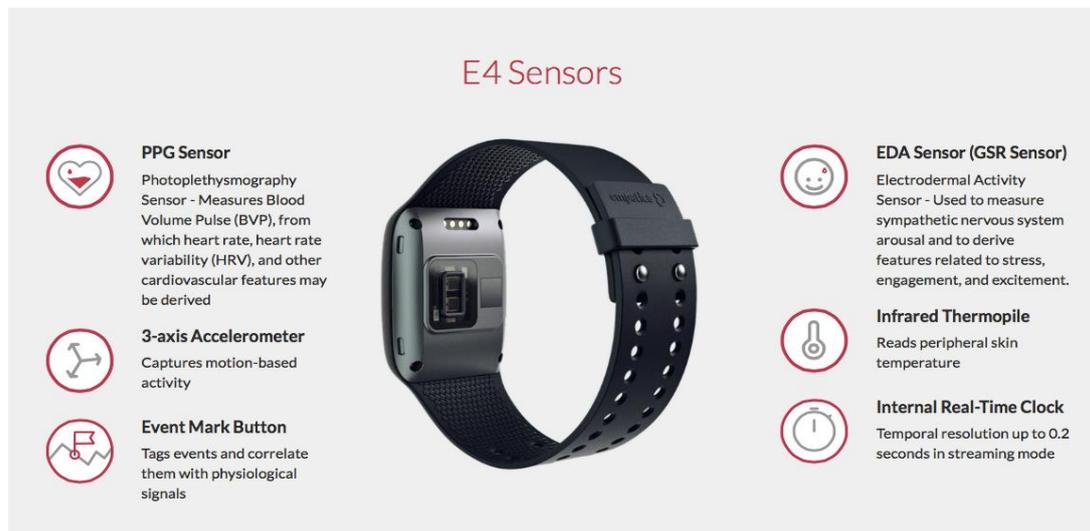


Figure 5. E4 wristband by empatica, (<https://www.empatica.com/research/e4/>)

The Qualitative Method

Semi-structured interviews with participants.

Nature of data collected and analysed (see Figure 6):

1. Sketches showing how participants perceived the synaesthetic environment.

2. Before and after real time diagrams of the EDA (electrodermal activity) produced by participant engagement.
3. Screen recordings of the participants' 'Synaesthetic Scape' journey.
4. Audio recordings of the semi-structured interview.
5. Transcripts of the audio recorded.

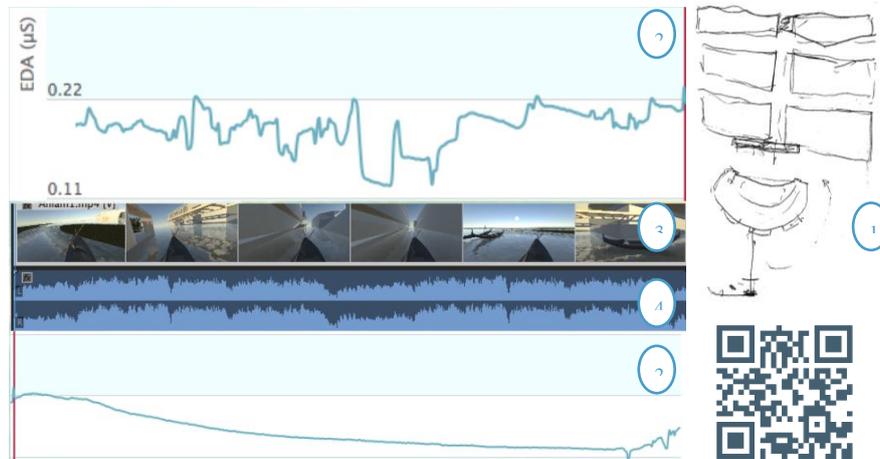


Figure 6: Sample of data collected from stage 2

Stage Three

'Synaesthetic Scape' 2—Hypothesis and Questions

'Using real sounds in the virtual environment will reflect a realistic synaesthetic experience'.

- How might sounds influence users' interactions with the 'Synaesthetic Scape'?
- Will real sounds influence the emotions and imaginations of participants as the music did in the previous experiments?
- What are the differences between using real sounds, as the emotional and multi-modality medium of the space, and the music used previously for the same purpose?

Stage Three Methods

The same combination of quantitative and qualitative methods used in stage 2 are also used in the stage 3.

Nature of Data Collected See (Figure 7):

1. Sketches of what the participants remember from the previous 'Synaesthetic Scape' experiment.
2. Sketches of how the participants perceived the developed 'Synaesthetic Scape'.
3. Before and after real-time diagrams of the EDA (electrodermal activity) produced by participant

engagement.

4. Screen recordings of the participants' 'Synaesthetic Scape' journey.
5. Audio recordings of the semi-structured interview.
6. Transcripts of the audio recorded.

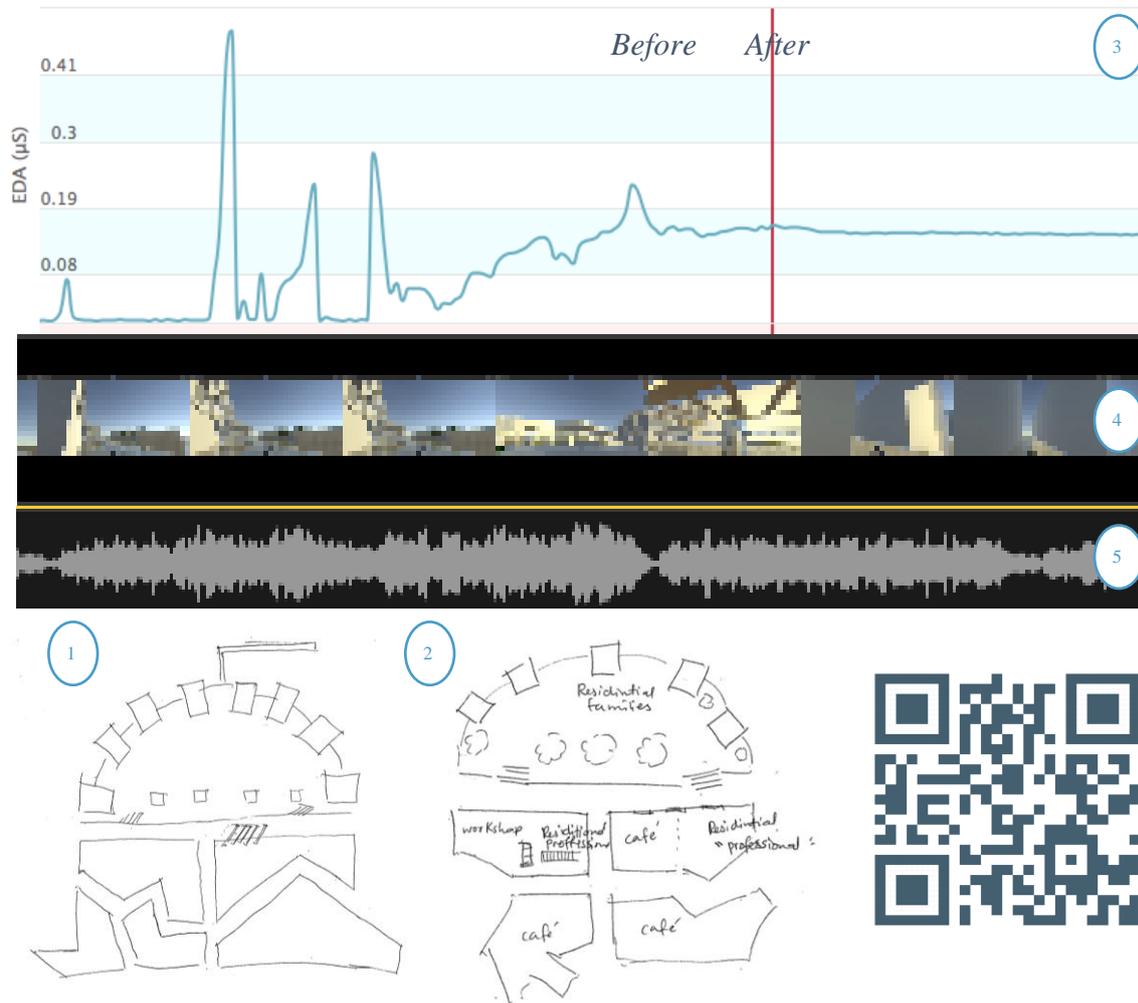


Figure 7. Sample of data collected in stage 3

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Redefined Norms in Education and Their Impact on Engineering Competencies

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Abstract: Engineering education is required to prepare the learners for the role of successful engineers through technological proficiency and innovation. An essential learning based on cognitive, affective, and psychomotor domains of learning are trusted to provide successful result. Since beginning of new century academia, industry and governments have given special consideration towards standardization and quality of engineering education through reforms and development of desired engineering attributes and competencies. The efforts have identified competencies required to succeed in contemporary team-based environment. Current pandemic environment has developed sufficient uncertainty in identifying post pandemic “NORM”. This paper analyzes different scenarios such as reverting to pre-pandemic NORM (Conventional), defining of a new NORM (Hybrid) or business as usual and continuation of pandemic scenario (Virtual). The paper also evaluates the perception that “Engineers graduated during pandemic environment are weaker than pre pandemic engineers” thus elaborates possible competency weaknesses.

Keywords: Engineering competencies, Online education, Scenario based analysis, Key performance indicators, Alternate to laboratory

Introduction

Engineering is a practicing profession, committed to tackling and controlling fundamental resources that are key elements for innovation and development of new technology, i.e., materials, energy and information (Feisel & Rosa, 2005). It prepares the learners to deal with resources of nature and resolving the real-life issues. The historical background establishes the essential requirements to prepare the engineers of future. Over the decades with increase in advancement and emergence of new technologies a concept of global technical workforce shortage has emerged.

As the focus of this paper is on engineering education that prepares the future engineers therefore, some significant reports published on defining the engineering are being referred in this discussion. The significant features of four reports published over last 100 years are briefly given in **Hata! Başvuru kaynağı bulunamadı..** With the exception in language, the engineering definition nearly remained unchanged from its first appearance in Institute of Civil Engineers' Royal Charter, 1828. Despite several consistencies, the reports elaborate trends in the development of engineering and task of engineer (Cheville, 2014).

Table 1. Defining Engineer and Engineering

Engineer/ Engineering	Mann (1918)	Grinter (1955)	EEPUS (1985)	Engr 2020 (2004)
Purpose	<ul style="list-style-type: none"> Improve industrial production Elevate mechanical arts to a learned profession 	<ul style="list-style-type: none"> Apply basic science for economic advance Discover and create through research 	<ul style="list-style-type: none"> Serve necessary technical function in larger system 	<ul style="list-style-type: none"> Creative element of social-technical system Increase prosperity Avert catastrophe
Role	<ul style="list-style-type: none"> Apply scientific principles to production Manager 	<ul style="list-style-type: none"> Provide technical advances to larger economic system 	<ul style="list-style-type: none"> Member of team that includes management and technicians 	<ul style="list-style-type: none"> Advance technical breakthrough Leadership Tackle societal problems
Preparation	<ul style="list-style-type: none"> Learn Science Apply Science in mechanic arts Managerial skills 	<ul style="list-style-type: none"> Predominantly technical De-emphasis of social Two tier system undergraduate and graduate 	<ul style="list-style-type: none"> Technical preparation in social context Able to function on a team 	<ul style="list-style-type: none"> Function with in social-technical system Leadership and management
Social- Technical Duality	Apparent social-technical duality increases over time.			

Table 1 shows that in order to prepare an engineer, all the reports focus on grasp of mathematics, analytical skills and science. Each report recognizes that integration of much needed social and technical knowledge is not

easy. It has been reported that in some countries engineering students have disengaged due to this complex requirement. The report titled as “The Engineer of 2020” states that contrasted requirements have resulted in disaster:

“Engineering education must avoid the cliché of teaching more and more about less and less, until it teaches everything about nothing. Addressing this problem may involve reconsideration of the basic structure of engineering departments and the infrastructure for evaluating the performance of professors as much as it does selecting the coursework students should be taught”. Thus, this century old problem of duality in engineering education is seen as an immediate and challenging issue that needs resolution.

The graduates are required to possess communication, multidisciplinary team work, and lifelong learning skills and awareness of social and ethical considerations associated with the engineering profession (Rugarcia, Felder, Woods, & Stice, 2000). These skills are listed as essential requirement for a future engineer to cope with the effects of fast paced modernization. Several programs have been initiated to conduct research on suitable pedagogy for engineering education and shaping of answers to problems being faced by the contemporary world such as sustainability (Grasso, Callahan, & Doucett, 2004). Thus, a term “Engineering competency” evolved, which means possession of specified level of engineering skill or knowledge and ability to perform a task. American Association of Engineering Societies (AAES) and the US Department of Labour (USDOL) defined a competency model to assist the academia and industry for preparing the engineering workforce (Khan, 2018).



Figure 1. Engineering Competency Model

A lot of emphasis has been put on to produce future engineers, who are competent to take on the challenges of contemporary world. Therefore, it is must for them to develop a talent of employing the set of related knowledge, skill, and aptitude for successful performance of a task. The model is expected to be used by educators, employers, industry leaders, and human resource for current and future engineers (Prelewicz, 2003 - 2018). The tiers 1 to 4 shown in the model are considered as the common core competencies whereas, tiers 5 and 6 are discipline-specific and job-specific comprising management and other requirements in engineering profession. The details of common competencies are as follows:

Personal Effectiveness: Interpersonal Skills, Initiative, Integrity, Professionalism, Adaptability and Flexibility, Dependability and Reliability, and Lifelong Learning are declared as basic abilities to be professionally successful engineer.

Academic Excellence: Competency in Reading, Writing, Science and Technology, Computer, Mathematics, Critical and Analytical thinking, and Communication skills are developed to deliver his thoughts at different platforms.

Workplace Skills: Creative thinking, Teamwork, Problem solving, Planning & Organizing, Business fundamentals, Client focus, Scheduling & Coordinating, Checking, Examining & Recording, Prevention & Decision making, Seeking & Developing opportunities and working with tools & technology are workplace skills to approach challenges with solutions. “*These skills basically require laboratory or workshop environment*”.

Technical Competencies: Professional ethics, Foundations of engineering, Engineering design, Manufacturing & construction, Engineering economics, Business, Operation & Maintenance, Security, Legal and public policy, Sustainability, Quality control & Quality assurance, Societal & Environmental impact, are additional significant industrial competencies.

Table 2. Graduate Attributes

Att #	Name	Description
WA1	Engineering Knowledge	Breadth and Depth of Knowledge
WA2	Problem Analysis	Complexity of Analysis
WA3	Design/Development Solutions	Breadth & uniqueness of engineering problems i.e. the extent to which problems are original and to which solutions have previously been identified and coded
WA4	Investigation	Breadth & depth of investigation and experimentation
WA5	Modern Tool Usage	Level of understanding of the appropriateness of the tool
WA6	The Engineer & Society	Level of knowledge and responsibility
WA7	Environment & Sustainability	Types of solutions
WA8	Ethics	Understanding and level of practice
WA9	Individual & Teamwork	Role in and diversity of team
WA10	Communication	Level of communication according to type of activities performed
WA11	Project Management & Finance	Level of management required for differing types of activity
WA12	Life-long Learning	Preparation for and depth of continuing learning

The unequal worldwide growth of technical workforce forced their movement around different regions. It dictated the recognition of engineering qualifications and competencies governed through different international

accords. One of the multi-lateral agreements commonly known as “Washington Accord” regulated substantial advances towards standardization of engineering education. The signatories of the accord demonstrated enthusiasm in developing and recognizing the good practice in engineering education. Various professional engineering bodies that control or promote engineering activities stressed on development and assessment of these generic competencies (Male, 2018).

Learning Domains

Learning process continues throughout the life of a human, which can be accomplished through formal or informal means. The simpler and mostly followed learning categorization is proposed by a team of researchers led by Benjamin Bloom. The taxonomy categorizes the learning in three domains i.e., Cognitive (knowledge), Psychomotor (skills) and Affective (attitudes). In common, words these are also known as Mental skills (related to head/brain), Manual/Physical skills (related to hand) and Feelings or emotional areas (related to heart) (Krathwohl, 2002). The three domains of learning are shown in Figure 2. The levels of three domains are widely published and not explained in detail in this paper but they play a vital role in describing the learning outcomes, decision on selection of teaching techniques and their corresponding assessment mechanism during teaching and learning process.

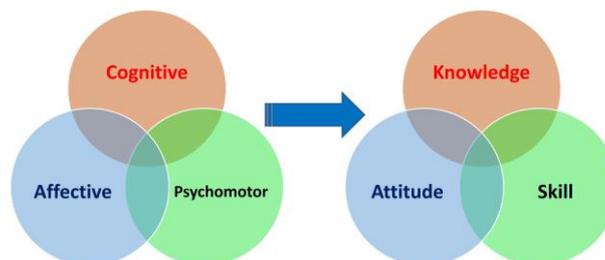


Figure 2. Learning Domains

E-Learning Programs Delivery

Interesting Predictions

Science is important to solve world problems that affect humanity, and it will continue to amaze humans with its discoveries and creations. The core of science's self-modification is technology which is advancing exponentially.

Table 3. Interesting Predictions

Shopping malls will wipeout	Online shopping
TV transmission becomes extinct	Video on demand
Large offices will not be required	Work from home
Restaurant eating reduces	Home delivery
Education on convenience	Online program delivery

On the onset of this century, it was predicted that rapid advancements of technology will take humans to new heights which will have its side effects. As result of this rapid technological advancements, scientists have already forecasted a long list of accomplishments in coming decades (Khan & Ashraf, 2017). A few of these given in Table 3, became a quick reality as result of human response to recent pandemic. The last row of the table shows that transformation to E-Learning was predicted to happen, but at a slower pace (may be a decade or half). To minimize the negative impact of suspension on education, mostly the higher educational institutions responded well by transferring studies to an E-learning model. The developed world was relatively less impacted by this sudden transformation as compared to the underdeveloped world. The new learning methodology demanded new processes, new policies, synchronous or asynchronous deliveries, alternate assessment methods, online and offline examinations, virtual invigilation.

It is an established fact that aspiration behind actions and intentions of a learner supports him to achieve. Researchers have agreed to the fact that a learner's motivation towards learning or achieving a specific goal can be either intrinsic or extrinsic (Newstead, 1999). An intrinsically motivated learner is the one who admires learning while an extrinsically stimulated learner is purely anxious to get grades. In addition to the low motivation level of learner, education sector has also reported various other challenges along with obvious advantages as shown in Table 4. It has also been reported that during this period the transformation had varied impact for different regions of the world (Siyabi, Khan, Hussain, & Rashdi, 2020).

Table 4. Challenges and Benefits of E-Learning

Major Challenges	Major Benefits
<i>Technological pedagogical content knowledge</i>	<i>Flexibility makes it cost effective, saves time and human resource</i>
<i>Technology-centered vs Student-centered approach</i>	<i>Self-paced with electronically available contents thus enhances knowledge retention</i>
<i>E-learning and the learning cycle</i>	<i>No limit on class size thus targets large audience</i>
<i>E-learning material</i>	<i>Collaboration encourages learning experience sharing</i>
<i>Assessment techniques and process</i>	<i>Room for discretion due to 24/7 availability of contents and unlimited watching</i>
<i>Feedback communication</i>	<i>Easy course tracking through electronic means and quick to update</i>
<i>Learners' motivation</i>	<i>Environment friendly provides paper less training</i>
<i>Performance evaluation criteria</i>	
<i>Academic quality assurance</i>	
<i>Academic integrity</i>	
<i>Success standards</i>	

Hands on Labs to Online Activities

Existing norms and policies existed for face-to-face (F2F) delivery lacked to address the challenges of E-learning, therefore, as highlighted earlier new norms, policies, processes, procedures were defined to cope with new techniques. All this was done at a rapid pace to save on learners' time and ensure continuity of education at all levels. Published studies focused primarily on the success of E-learning where the stress is put on the conditions, characteristics, or variables that, when appropriately sustained, managed, or retained, considerably impacted a specific industry. Programs delivering technical contents requiring on hand practice were affected more. The modules mainly comprising theoretical contents and had no laboratory or practical elements were relatively less impacted due to the change of learning methodology. However, due to lockdown, an alternative assessment to the written on-campus exam had to be proposed. As an alternate, an online examination having numerical problems, scenario based, or multiple-choice questions was developed.

A study published recently (Alqahtani & Rajkhan, 2020), established that blended learning demonstrates one of the key success element for the institutions delivering such programs as it mitigates the drawback of practical work experience. Primarily, blended learning integrates the traditional F2F and online sessions. The newly evolved alternate techniques to address these deficiencies and develop the lab related competencies are dynamic lab simulations, smart work sheet, interactive simulations with smart sheet data analysis (Francis, Smith, & Turner, 2020). Brief features and benefits of such attempts are given in subsequent paragraphs.

Dynamic Lab Simulations: 2D key learning outcomes (animations)

- *Active learning and passively watching video*
- *Familiarization (equipment, techniques, health, and safety)*
- *Appreciation into intricacies*
- *Economical to avoid wastage of material*
- *Superimposing on same screen*

Smart Data Worksheets: Complex scientific data analysis

- Graphing
- Spectrum analysis
- Multi step calculations
- Lab or Randomized data
- Personalized feedbacks

Customized Smart Worksheets: Integrated to program requirement

- Tailored to lab requirements
- Embedded in VLE
- Integrated to gradebook
- Interactive Simulation with Smart Worksheet

These creative techniques amicably resolved and achieved the outcomes for arts and science programs where the basic requirement is to generate data and interpret. However, in case of engineering this lacks full development of engineering competencies and completing requirements expected from technical and engineering programs. Some of the engineering programs such as, Aeronautical, Marine, Automotive, Civil etc. either require the development of fault diagnosis/troubleshooting or need hands on work experience, else, such graduates will go to the field without fully developing the first four levels of competency model at educational institutions. The graduates not equipped with these essential competencies to a required standard, may not fall as first choice of employers thus their employability will be at risk. This baggage will not only be felt a burden on industry but also generate a time constraint for development of 5th and 6th tier i.e., discipline and Job specific competencies.

Educational Norms

The world trusted on E-learning during COVID to ensure the continuity of education for the learners. The new alternative delivery technique required new processes, new policies, synchronous or asynchronous deliveries, alternate assessment methods, online and offline examinations, virtual invigilation. Therefore, new NORMS became essential to address the challenges faced by learner and teacher interacting through online sources and on opposite sides of screens. Requirement of new NORMS became a must for institutions that previously never used E-learning to this amplitude. Academics started discussing whether the outcomes can be fully delivered and assessed while learner is off campus and Lab work can be accomplished without access to teaching laboratories?

Academic managers answered most of these queries with definition of new norms. Content delivery challenges were duly addressed and innovative assessment techniques through challenging of applied MCQs to prove that these are not an easy option along with the scenario-based questions were trusted upon. Numerous policies were issued, processes were defined and implemented, and quality frameworks were documented. Having gone so far down the lane, the bigger question bothering the academic sector remains unanswered. The question of immense importance for all and specifically for engineering education stays – what will be the future educational norms? Will the world ever go back to pre-COVID routine, or we will continue the newly defined routines/norms? Will there be an emergence of something new and entirely different? What will be the new normal?

Conclusion

The transformation from conventional learning to an E-learning environment generated different challenges. It became relatively tougher for the underdeveloped world to cope up with the demanding requirements of E-learning. Education sector developed different alternate and suitable methods for continuation of the teaching and learning process. Delivery of programs and assessments of outcomes were addressed differently across the world. Alternate methods for delivery, assessments, feedback, and lab work were developed and implemented.

American Association of Engineering Societies (AAES) and the US Department of Labour (USDOL) has prepared a competency model that clearly elaborates the required skills by engineering graduates. These newly developed methods fully met the requirements of science or arts programs but partially fulfilled the demands of engineering programs. A deficiency in development of the essentially required competencies among engineering graduates was reported. The newly developed methods could not fully address the teaching of hands-on skills to engineering graduates when students did not have access to engineering workshops.

An uncertainty towards the norms to be followed in future has also been observed. This uncertainty of when and how the normal environment in education sector be returned is highly impacting the engineering education. The education sector is not sure whether the pre-COVID environment be ever returned, or they will keep operating in the revised environment. In case the return to normality is not possible and continuity of COVID environment does not prevail, the in between hung education sector may resort to defining the new NORMS.

Acknowledgements or Notes

Authors of this research article are thankful to the Department of Research at Military Technological College Muscat Oman for their support in the conduct of this research.

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Providing Health Security against COVID-19 Pandemic in the Office Spaces of European Programme Support Office in North Cyprus: An Architectural Aspect as a Different Approach to Ventilation of Spaces with Fresh Air

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Abstract: In this paper EUPSO's interesting project will be explained by architect and project manager Erhan Onuralp. Project has been awarded in June 2020 and those days most of the scientific aspects were not known on COVID 19 virus. Mr. Erhan Onuralp with his 32 years experience synthesize ANSI/ ASHRAE standards and other scientific researches which were very limited in that dates within his project scope on his EUPSO ventilation project. Ventilation and related installations are in mechanical engineering scientific area. This paper will be an interesting example in the symposium. A mechanical design was designed by an architect according to sitting places and distances. Interior spaces have still a %100 percent risk for COVID 19 spread. Displacement ventilation theory was commented on in European Programme Support Office Ventilation project. Special detailing was prepared to enable this kind of ventilation system. Different model of piping was put forward in the design. All these designs will be implemented. We will enter the scientific detailing for determination and the amount, quality of air supplied to the existing building. According to these determinations full mechanical ventilation and additional systems will be in the context of this study. In addition to the ventilation element, the joint operation and efficiency of the ventilation and air conditioning solution will also be discussed. Summer seasons in Cyprus are usually extremely hot (35-45 degrees Celsius). The combined solution of the cooling (climatization) and the ventilation of the office building will also be discussed and solved in the EUPSO ventilation Project design

Keywords: Indoor Air Quality, HEPA filter, Ventilation, Mechanical Ventilation, Architectural Aspect

Introduction

Air (oxygen) is an important determinant of health. A wide range of adverse effects of ambient air pollution on health has been well documented by studies conducted in various parts of the world. Fresh clean air must be supplied to the living areas in buildings. Due to COVID-19 new regulations and recommendations forcing architect and engineers to design cleaner atmosphere in the buildings. This can be achieved by opening the

windows or using mechanical ventilation techniques. Office buildings with mechanical heating, ventilation, and air-conditioning (HVAC) systems are designed to provide air at comfortable temperature and humidity levels, free of harmful concentrations of air pollutants.

While many of us tend to think of ventilation as either air movement within a building or the introduction of outdoor air, ventilation is actually a combination of processes which results in the supply and removal of air from inside a building. These processes typically include bringing in outdoor air, conditioning and mixing the outdoor air with some portion of indoor air, distributing this mixed air throughout the building, and exhausting some portion of the indoor air outside. The quality of indoor air might deteriorate when one or more of these processes is inadequate. For example, carbon dioxide or unhealthy viruses may accumulate in building spaces if sufficient amounts of outdoor air are not brought into and distributed throughout the building.

How did Dr. Erhan Onuralp get the chance to design a mechanical project as an architect and project manager? In year 2016 EUPSO refurbishment project was designed by Onuralp Project Development & Management Ltd. and by him. We have succeeded in completing the project implementation within the foreseen budget. European Support office is an office which supports European Union funded projects for the Turkish Community in North Cyprus. In the office building there are almost 50 staff working. The interior design is well designed and working very well. In 2016 this building was a residential building and had 4 flats in each floor. Each flat had two bedrooms and one living space combined with an open kitchen corner. The building has 5 floors.

Each floor measures roughly 260 m². At the ground floor there were 4 shops with mezzanine floors. The refurbishment project changed the function from a residential apartment into an office building with a conference rooms, 5 meeting rooms and 40 office spaces.

In the first week of March 2020, COVID-19 cases started to be seen in North Cyprus and subsequently a lockdown took place for almost 3 months. The unknown features are very unknown and all of us search about the new scientific researches on cases and data which were collected from the COVID-19 cases. During this period, the administration the EUPSO office contacted me in order to take precautions and create safe indoor environment within their office against COVID-19 virus spread.

In May 2020, we started to look for scientifically supported solution on how we could ensure clean and safe spaces for the staff to return their offices. Within a month period we prepared a report with my mechanical engineers in my project management firm on how this would be realized. We took on a great responsibility to agree that we would be able to solve this problem with a project. During this period our firm conducted excessive research on how to project a new scope of the Ventilation system and indoor air circulation which should be handled in different way. In existing ventilation systems in North Cyprus, mixed ventilation systems are used based on mixing air in the space by cooling and heating. There was important task to be undertaken by the team in terms of design that would protect staff from inhaling contaminated air and passing it to each other.

Transmission Ways of COVID-19 Office Indoor Spaces

COVID-19 is a disease caused by the SARS-CoV-2 virus, spreads from country to country, following modern travel routes. It was first reported to the WHO Country Office in China on 31 December 2019. After that, it inevitably crossed the country's boundaries, and has become a global pandemic. Nowadays we have accountable knowledge of several aspects of infection spread, including on one critical aspect of the SARS-CoV-2 virus: how this virus transmits. In general, it is considered that viral respiratory infections spread by direct contact, such as touching an infected person or the surfaces and fomites that the person has either touched, or on which large virus-containing droplets expired by the person have landed and there the virus can remain stable for days. The droplets can also be deposited directly on a person in close proximity to the infected person. Therefore, frequent handwashing and maintaining a distance of at least one meter (arm's length) are considered the main precautions against contracting the infection. One transmission route that is mentioned only in passing, or not at all, is the transport of virus-laden particles in the air. Immediately after droplets are expired, the liquid content starts to evaporate, and some droplets become so small that transport by air current affects them more than gravitation. Such small droplets are free to travel in the air and carry their viral content meters and tens of meters from where they originated as graphically presented in [Figure.1](#) Large droplets can remain airborne for thirty minutes and may infect people within a six-foot range. Smaller, lighter droplets can travel further and remain in the air for even longer.

Modes of transmission with airflow:

- SARS-CoV-2, the virus that causes COVID-19, is thought to spread mainly from person-to person through respiratory droplets.
- Infectious respiratory droplets are produced when an infected person coughs or sneezes.
- Droplets can land in the mouths or noses of nearby people.
- Droplets can land on surfaces and be spread through contact with contaminated surfaces.
- When in close contact with an infected person, droplets can be inhaled into the lungs.
- Airborne transmission in some circumstances seems probable.

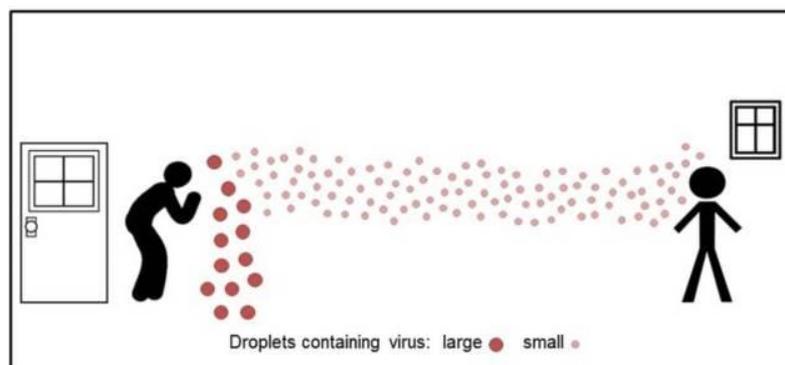


Figure 1. Larger droplets with viral content deposit close to the emission point (droplet transmission), while smaller can travel meters or tens of meters long distances in the air indoors (aerosol transmission).

Airborne Transmission of SARS-CoV-2 through Air in Toilet Rooms

Transmission of SARS-CoV-2 through the air is sufficiently likely that airborne exposure to the virus should be controlled. Changes to building operations, including the operation of HVAC systems can reduce airborne exposures. ASHRAE Statement on operation of heating, ventilating and air conditioning systems to reduce SARS-CoV-2 transmission: The SARS-CoV-2 virus may be aerosolized by flushing the toilet. Studies have shown that toilets can be a risk of generating airborne droplets and droplet residues that could contribute to transmission of pathogens.

- Keep toilet room doors closed, even when not in use.
- Put the toilet seat lid down, if there is one, before flushing.
- Vent separately where possible (e.g., Turn exhaust fan on if vented directly outdoors and run fan continuously).
- Keep bathroom windows closed if open windows could lead to re-entrainment of air into other parts of the building. The risk of propagation can increase based on ambient factors, such as temperature and humidity levels. Social distancing, sufficient ventilation, maintaining recommended relative humidity levels, and surface cleaning can decrease the risk of contracting COVID-19.

Are Temperature and Humidity Matters?

When the air is humid and warm, the droplets fall to the ground more quickly, and it makes transmission harder." The introduction of cold and dry air in the winter escalates the spread of Coronavirus. However, warmer temperatures will not make it disappear. Coronavirus can only be inactivated if exposed to temperatures above 133°F (56°C) for 30 minutes or more, which is not likely to occur with office (working spaces) air distribution systems.

Air Movements in Office Buildings

Understanding air movement in buildings is crucial whilst investigating indoor air quality. Airflow patterns in office buildings are the result of combined forces that are dominated by stack effect and by mechanical ventilation. Indoor air movement and conditions are affected by changes in wind velocity, wind direction, and outdoor temperatures. Unless a building is properly air sealed via compartmentalization, air could very well move from one to another, increasing the risk of cross contamination. Human activities such as walking, breathing, or using equipment also contribute to air movement within working spaces.

Ensuring Indoor Air Quality against Pandemic Coronavirus Risks

The indoor air quality of air-conditioned offices is a subject of public health importance because we spend a substantial amount of time in these premises. Good indoor air quality can lead to improved productivity at the

workplace. On the other hand, poor indoor air quality will cause productivity to drop because of comfort problems, ill health and sickness absenteeism.

Ventilation plays a crucial role in relation to the indoor pollution levels. Achieving appropriate indoor climate conditions, including good IAQ, requires in most cases the use of energy. The implementation of ventilation strategies for achieving appropriate indoor air quality conditions are in practice translated into the need for certain investments. Cleaning indoor air with exhausting the polluted air (air may contain COVID-19 viruses) from the office spaces by HVAC system. Fresh filtrated outdoor air is supplied by HVAC system for the office spaces equivalent to amount of exhausted air.

Can Ventilation Systems Spread COVID-19?

Indoors, heating and air conditioning units may also draw virus-laden air toward certain parts of a room based on the velocity and direction of airflow. Another concern is some HVAC systems can cycle out stale air containing viruses and other particles just like ceiling fans and other dilution ventilation equipment. In large commercial buildings equipped with central ventilation systems where recirculation is used, the risk of cross contamination is high. One possible route for cross contamination is the passage of airborne dust via the ducting system when the HVAC system is off or in a failed state. Unless equipped with appropriate filtering, systems that use mixing ventilation would increase the risk of virus spread. See Figure 2.

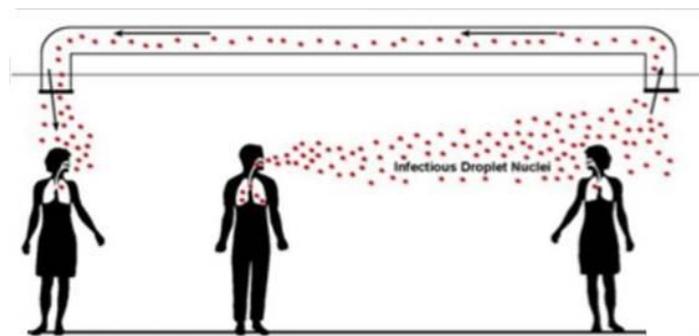


Figure 2. Infectious air passage risk through horizontal canals of Ventilation system

A displacement ventilation system would significantly reduce the risk of propagation as low air velocity would force droplets to quickly fall on the floor. While this system is a great option for new construction, its implementation would be costly as a retrofit. In Figure 3 below provides us with information regarding an example of a mixed ventilation system, indoor air flow circulation in a restaurant increasing coronavirus spread through the guests.

Air Filtration and Air Cleaning Within HVAC Systems

Conventional air filters with an improved Minimum Efficiency Reporting Value (MERV) between 13 and 15

can reduce levels of droplet nuclei but are not likely to be effective at stopping any unattached virus particles. These filters could assist in reducing the likelihood of droplet nuclei from spreading and may be within the fan capabilities of existing systems.

High Efficiency Particulate Air (HEPA) Filters

HEPA type of air filter can theoretically remove at least 99.97% of dust, pollen, mold, bacteria, and any airborne particles with a size of 0.3 microns (μm). The diameter specification of 0.3 microns responds to the worst case; the most penetrating particle size (MPPS). Particles that are larger or smaller are trapped with even higher efficiency. Using the worst-case particle size results in the worst-case efficiency rating (i.e. 99.97% or better for all particle sizes). All air cleaners require periodic cleaning and filter replacement to function properly. These filters are typically used in office buildings hospital operating rooms, acute care areas and clean rooms. HEPA filters are unlikely to be a practical option for most existing HVAC systems due to their high pressure drop. Ventilation system of EUPSO will be designed to get clean air from atmospheric conditions to inner office spaces according to HEPA filters properties. Additionally, HEPA filters require specific housings and cannot be retrofitted as a direct replacement for traditional filter media.

Ventilation System against Pandemic Spread

Mixing Ventilation Vs. Displacement Ventilation

Mixing ventilation, is a traditional method for supplying conditioned air to spaces. Conditioned air is blown in through the ceiling or wall and dilutes the air in the room in an attempt to provide an even temperature but, unfortunately, it also evenly distributes contaminants through the space. In other words, the exhaust suction and fresh air inlet are all from the ceiling. In mixed air ventilation all the air in the space are mixing and it creates the contaminated air mixing with clean air injected. See figure:3

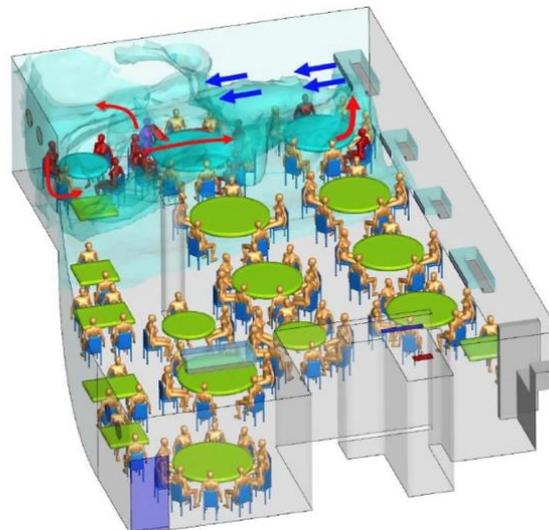


Figure 3. Figure shows mixed ventilation system indoor air flow circulation

With displacement ventilation, air is introduced at low velocity into a room at a low level and is exhausted at the ceiling. The flow of air is maintained by convective forces, which also have the effect of the concentration of pollutants rising from floor to ceiling. Displacement ventilation leads to cleaner air, as contaminants are removed from the occupied zone in a room towards the ceiling, as well as fewer complaints about drafts. This system is extremely different from traditional mixing distribution, or mixing ventilation. In mixing ventilation, air is supplied to a room at high velocity from the ceiling and all the air in the room is mixed together to provide a uniform temperature. The downside to this approach is that contaminants are mixed with the air where they are continuously present in the breathing zone; thus, the indoor air quality is not as high as in displacement ventilation. Figure: 4 illustrates the differences between Mixing ventilation and Displacement ventilation

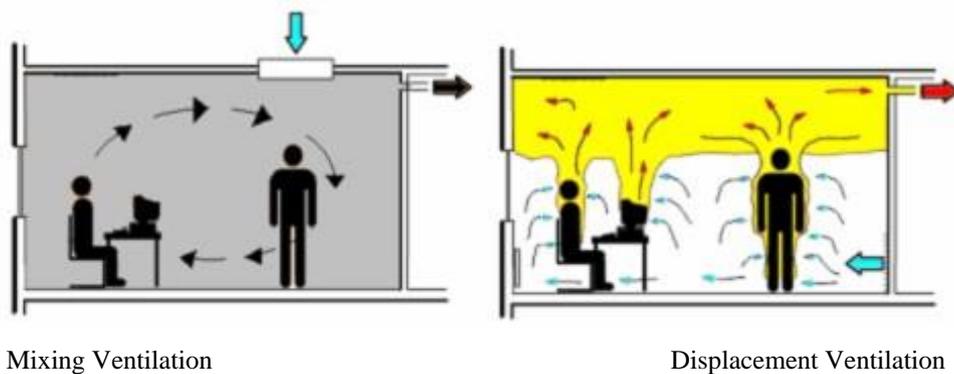


Figure 4. Differences between Mixing Ventilation and Displacement Ventilation

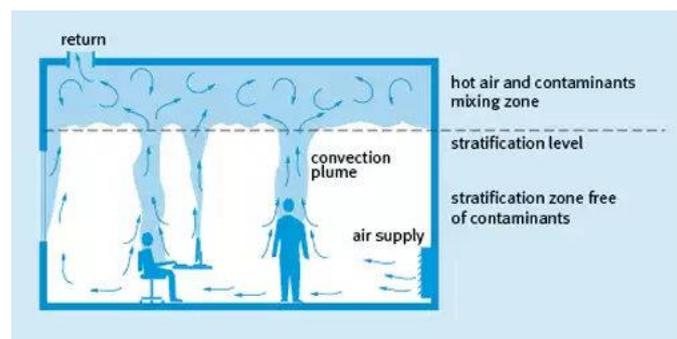


Figure 5. Displacement Ventilation stratification level

Displacement ventilation is used mostly in Europe. Displacement ventilation is a strategy that has been proven to provide superior air quality in European buildings and may possibly save energy. Displacement Ventilation is the preferable solution for providing COVID virus free spaces.

EUPSO Ventilation Project

"How can we make an air ventilation system that relies upon pulling natural air?" Air ventilation systems typically rely upon controlling artificial air to supply into a surrounding environment. However, this can consume a large amount of energy and can make a large amount of noise. So how can we use our architectural

and engineering mindsets to fix this problem? We know that at all times buildings will have clean air surrounding it. And if we could get some of this into our building, then it would make the internal environment much nicer. So, what if we were to use diffusers near the floor of an edifice to siphon outside air at low velocities into the interior, and then let the waste heat rise and recycle it into the exterior? This is the fundamental concept behind *displacement ventilation in EUPSO premises*.

In EUPSO Ventilation project, we will enter the scientific detailing for determination the amount and quality of air supplied to the existing building. According to these determinations full mechanical ventilation and additional systems will be in the context of this study. In addition to the ventilation element, the joint operation and efficiency of the ventilation and air conditioning solution will also be discussed. Summer seasons in Cyprus are usually extremely hot (35-45 degrees Celsius). The combined solution of the cooling (climatization) and the ventilation of the office building will also be discussed and solved in the EUPSO ventilation Project design.

Determination of Ventilation System in EUPSO Ventilation Project

According to all our professional experience and scientific researches, The interpretation of displacement ventilation will be designed with fresh air inlets close to the floor level and outlets at the ceiling which the highest level of the office space. During full mechanical system installations and ducting system (inlet and exhaust), fresh air units and exhaust fans, some extra electrical and construction will be installed too. These systems will be running on 7/24 principle and during night and weekend periods adjustable speed must be set to half load condition. These devices are generally operating at normal noise levels so there will be no problem with close environment.

Basement Floor must be well ventilated by mechanical equipment based on 7/24 principle. All the meeting rooms at floors and Conference rooms must be equipped with mechanical ventilation.

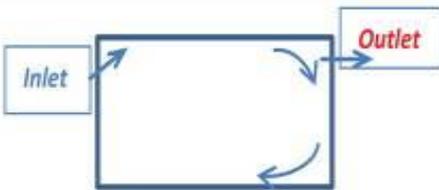
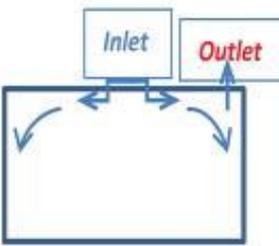
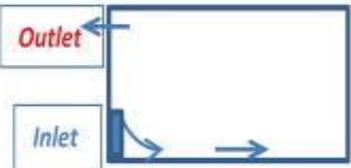
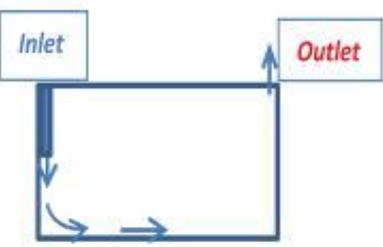
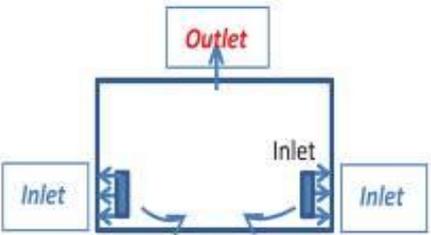
Type	Locations of air inlet and outlet	Main characteristics
Mixing ventilation (wall supply and extract)		<ul style="list-style-type: none"> • High momentum flow • Uniform mixing through the room • Can be used for cooling and heating • Limited IAQ and energy efficiency
Mixing ventilation (ceiling supply and extract)		<ul style="list-style-type: none"> • High momentum flow • Uniform mixing through the room • Can be used for cooling and heating • Suitable for large spaces • Limited ventilation and energy effectiveness
Displacement ventilation (wall supply and extract)		<ul style="list-style-type: none"> • Buoyancy-driven stratified flow • Limited flow penetration • Only suitable for cooling • High ventilation effectiveness
Impinging jet ventilation (ceiling supply and extract)		<ul style="list-style-type: none"> • Medium momentum flow • Deep airflow penetration • Can be used for cooling and heating • High IAQ and energy efficiency
Confluent jets ventilation (wall supply and ceiling extract)		<ul style="list-style-type: none"> • Medium momentum flow • Deep airflow penetration • Can be used for cooling and heating • High IAQ and energy efficiency

Figure 6. Inlet and Outlet Models in Mixing vs Displacement Ventilation Systems

According to the computer programed indoor air quality estimations at the project design phase the capacity of installations for each office space will be designed and expressed in the terms of reference in detail. The corridors and mezzanine floors and Staircase spaces have static air and damp precipitations which increase risks potentials to keep viruses in them. These spaces will be designed especially for exhausting the static air to outside and allow fresh air to inside. Individual aspirators will be installed in congested areas.

There will be a special fan which increases the indoor air pressure in the center of the building and this pressure will create a movement of the static air in the center of the building towards outside and increase the movement through the exhaust canals. Indoor spaces with human occupancy must be heavily ventilated, exclusively with fresh air to decrease virus concentrations, in the event of possible contamination by suspended particles, and to reduce the risk of infection. Because of COVID-19 virus ventilation of human occupied regions need to be supply 100% fresh outdoor air.

While our attention is focused on the spread of Coronavirus (COVID-19), and we are thinking about the necessary precautions that are needed to reduce our chances of coming in contact with this virus. We know that Coronavirus is not the only disease, germ and virus which We need to combat in our work places too. One-way people can be proactive and protect themselves from getting sick in general is by being educated on Indoor Air Quality (IAQ). Covering your mouth when you cough or sneeze is the first step to control the spread. However, residual contaminants can travel through your HVAC system, where all air in the work place is circulated and can contribute to the spread of an airborne virus. But we detail the canal and ducting systems for preventing these risks with vent details.

The Coronavirus has the same traits as other viruses such as the common cold, the flu, and a sore throat, by how it is spread from person-to-person. Tiny pathogens spread in the air can be fungi, bacteria, or viruses as *shown in figure:7*. The difference between a virus and bacteria is viruses are much smaller than bacteria, and viruses cannot survive without a host. According to the Mayo Clinic, less than 1% of bacteria cause disease in people. Today there are different techniques how to treat bacteria and viruses, but we may suggest, MERV type filters also can be used for some aspects but they are not very effective on COVID-19 virus. Atmospheric air is accepted as clean air.

Project Design and Implementation Phase

Project designer's objective is to implement an interpretation of Displacement ventilation system to EUPSO ventilation system. This system improves internal air quality and complies with the new requirements brought about by the COVID-19 pandemic for the benefit of the European Union Programme Support Office in Nicosia. First of all, one of the solutions is to take the exhaled air out of

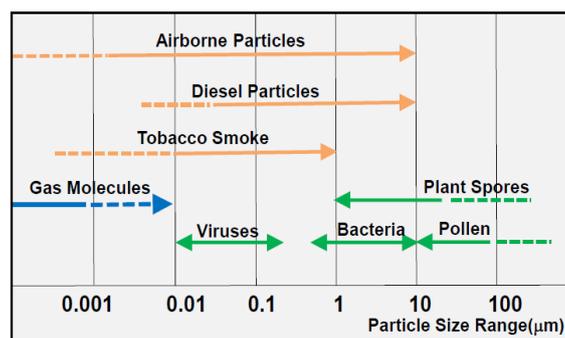


Figure 7. Particle size ranges in the indoor air

The spaces firmly, directly and efficiently. Secondly, the removed air will be substituted with fresh atmospheric clean air. Thirdly, air pressure will be in balance and in a way that pushes the exhaled air towards the exhausted vents at the ceiling. In basic planning principle, fresh air vents will be levelled close to the floor and the exhausted air vents will be at the top of the staff. In the planning of the exhaust air vents, they will be situated at the top of or very close to the position of the sitting area of the office user. Architectural design takes effect in positioning according the space usage. On the other hand, the forms and directions of the pipes and canals are designed for better interior views and perspectives.

The existing VRV air conditioning system negative effects will be diminished by designing special panel in front of the office units (as an obstacle) to drop the spread level of cooling air to 120 cm high from the floor level. The four heat exchangers at the roof will be donated by 4 HEPA filters to clean fully the outdoor fresh air from dust and other contaminants. All the main supply ducts are designed to be installed by hanging them vertically on to the three facades of the building. The building is divided in four zones at each office floor and these four zones are connected vertically to a heat exchanger at the roof. All the vertical ducts and horizontal canals' cross sections are mechanically calculated and decided by the engineers of Onuralp Project Development & Management Ltd.

All displacement ventilation design principles are used in the Ventilation design of EUPSO building. Our Ventilation theory is an application and interpretation of displacement ventilation. In our design we separate the fresh air and exhaust air ducts from each other situate them at different levels in indoor space. Fresh air will be supplied from closer to the floor level and left the exhaust vents at the ceiling alone. So, the air movement from the ground level is raising up to the ceiling. The products of the users are pressed up to the ceiling and are exhausted by the exhaust vents from the top of the area that the user is using.

Project design scope are directed and detailed by architect Erhan ONURALP. Architectural aspect can be seen in the placement of vents with their levels. The details and planning drawings are presented in architectural drawing technical standards. The positioning of the exhaust vents are on the top of the working areas of the officers. The polluted warmed stratified air will be evacuated rapidly from the ceiling level. First of all, Interior design of the building office spaces designed was finalized and then the mechanical project design is concluded. The positioning of the fresh air inlet vents for each office are:

- Far from the exhaust vent
- Designed gooseneck type vents to eject fresh air down towards floor surface slowly
- Fresh air vent and exhaust vent level has min. 220 cm difference.

In all sanitary spaces individual aspirators are designed to be installed for ventilation. The aim is to have create a separation from the office areas ventilation system avoiding the risks of bad odours from the toilets.

Project Implementation

The installation location of the ventilation system will be the European Union Programme Support Office (EUPSO) in Nicosia, Cyprus. The building is located at the following address: 63A Şht. Ecvet Yusuf Avenue Nicosia, Cyprus.

The building that hosts the EUPSO comprises four stories, one ground floor with mezzanine and one basement. The building that hosts the EUPSO is located in a busy road in an urban, mainly residential area. Temporary and short-stay parking for up to 2 vehicles is available in front of the building, as well as a loading bay on the side. Project implementation will comprise the procurement of ventilation supplies and the required works in the existing building where the European Union Programme Support Office (EUPSO) in Nicosia.

The contract authority fully expects to be ensured a COVID-free indoor air quality in all spaces within EUPSO. The Contractor should ensure in a reasonable manner that the offered equipment and supplies allow achieving a COVID-free indoor air quality, in line with relevant standards (e.g. ASHRAE 62.1 – 2013).

All materials and installations shall be of suitable quality for the required purpose. All works and equipment should be able to work under the prevailing environmental and climate conditions in Cyprus. These include intense heat during the summer, heavy rain and wind during the winter, occasional hail, and high concentrations of dust in air.

The Contractor supplies and works should facilitate the intended mode of operation of the Displacement ventilation system. Civil, electrical and mechanical works shall be suitable for continuous and discontinuous operation up to 24 hours per day under the prevailing environmental and climatic conditions.

Mechanical equipment such as motors and fans should be of adequate quality, have good bearings, and have sufficiently high Ingress Protection (IP) numbers for rain and dust.

The installation of the ventilation system at EUPSO has been disaggregated in a number of items or unit activities according to the Contracting Authority's design. All activities in this contract should adhere to these technical specifications, which represent minimum technical requirements. Equipment with better specifications will be accepted as compliant.

All Contract works should be in compliance with EN standards and the supplied materials to the site must also be according to EN standard and CE registered materials /parts/ components. The supplier should obtain all the materials, parts and components of the Ventilation project from EU countries or EU candidate countries. The contractor should read the Terms of Reference very carefully and will be able to ask questions within 5 days before the tender collection deadline.

The Contractor should take special note on the following general requirements:

- All the ducts, duct parts and components should be produced with double-walled acoustic and heat insulation with double metal sheets. The thickness of the metal sheets should be 0.5 mm as a minimum.
- All the interior ducts should be produced from stainless steel G304 and have a 15 mm rubber-based (min.90kg/m³) sandwich type acoustic insulation.
- All the exterior ducts and pipes should be produced from galvanised steel with a minimum thickness of 0.5 mm and have a 30 mm layer of very high density rockwool sandwich type thermal insulation.

The specifications of the required rockwool insulation are given below:

Standards	EN 14303, ISO 14001
Density	120 kg/m ³
Fire rating	Fire properties A2-s1, d0
Thermal Conductivity	0.033 – 0.034 W/m·K

The Contractor must add to their offer at tendering stage any relevant brochures, leaflets, technical documents, manuals, or any other related documentation to assess compliance as per the technical specifications of the following supplies:

- Heat exchanger ventilation units.
- Roof-type exhaust unit.
- Interior ducts, parts and accessories.
- Exterior ducts, parts and accessories.
- All types of vents.
- Electric control panel and switches.

In the implementation period which has already started on 15.09.2021, it was expected to execute all the necessary actions to have a Displacement office ventilation system in place, such as (but not limited to) procuring, storing, delivering, unloading, installing, and commissioning such system. In addition, the contractor will be expected to undertake any necessary civil, mechanical or electrical works to guarantee the performance of the ventilation system according to these Technical Specifications.

The contractor must prepare programme of works with time schedule. How will they handle the implementation of the project? How can for example the works be done parallelly to shorten the total duration of the project? How will they be able to work silently? How will they coordinate the external works and internal works with durations and manpower?

- The Contractor should fill the procurement of materials/parts table.
- The contractor must fill out the material acceptance form. Materials can be ordered or delivered only after completion of the form will be approved by the control. Control architect / engineer can ask for samples of any materials/parts/components if necessary.
- The contractor will prepare detail of implementation drawings of very important sections which will be

decided with the control. Implementation drawings folder which suites %100 with the project drawings will be submitted before the start of the project implementation. Special production details from the companies will also submitted during the implementation period.

Work Programme

The Contractor must prepare a work programme with a detailed schedule, reflecting their proposed approach to undertake the project while minimising disruption to the daily office activities. The plan should provide information with enough level of detail on the following:

- Estimated time required to purchase supplies and materials before mobilising to site.
- Estimated time to complete the works on site.
- Expected use of manpower.
- Mitigating actions to minimise disruption, noise, and dust.
- Mitigating actions to protect existing supply connections (electricity, water, sewerage),
- as well as office furniture and IT equipment.
- Coordination actions between external and internal works.

This programme will be used as a basis for monitoring progress and supervise works. Planning of works should be done in two sections: (1) external works (outdoor works such as vertical ducts, machine ventilation units positioning, scaffolding, etc.) and (2) internal works (indoor works like canals and ducting, opening holes for passages, etc.).

Before Commencement

Before entering the EUPSO building for the first time, every member of the Contractor staff, subcontractor, and suppliers should provide a *negative PCR* test for COVID-19 performed within the last 72 hours to the Control Architect. The Contractor will undertake any PCR tests at their own expense. The Contractor is required to record the daily access of all their staff members, as well as those of subcontractors, suppliers, or any other individual involved in the execution of the works. These records should be maintained in a log that should be readily accessible to both the Contracting Authority, the Control Architect, and Turkish Cypriot health stakeholders at any given time.

Members of the Contractor staff that have been diagnosed with COVID-19 during the duration of the contract will need to adhere to the isolation and quarantine requirements in force at the time and should not return to site without proper medical clearance. The Contractor is obliged to find suitable replacements and submit them for the approval of the Control Architect. In the case of replacing key personnel, such as the Contractor's Engineers and Representatives, substitute staff should verify the selection criteria of this procurement procedure. The

Contractor is required to undertake the works fully respecting the current use of the building as offices.

Before starting works, the Contractor should properly ensure that all obstacles have been removed and/or temporarily relocated. This may include boxes, shelves, tables, desks, chairs, IT equipment, etc. If an object cannot be removed from its present location, it should be covered or protected with appropriate materials to guarantee its integrity. During works, the Contractor and its staff should make all the necessary arrangements to avoid damage to the building and the objects within it. Special attention and care should be taken with the existing electrical connections.

After works, the Contractor should reinstate the building to its original state. This includes returning the removed objects to their original location, the uncovering of protected elements, and the full cleaning of spaces. Cleaning should be understood as removing construction waste, debris, and dust to a sufficient degree. The Contractor should be responsible for the waste generated during the execution of the contract. This includes cardboard boxes, packaging, rubble, metal scraps, or equivalent. The Contractor will not be allowed to use the rubbish bins of the building for the disposal of such waste.

Design Results of EUPSO Ventilation Project

The compelling factors affecting the Ventilation works design of EUPSO:

- The building is existing building and facade windows limited the surface for using for the vertical duct passages.
- The building will continue to be used as an office during construction.
- It's not possible to open vertical shafts in central core of the building.
- For a non-dense pipe medium, short-length thin, elegant circulation canals (ducting system) (ducting) should be considered.
- Since the height of the spaces was limited, it is impossible to overlap the horizontal canals under the ceiling.
- All the horizontal canals (ducting system) should pass slightly under the reinforced concrete beams of the slab.

The exhaust vents are positioned on the top of the working spaces (see figure:8). The fresh air gooseneck vents (see the detail figure:17) are positioned next to working space away from the exhaust vent. Gooseneck vents are designed to inject the fresh air down to the floor level with a low flowrate. Displacement ventilation features were interpreted to be obtained in this scheme. In figure:9 You can see the design scheme at the second-floor meeting room. The exhaust vents are positioned in middle of the meeting space where the exhaled air of the meeting participants will raise up to the center of the room. The fresh air inlet is positioned next to the air conditioning indoor unit as gooseneck vent which injects the cool air towards to the floor level (fig:17) Displacement ventilation features were interpreted to be obtained in this scheme too. In figure:10 You can see

the design scheme at the ground floor conference room. Ground and mezzanine floor will be ventilated with separate heat exchanger which will be hanged on the north facade wall at 5 m high from the ground. The exhaust vents position middle of the conference room where the exhaled air of the meeting participants will raise up to the center of the room. The fresh air inlets are positioned on inner walls as gooseneck vents which inject the cool air towards to the floor level (fig:19) The gooseneck vents have diffusers and they will be extended by a down pipe to the 120 cm from the floor level from the ceiling. Displacement ventilation features were also interpreted to be obtained in this scheme.

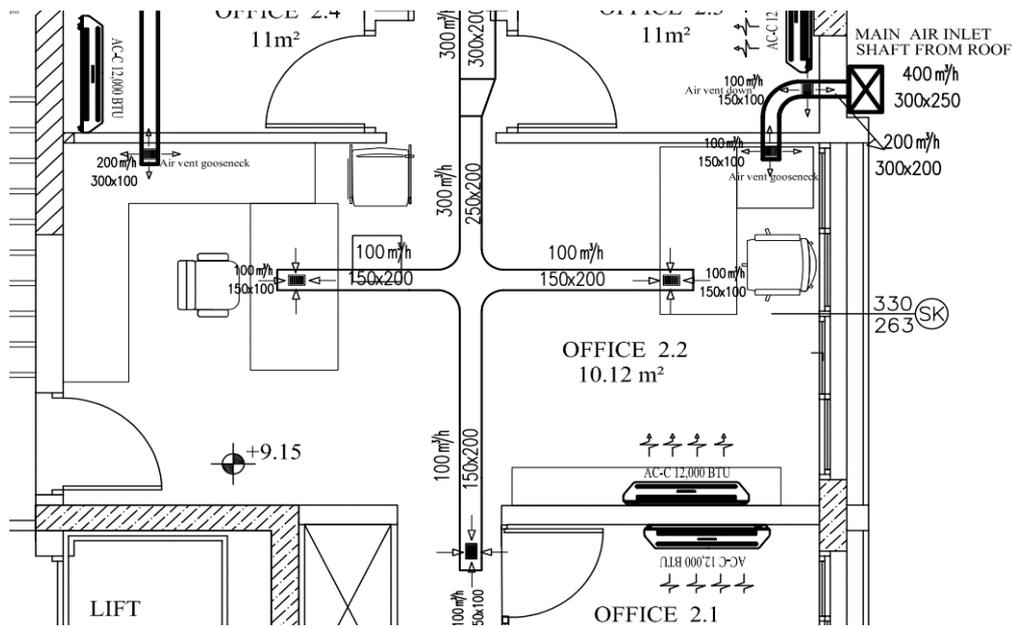


Figure 8. Planning scheme of exhaust ducts on the working spaces and fresh air gooseneck inlet vents at side walls

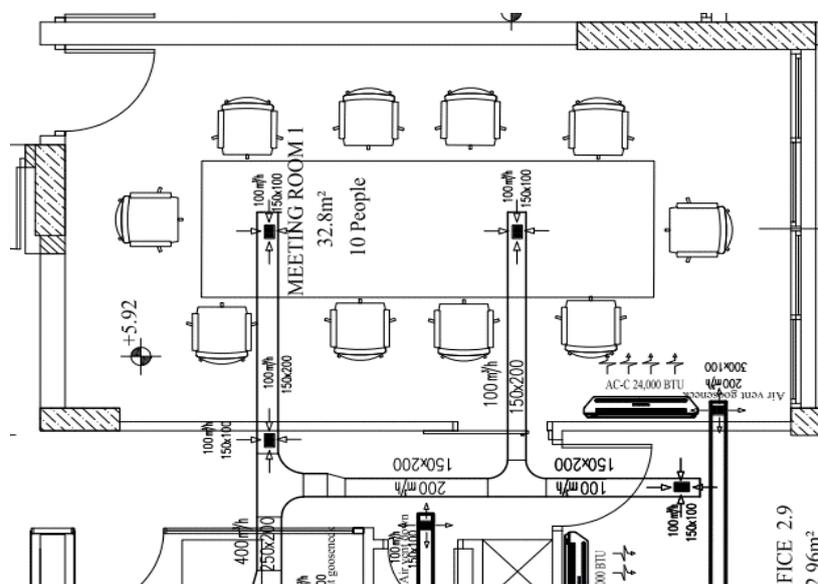


Figure 9. Planning scheme of exhaust ducts on the meeting space and fresh air gooseneck inlet vent

Table 1. Indoor air calculations of the offices related to Heat exchangers IGKHU-01 IGKHU-02

Resource: *Aktif mekanik Ltd. contractor of the works.*

HVAC Values Table

Heat Exchanger no:	Floor	Room name						Amount of Fresh Air		Chosen	Chosen
			Area	Height	Volum	Furnishi	Person	ASHRAE Standard	Fresh Air	Exhausted Air	
			m ²	m	m ³	ng	No	m ²	62.1-ASHRAE Standard 170-2017	flow rate	flow rate
IGKHU-01	FIRST F.	OFFİCE 1.6	10,83	3,20	35	2	2	2,50	19	100	100
	FIRST F.	OFFİCE1.4	11	3,20	35	1	1	2,50	9	100	100
	FIRST F.	OFFİCE 1.5	11	3,20	35	1	1	2,50	9	100	100
	FIRST F.	KORİDOR	22,2	3,20	71	-	2	3,80	30	200	200
	SECOND F.	KORİDOR	15,3	3,20	49	-	2	3,80	21	100	100
	SECOND F.	OFFİCE2.6	10,83	3,20	35	1	1	2,50	9	100	100
	SECOND F.	KİTCHEN	7,1	3,20	23	1	1	3,80	19	100	100
	SECOND F.	OFFİCE2.5	11	3,20	35	1	1	2,50	9	100	100
	THIRD F.	KORİDOR	15,3	3,20	49	-	2	3,80	21	100	100
	THIRD F.	OFFİCE 3.7	21,7	3,20	69	-	1	2,50	9	100	100
	THIRD F.	OFFİCE	7,1	3,20	23	1	1	2,50	13	100	100
	THIRD F.	OFFİCE3.5	11	3,20	35	1	1	2,50	9	100	100
	THIRD F.	OFFİCE3.6	11	3,20	35	1	1	2,50	9	100	100
	FOURTH F.	KORİDOR	15,3	3,20	49	-	2	3,80	21	100	100
	FOURTH F.	OFFİCE 4.8	21,7	3,20	69	-	1	2,50	9	100	100
	FOURTH F.	KİTCHEN	7,1	3,20	23	-	1	3,80	19	100	100
FOURTH F.	OFFİCE4.6	11	3,20	35	1	1	2,50	9	100	100	
FOURTH F.	OFFİCE4.7	11	3,20	35	1	1	2,50	9	100	100	
IGKHU-02	FIRST F.	OFFİCE 1.1	18,3	3,20	59	2	2	2,50	18	300	200
	FIRST F.	STAGE FOR GOODS	11,55	3,20	37	-	-	0.75 [L/s.m ²]	35	-	100
	FIRST F.	OFFİCE1.2	11	3,20	35	1	1	2,50	9	100	100
	FIRST F.	OFFİCE 1.3	11	3,20	35	1	1	2,50	9	100	100
	SECOND F.	OFFİCE 2.2	10,12	3,20	32	3	3	2,50	27	300	300
	SECOND F.	OFFİCE2.3	10,83	3,20	35	1	1	2,50	9	100	100
	SECOND F.	OFFİCE2.4	11	3,20	35	1	1	2,50	9	100	100
	THIRD F.	OFFİCE 3.3	11	3,20	35	1	1	2,50	9	100	100
	THIRD F.	OFFİCE	24,35	3,20	78	3	3	2,50	27	300	300
	THIRD F.	OFFİCE3.4	11	3,20	35	1	1	2,50	9	100	100
	FOURTH F.	OFFİCE 4.3	24,35	3,20	78	3	3	2,50	27	300	300
FOURTH F.	OFFİCE4.4	11	3,20	35	1	1	2,50	9	100	100	
FOURTH F.	OFFİCE4.5	11	3,20	35	1	1	2,50	9	100	100	

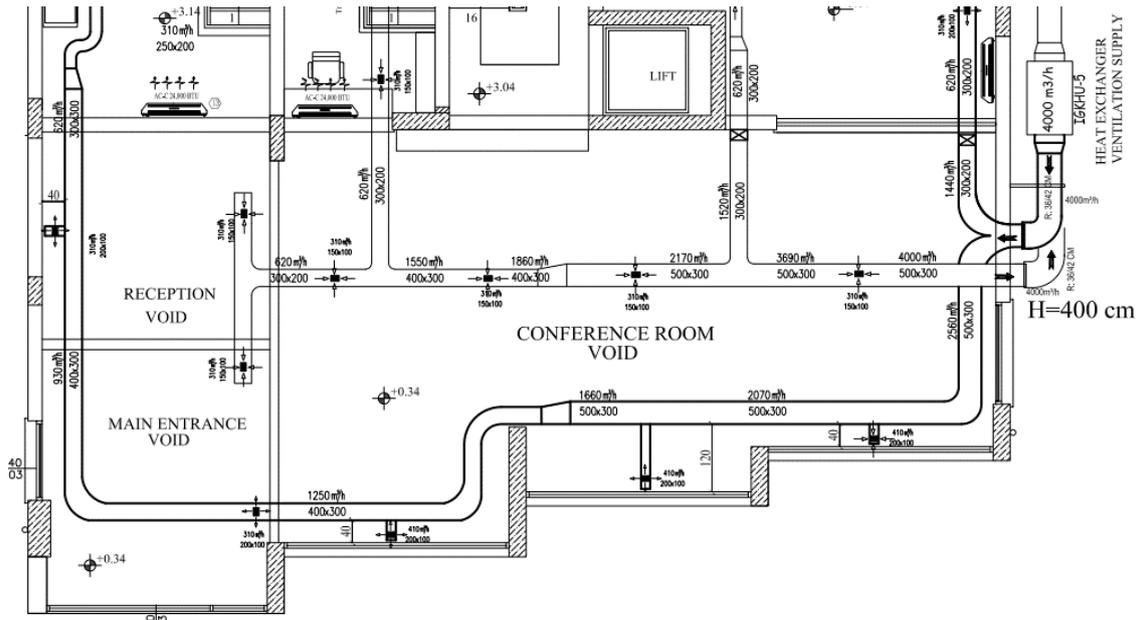


Figure 10. Planning scheme of the exhaust ducts in the conference room (ground floor) and fresh air gooseneck inlets situated parallel to the walls with downpipes extending to the floor level

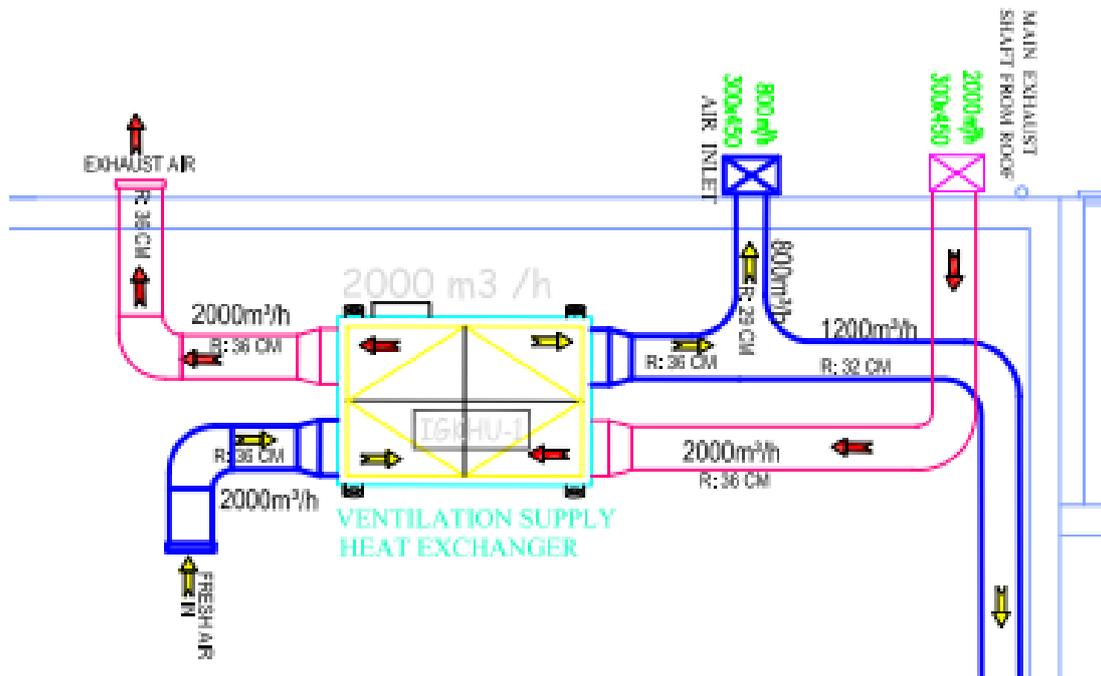


Figure 11. One of the four Heat Exchangers at the roof serving for EUPSO ventilation system

Table 2. Indoor air calculations of the offices and meeting rooms/conference room related to Heat exchangers

IGKHU-03 -04 and 5 Resource: Aktif mekanik Ltd. contractor of the works.

HVAC Values table											
Heat Exchanger no:	Floor	Room Name	Area	Height	Volume	Furnishing	Person	Amount of Fresh Air		Chosen	Chosen
			m ²	m	m ³	no	m ²	ASHRAE Standard 62.1-ASHRAE Standard 170-2017	Fresh Air Flow rate	Exhaust Air Flow rate	
								L/s/person	m ³ /h	m ³ /h	m ³ /h
IGKHU-03	FIRST F.	MEETING ROOM-1	32,8	3,20	105	10	10	2,50	90	200	200
	FIRST F.	OFFICE1.7	12,96	3,20	41	1	1	2,50	9	100	100
	FIRST F.	KORİDOR	6,4	3,20	20	-	1	3,80	9	200	200
	SECOND F.	MEETING ROOM-1	32,8	3,20	105	10	10	2,50	90	200	200
	SECOND F.	OFFICE2.9	12,96	3,20	41	1	1	2,50	9	100	100
	SECOND F.	OFFICE2.8	8,65	3,20	28	1	1	2,50	9	100	100
	SECOND F.	KORİDOR	6,4	3,20	20	-	1	3,80	9	100	100
	THIRD F.	MEETING ROOM 3	56,8	3,20	182	11	11	2,50	99	200	200
	THIRD F.	OFFICE3.8	12,96	3,20	41	1	1	2,50	9	100	100
	THIRD F.	OFFICE3.7	8,65	3,20	28	1	1	2,50	9	100	100
	THIRD F.	KORİDOR	6,4	3,20	20	-	1	3,80	9	100	100
	FOURTH F.	MEETING ROOM 1	32,8	3,20	105	10	10	2,50	90	200	200
	FOURTH F.	OFFICE4.9	12,96	3,20	41	1	1	2,50	9	100	100
FOURTH F.	OFFICE4.8	21,7	3,20	69	1	1	2,50	9	100	100	
FOURTH F.	KORİDOR	6,4	3,20	20	-	1	3,80	9	100	100	
IGKHU-04	FIRST F.	DINNING AREA	25,6	3,20	82	10	10	3,80	137	300	300
	FIRST F.	STAGE FOR GOODS	11,55	3,20	37	-	-	0,75 [L/s.m ²]	35	100	100
	FIRST F.	STAGE FOR EXTRA M.	11,55	3,20	37	-	-	0,75 [L/s.m ²]	35	100	100
	SECOND F.	MEETING ROOM-1	32,8	3,20	105	10	10	2,50	90	200	200
	SECOND F.	OFFICE3.1	12,5	3,20	40	1	1	2,50	9	100	100
	SECOND F.	OFFICE2.1	8,76	3,20	28	1	1	2,50	9	100	100
	SECOND F.	KORİDOR	6,4	3,20	20	-	1	3,80	9	100	100
	THIRD F.	MEETING ROOM 3	56,8	3,20	182	11	11	2,50	99	200	200
	THIRD F.	OFFICE3.1	12,5	3,20	40	1	1	2,50	9	100	100
	THIRD F.	OFFICE3.7	8,76	3,20	28	1	1	2,50	9	100	100
	THIRD F.	KORİDOR	6,4	3,20	20	-	1	3,80	9	100	100
	FOURTH F.	OFFICE4.1	29	3,20	93	1	1	2,50	9	200	200
	FOURTH F.	OFFICE4.2	12,4	3,20	40	1	1	2,50	9	100	100
FOURTH F.	KORİDOR	6,4	3,20	20	-	1	3,80	9	100	100	
IGKHU-05	GROUND FLOOR	FOYER+ARCHIVE KOR	44,2	2,80	124	5	5	3,80	68	820	900
	MEZZANINE	DANIŞMA	8,5	2,80	24	1	1	2,50	9	310	310
	MEZZANINE	KITCHEN	26,8	2,80	75	-	5	3,80	73	310	310
	MEZZANINE	RECEPTION	14,1	5,60	79	5	5	2,50	45	310	310
	MEZZANINE	MAIN ENTRANCE	17,4	5,60	97	5	5	3,80	68	310	310
	MEZZANINE	CONFERENCE ROOM	89,62	5,60	502	39	39	2,50	351	1230	1230
	MEZZANINE	OFFICE0.1	45,8	3,20	147	7	7	2,50	59	620	620
EF-01	OTOPARK	OTOPARK	223,58	3,75	838	8 Araç	-	50 [L/s/car]	1440	-	4200

IGK DUCT Pressure Loss_Calculations

Table 3. Pressure Loss calculations of the designed system in case of HEPA Filter Properties *Resource: Aktif Mekanik Ltd. contractor of the works.*

Item No	Item	Width	Height	Hydraulic Diameter	AirFlow	AirFlow	Round Duct Velocity	Rectangular Duct Velocity	Roughness	Viscosity	Reynolds Number	Friction Coeff.	Unit Pres. Drop	Length	Total Duct Press.Drop	Fittings Pressure Loss	Total Fitting Coeff.	Velocity Pressure	Total Fitting P.D.	Total Pressure Drop	
		a	b	Dh	q	q	vD	vR	e	10 ⁶ .n	Re	l	R	l	DP	no z of f	Sz	Pv	DPf	DPto	
		mm	mm	mm	m ³ /h	L/s	m/s	m/s	mm	m ² /s			Pa/m	m	Pa			Pa	Pa	Pa	
	IGKHU-01 ÜFLEME																				
	Supply Duct																				
1	Grill																			20	
2	Duct			180	200	56	2,2		0,15	17,00	2,3E+00,4	0,027	0,43	5,0	2			0,03	0	2	
3	Reduction			180	200	56	2,2		0,15	17,00	2,3E+00,4	0,027	0,43	0,0	0	1	0,3	0,3	3	1	1
4	Elbow 90°			180	200	56	2,2		0,15	17,00	2,3E+00,4	0,027	0,43	1,0	0	1	0,4	0,4	3	1	2
5	Duct			200	300	83	2,7		0,15	17,00	3,1E+00,4	0,025	0,53	1,0	1			0,04	0	1	
6	Reduction			200	300	83	2,7		0,15	17,00	3,1E+00,4	0,025	0,53	0,0	0	1	0,3	0,3	4	1	1
7	Duct	200	150	189	300	83	3,0	2,8	0,15	17,00	3,3E+00,4	0,025	0,71	3,2	2			0,05	0	2	
8	Reduction	200	150	189	300	83	3,0	2,8	0,15	17,00	3,3E+00,4	0,025	0,71	0,0	0	1	0,3	0,3	5	2	2
9	Elbow 90°	200	150	189	300	83	3,0	2,8	0,15	17,00	3,3E+00,4	0,025	0,71	0,0	0	1	0,4	0,4	5	2	2
	Fire Damper																			20	
10	Duct	250	200	244	600	167	3,6	3,3	0,15	17,00	5,1E+00,4	0,023	0,71	3,2	2			0,08	0	2	
11	Reduction	250	200	244	600	167	3,6	3,3	0,15	17,00	5,1E+00,4	0,023	0,71	0,0	0	1	0,3	0,3	8	2	2
12	Duct	250	250	273	900	250	4,3	4,0	0,15	17,00	6,9E+00,4	0,022	0,87	3,2	3			0,11	0	3	

is an interpretation of displacement ventilation system based on using clean outdoor air for ensuring clean indoor air of the working places. Ventilation components are also components of interior design and in this project and

IGK DUCT Pressure Loss Calculations

Table 4. Pressure Loss calculations of the designed system in case of HEPA Filter Properties *Resource: Aktif Mekanik Ltd. contractor of the works.*

Item No	Item	Width	Height	Hydraulic Diameter	AirFlow	AirFlow	Round Duct Velocity	Rectangular Duct	Roughness	Viscosity	Reynolds Number	Friction Coeff.	Unit Pres. Drop	Length	Total Duct Press.Drop	Fittings Pressure Loss	Total Fitting Coeff.	Velocity Pressure	Total Fitting P.D.	Total Pressure Drop	
		a	b	Dh	q	q	vD	vR	e	$10^6 \cdot \nu$	Re	f	R	l	DP _{duct}	DP _{noz}	Sz	Pv	DP _f	DP _{tot}	
		mm	mm	mm	m ³ /h	L/s	m/s	m/s	m	m ² /s			Pa/m	m	Pa			Pa	Pa	Pa	
	IGKHU-02 ÜFLEME																				
	Supply Duct																				
1	Grill																			20	
2	Duct			180	200	56	2,2	0,1	17,0	2,3E+04	0,0	0,4	5,0	2			0,0	3	0	2	
3	Reduction			180	200	56	2,2	0,1	17,0	2,3E+04	0,0	0,4	0,0	0	1	0,3	0,3	3	1	1	
4	Elbow 90°			180	200	56	2,2	0,1	17,0	2,3E+04	0,0	0,4	1,0	0	1	0,4	0,4	3	1	2	
5	Duct			200	300	83	2,7	0,1	17,0	3,1E+04	0,0	0,5	1,0	1			0,0	4	0	1	
6	Reduction			200	300	83	2,7	0,1	17,0	3,1E+04	0,0	0,5	0,0	0	1	0,3	0,3	4	1	1	
7	Duct	200	150	189	300	83	3,0	2,8	0,1	17,0	3,3E+04	0,0	0,7	3,2	2		0,0	5	0	2	
8	Reduction	200	150	189	300	83	3,0	2,8	0,1	17,0	3,3E+04	0,0	0,7	0,0	0	1	0,3	0,3	5	2	2

advantages for the project effectiveness and success. This project also put forward that mixing ventilation system slowly will be left in mechanical ventilation design concept by mechanical engineers and architects in future.

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Appendix Figures

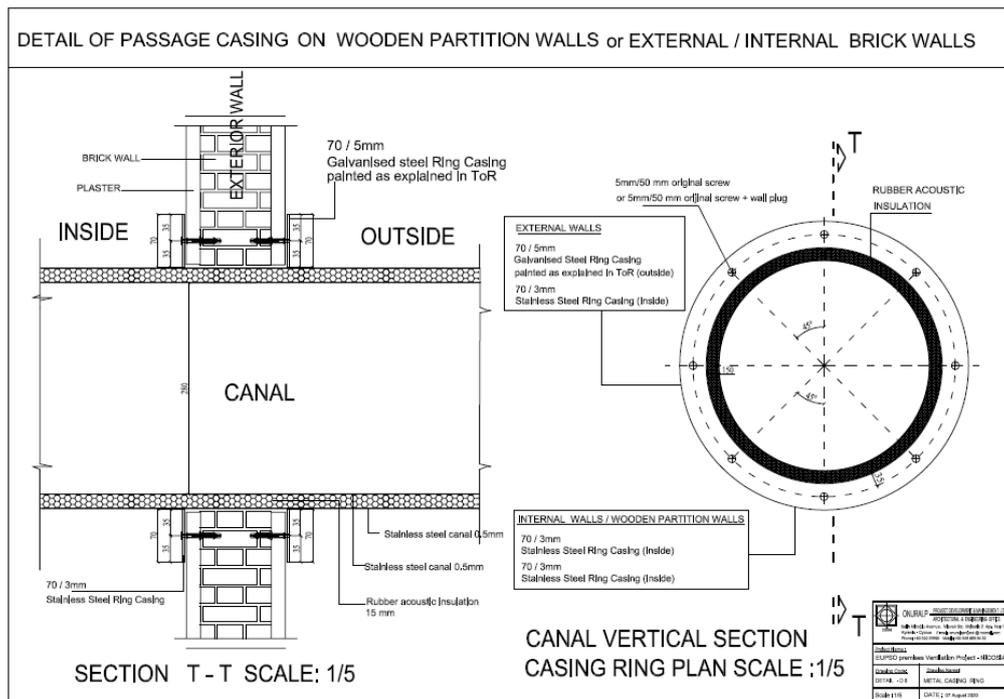


Figure 12. Horizontal Canal Passage through brick walls with casing – EUPSO project detail no:8

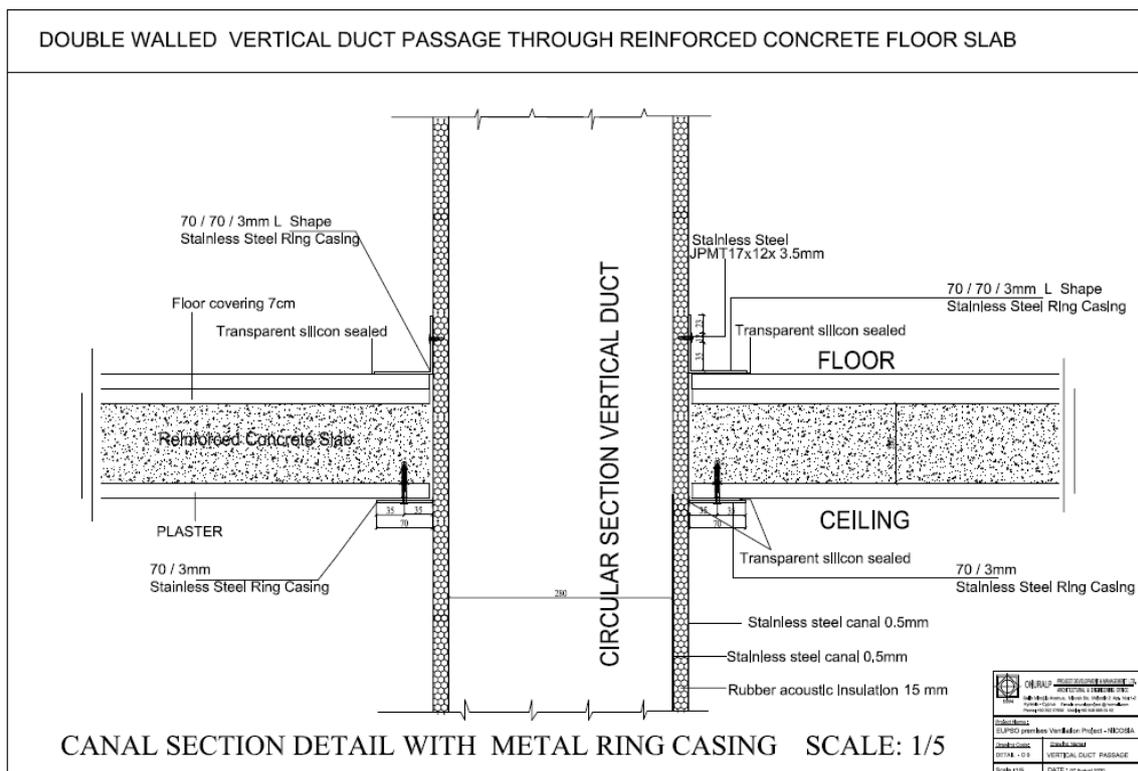


Figure 13. Vertical Duct Passage through Reinforced Concrete with Casing – EUPSO project detail no:9

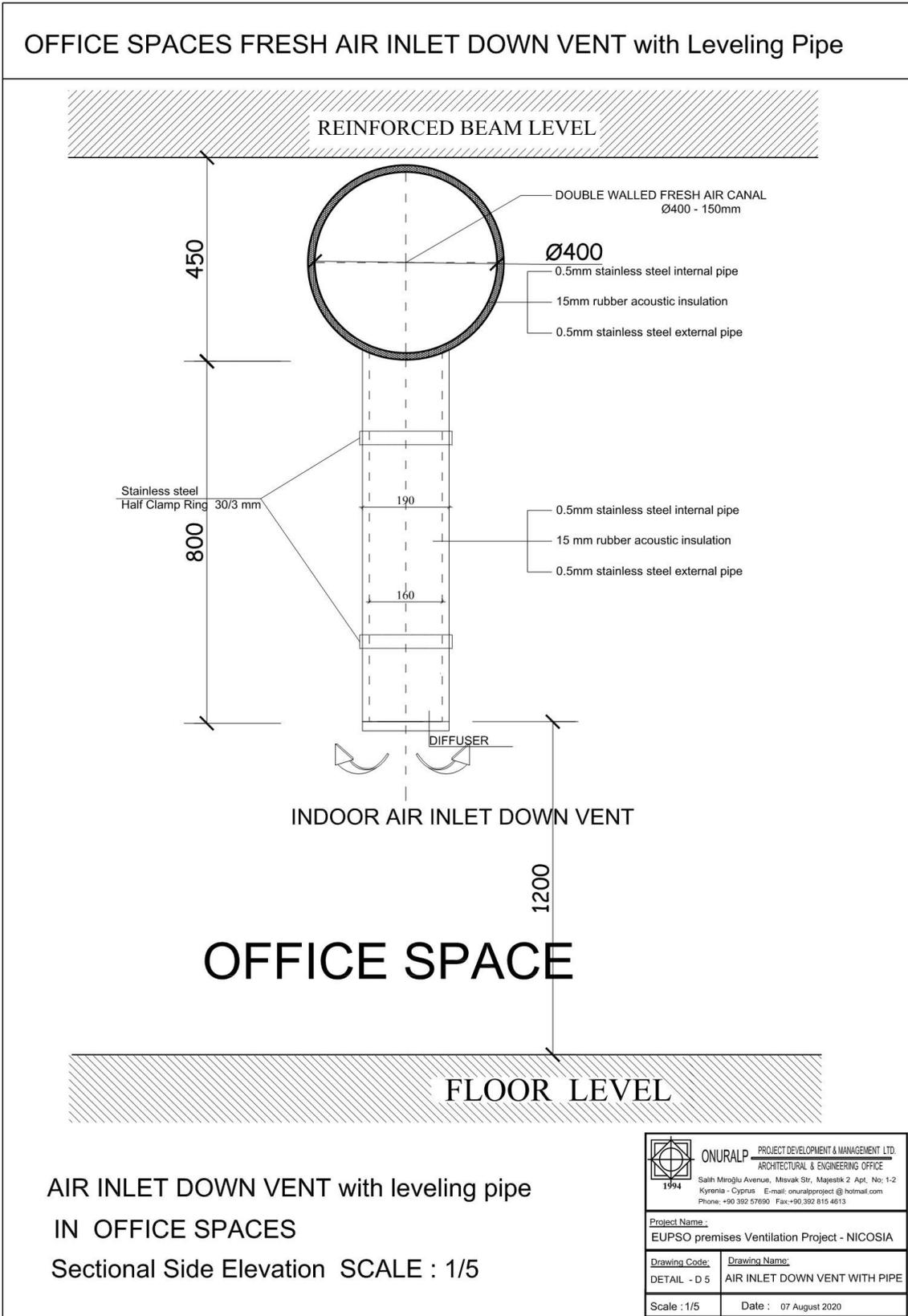


Figure 14. Fresh Air Inlet Down Vent – EUPSO project detail no:5

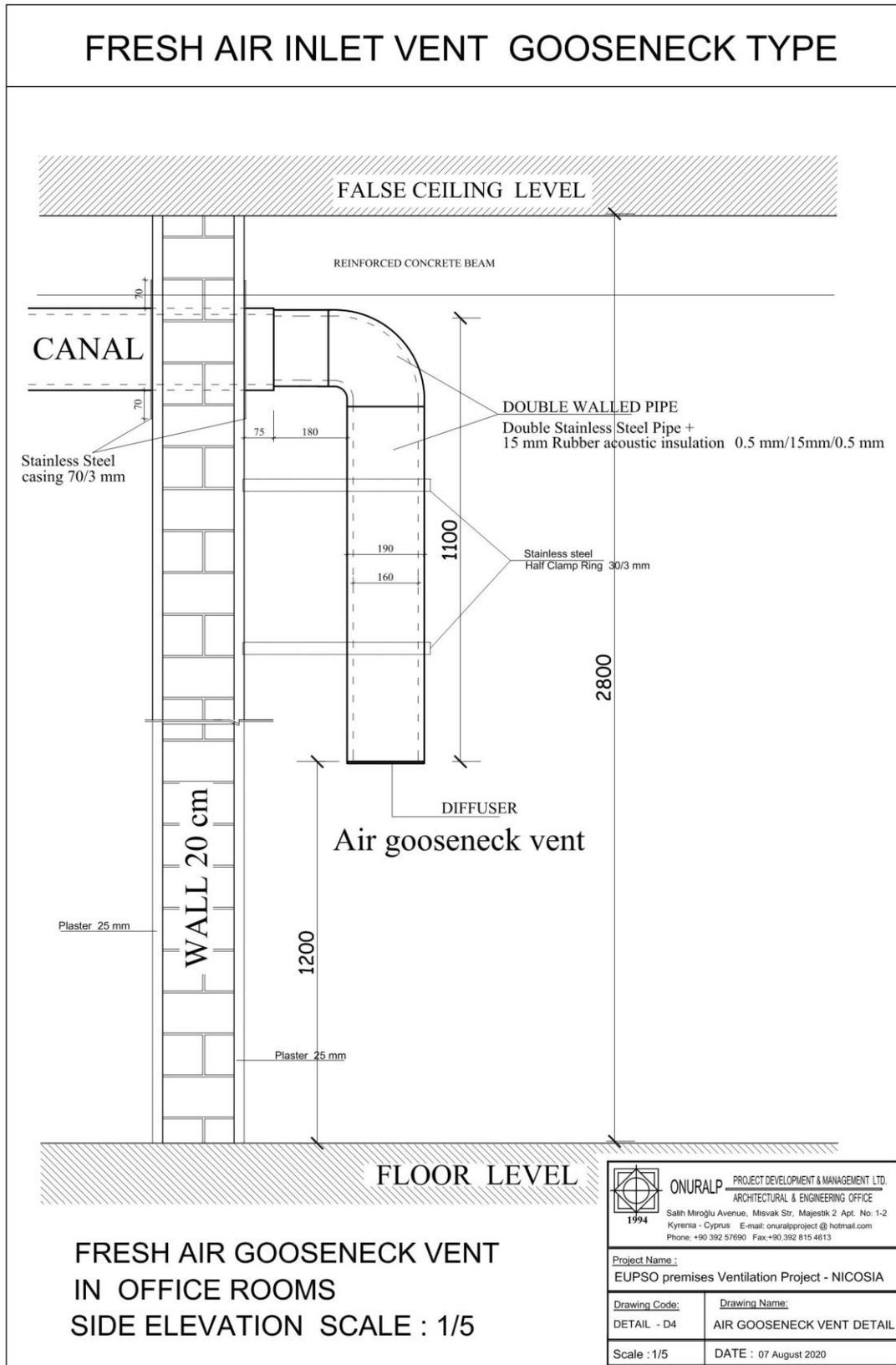


Figure 17. Indoor Fresh Air Gooseneck Vent detail – EUPSO project detail no:4

EXTERNAL VERTICAL DUCT DESIGN and SIZING ACCORDING TO FLOORS

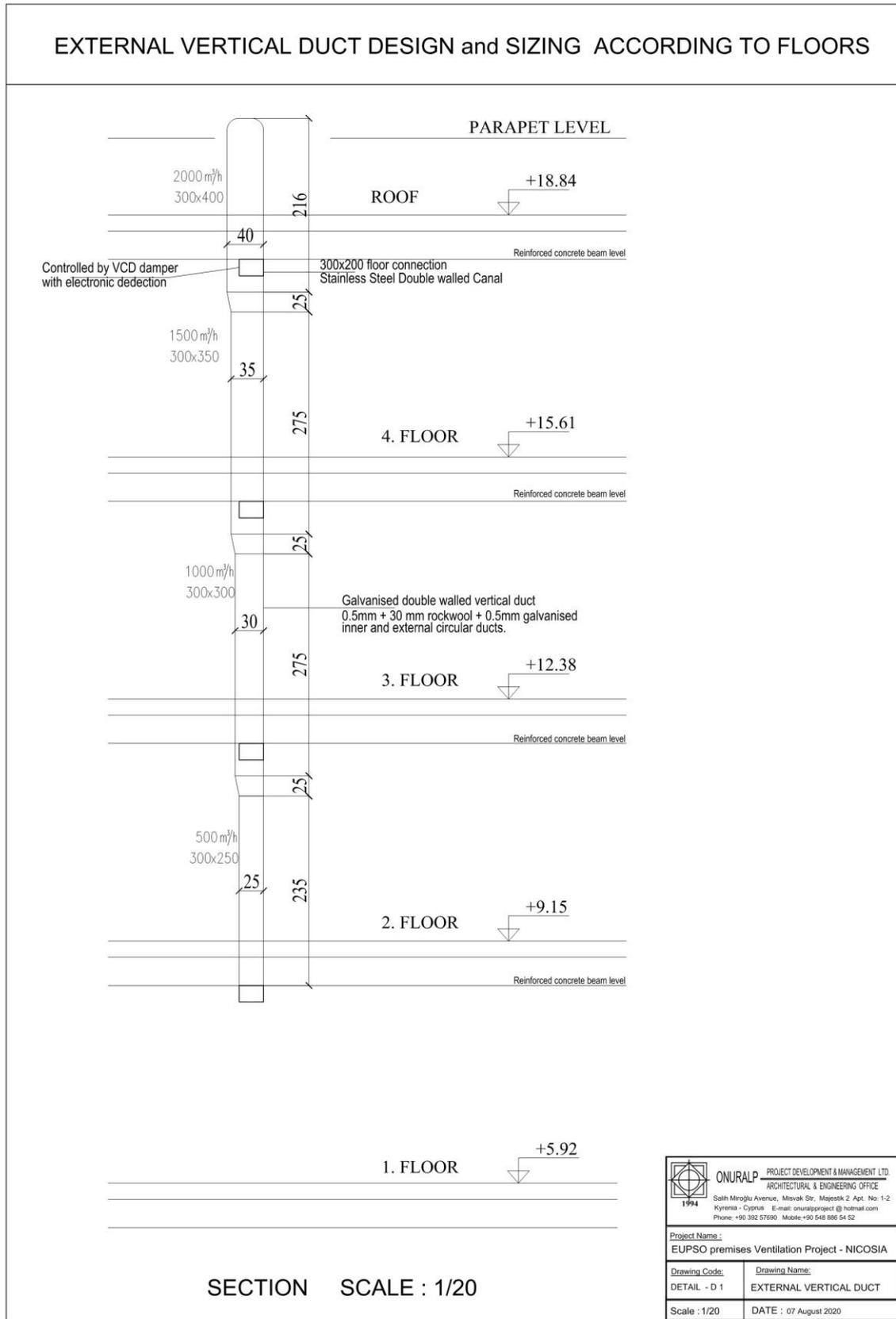


Figure 18. External Vertical Design – EUPSO project detail no:1

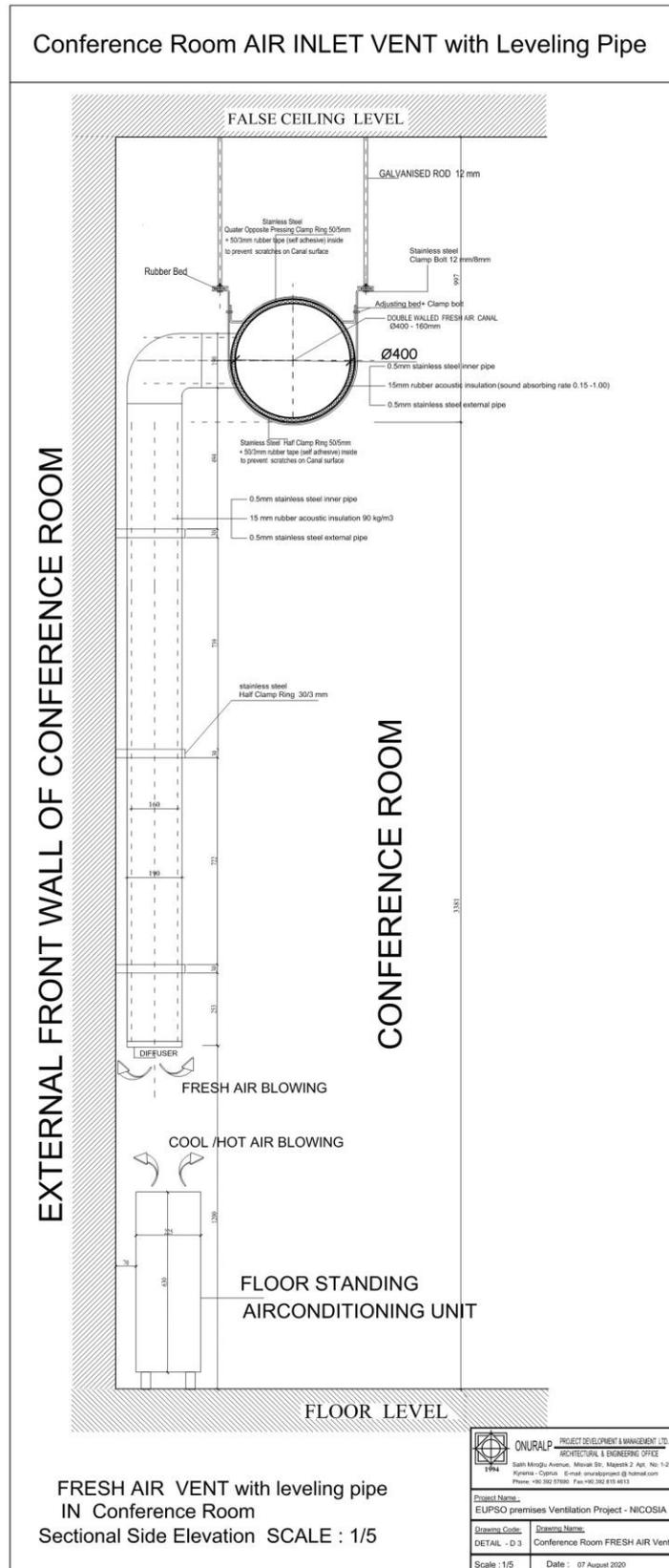


Figure 19. Fresh Air Leveling pipe with Vent in Conference Room – EUPSO project detail no:1

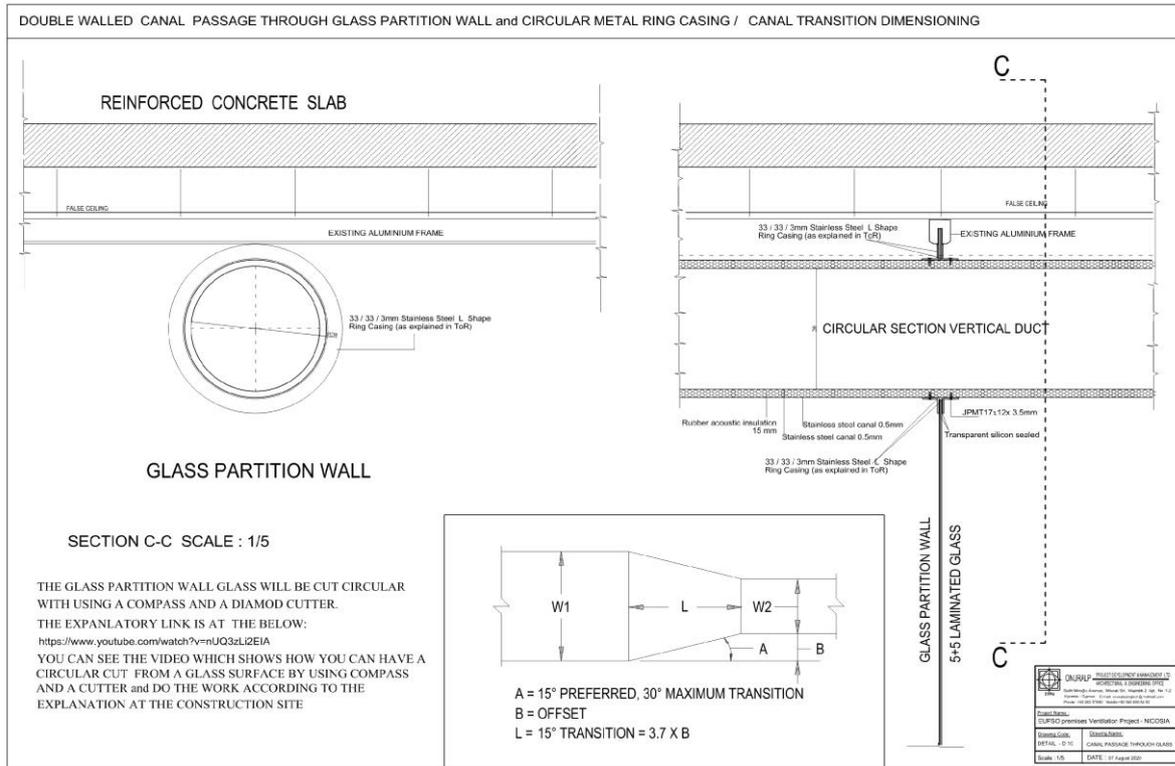


Figure 20. Passage through Glass partition wall – EUPS0 project detail no:10

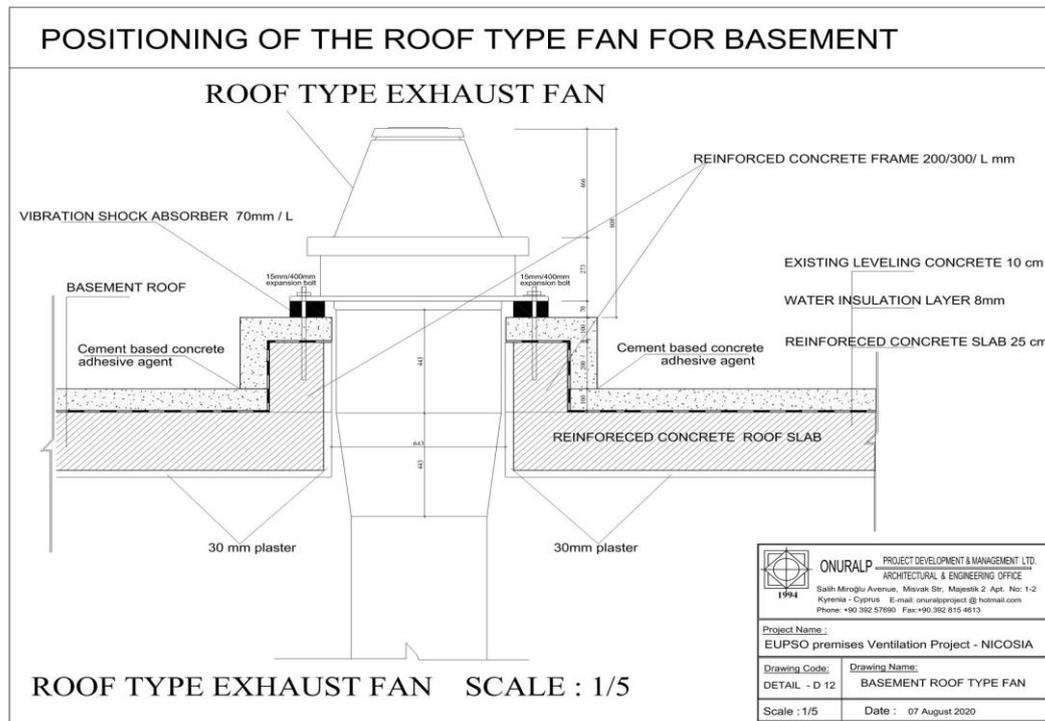


Figure 21. Roof Type Exhaust Fan Detail with Basement Roof Slab – EUPS0 project detail no:12

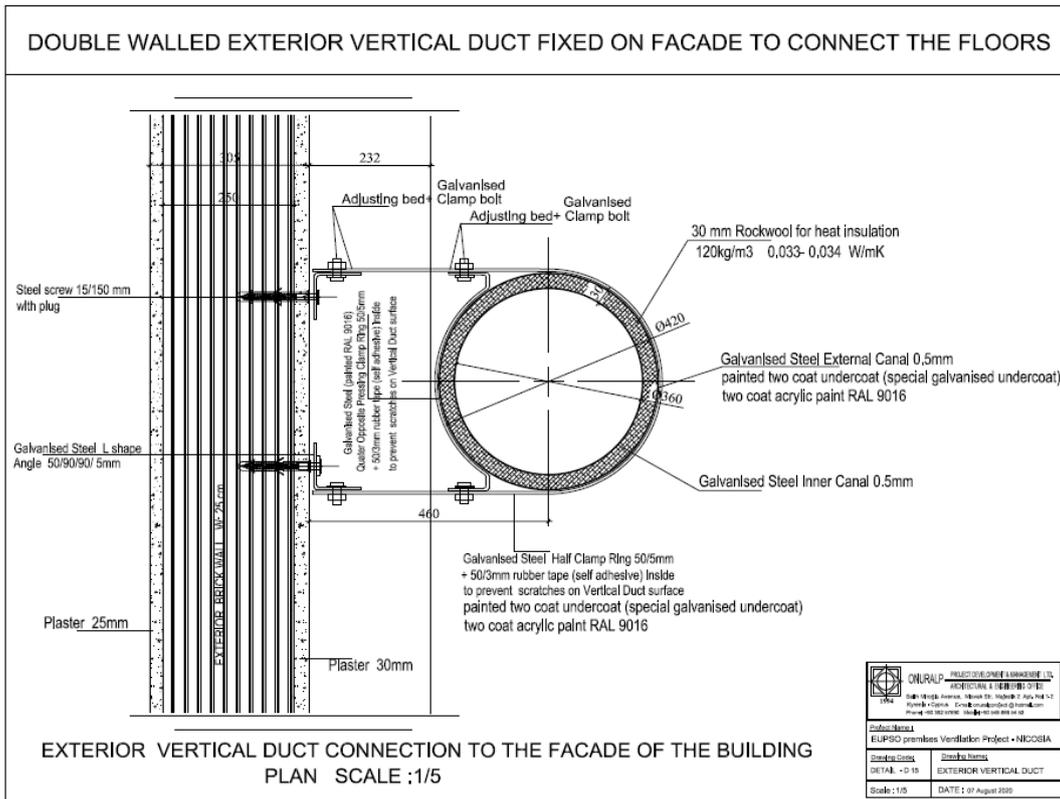


Figure 22. External Vertical Duct Connection to facades – EUPSO project detail no:15

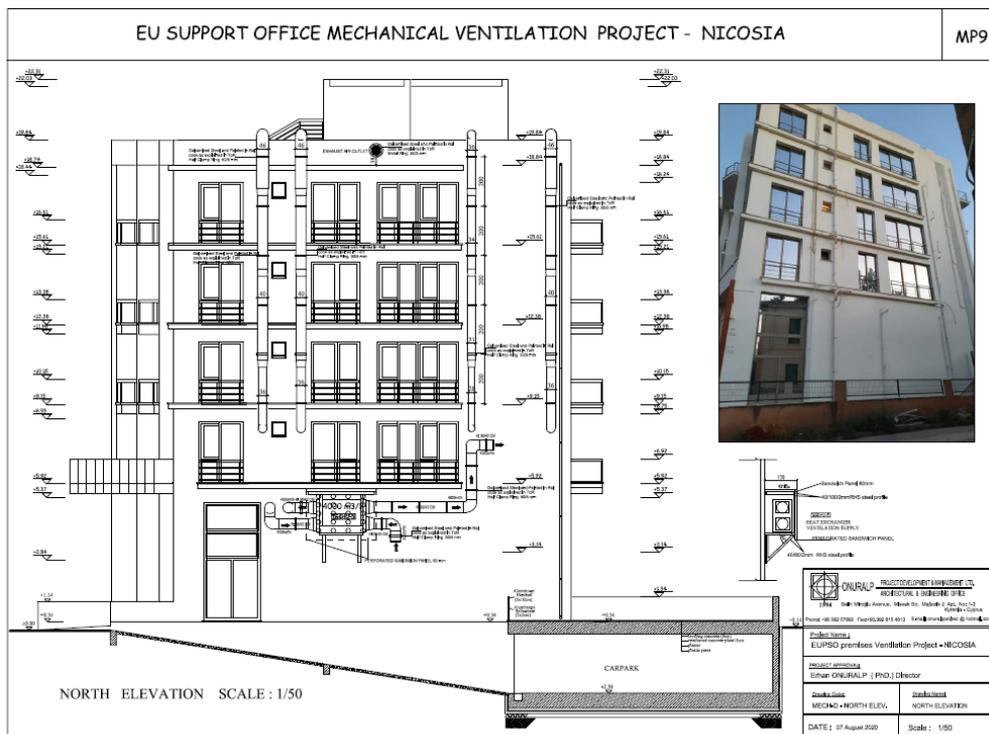


Figure 23. External Vertical Duct on North Facade planning – EUPSO project M9

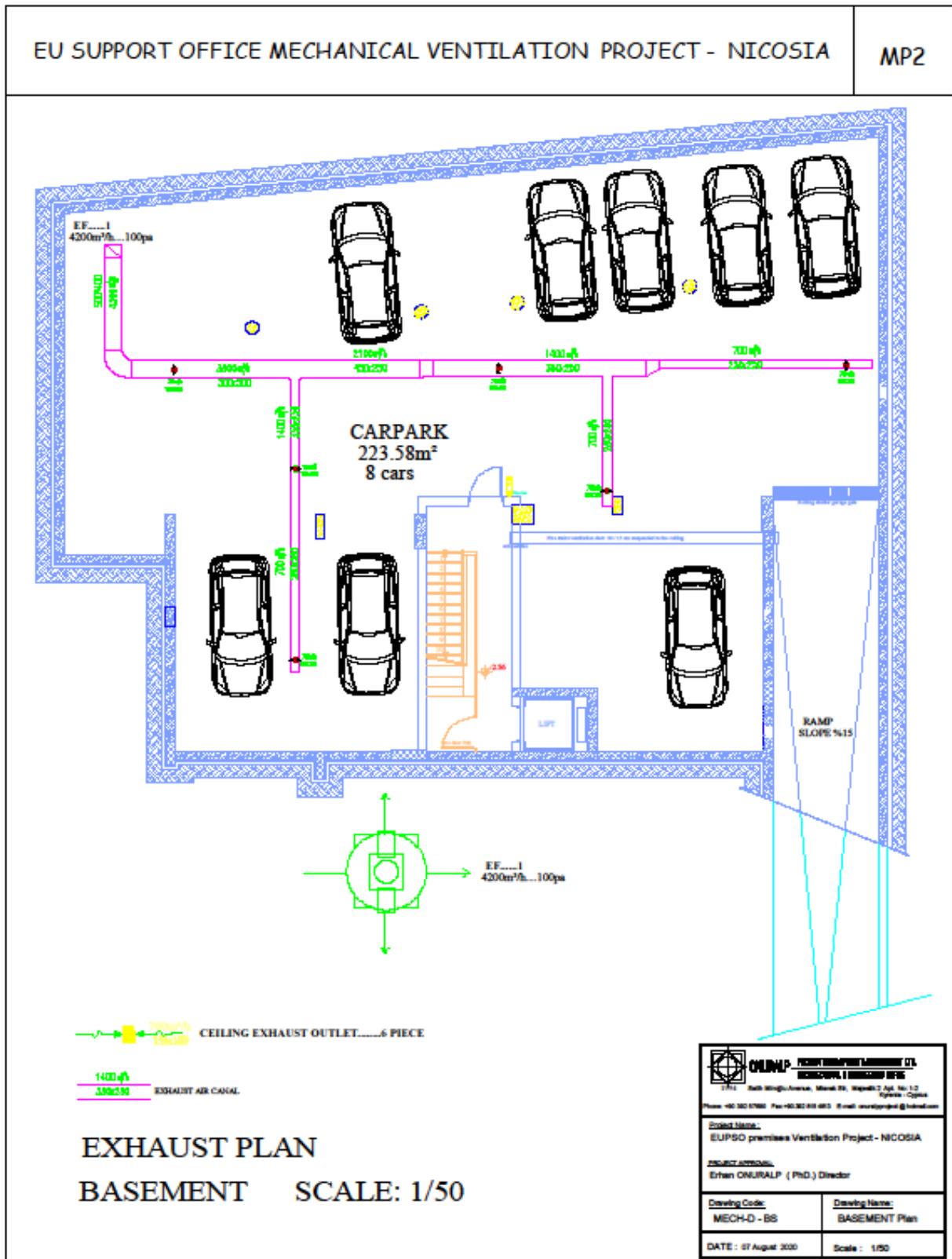


Figure 24. Basement Exhaust Plan – EUPSO project planning MP2

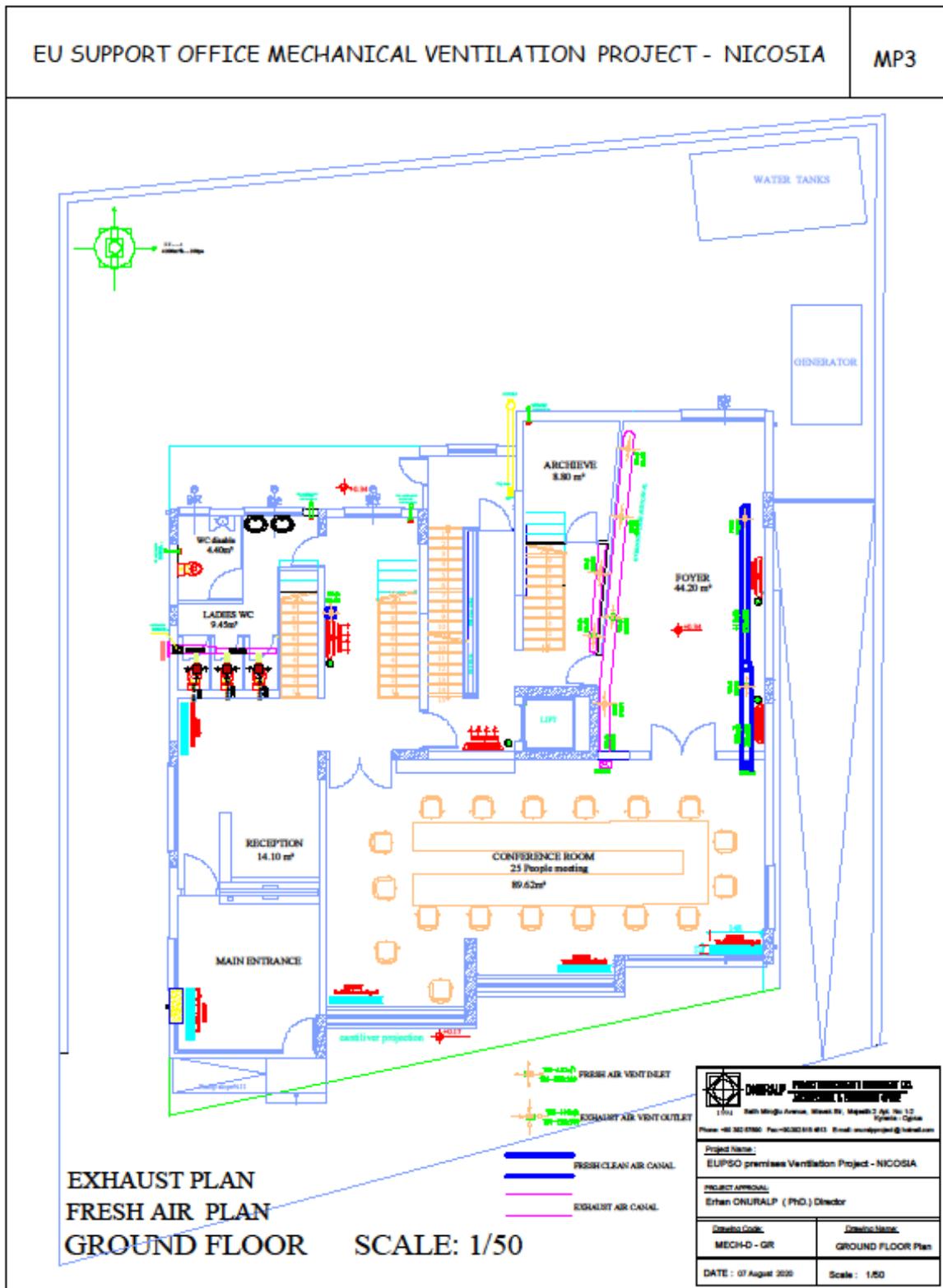


Figure 25. Ground Plan Exhaust – Fresh Air Planning – EUPSO project planning MP3

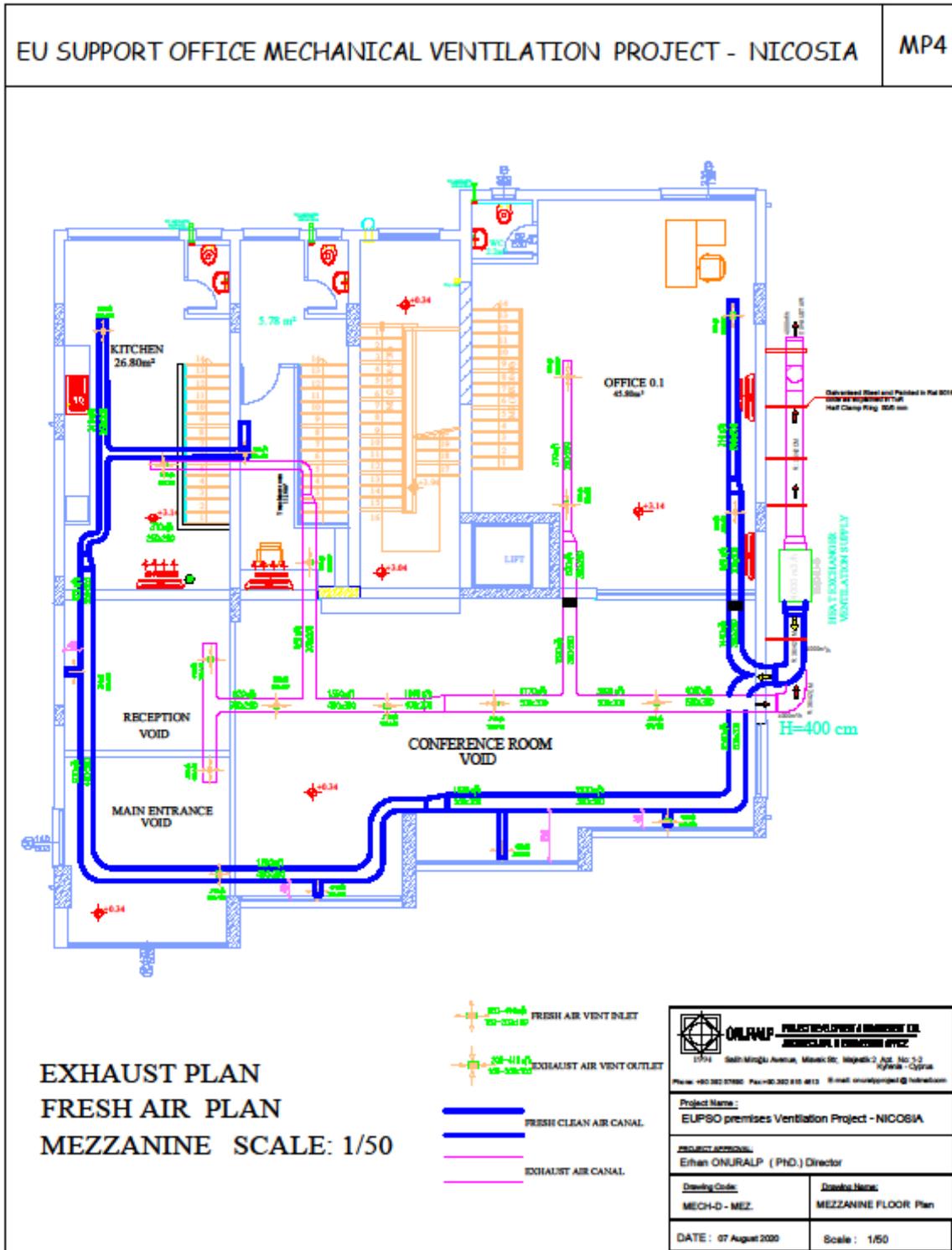
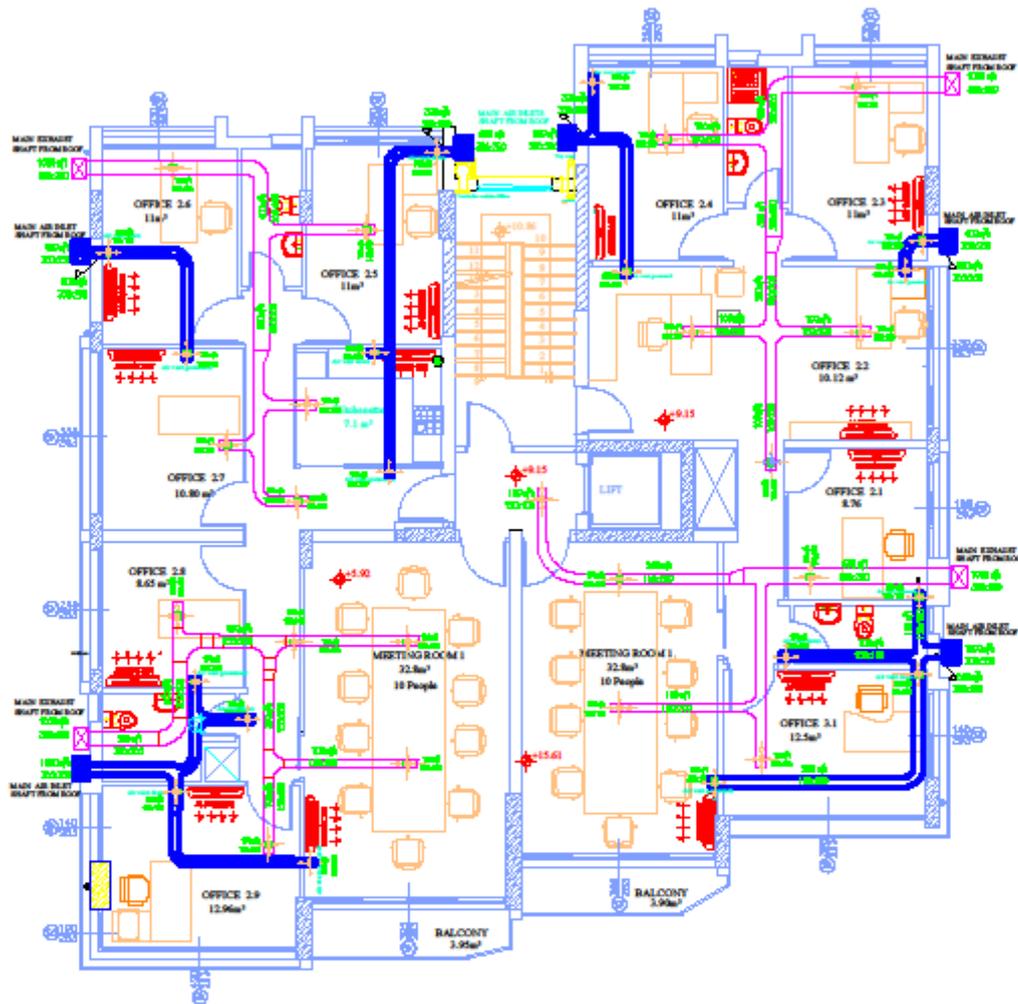


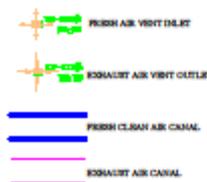
Figure 26. Mezzanine Floor plan Canal Planning Exhaust – Fresh air horizontal canals EUPSO project planning MP4

EU SUPPORT OFFICE MECHANICAL VENTILATION PROJECT - NICOSIA

MP6



EXHAUST PLAN
FRESH AIR PLAN
SECOND FLOOR SCALE: 1/50



ONURALP PROJE GELIŞTİRME VE İNŞAAT İŞİ YATIRIMCILIK VE MÜHÜRLEME ÖZEL İŞLETİM A.Ş. 10744 Salih Müezzinzade Avenue, Mersin 33, Şişli/Beşiktaş/İstanbul - Turkey Phone: +90 332 07880 Fax: +90 332 616 4813 E-mail: onuralp@onuralp.com	
Project Name: EUPSO premises Ventilation Project - NICOSIA	
Project Approval: Erhan ONURALP (PHD.) Director	
Drawing Code: MECH-D - SEC.	Drawing Name: SECOND FLOOR Plan
DATE : 07 August 2020	Scale : 1/50

Figure 27. Second Floor plan Canal Planning Exhaust – Fresh air horizontal canals EUPSO project planning MP6

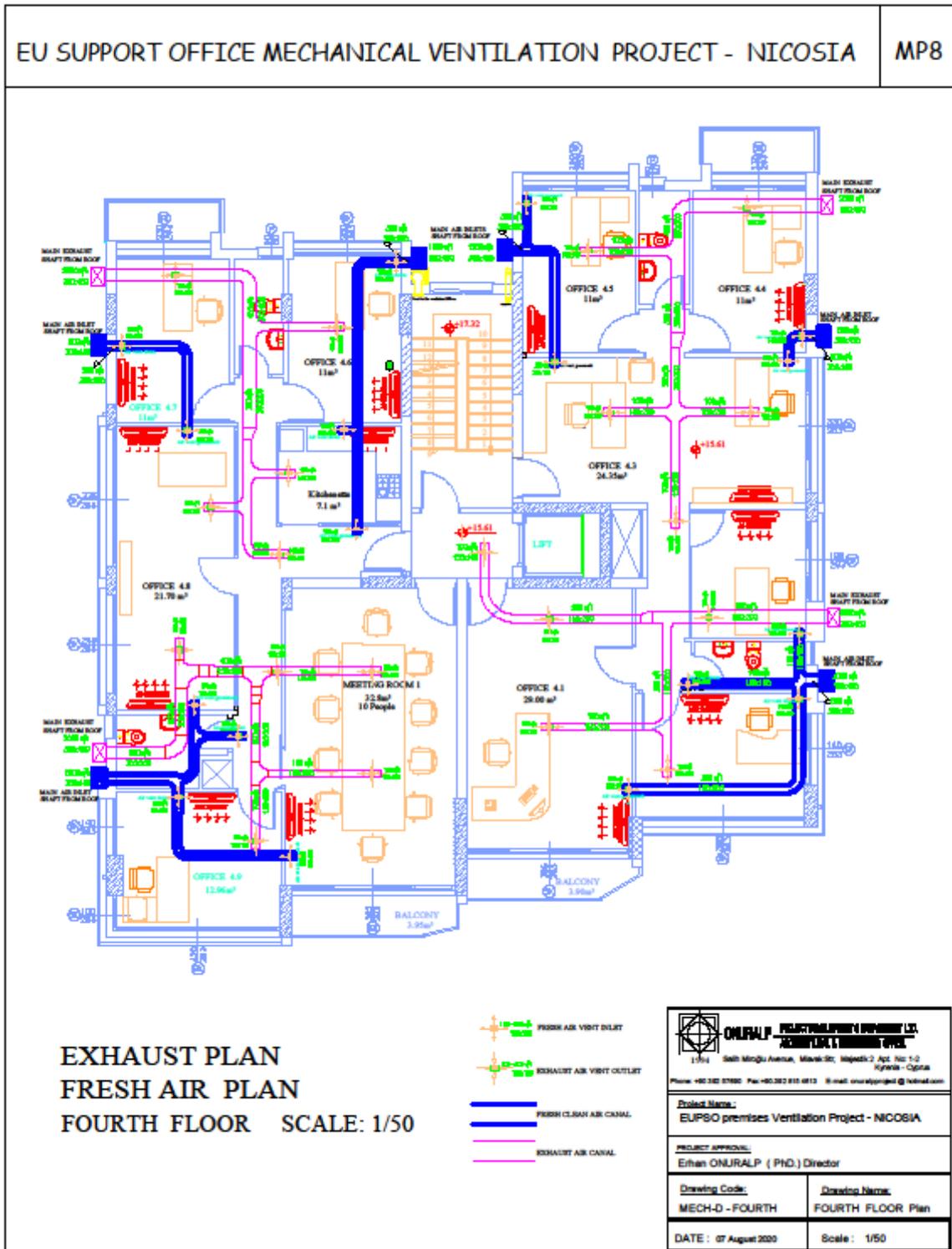


Figure 28. Fourth Floor plan Canal Planning Exhaust – Fresh air horizontal canals EUPSO project planning MP8

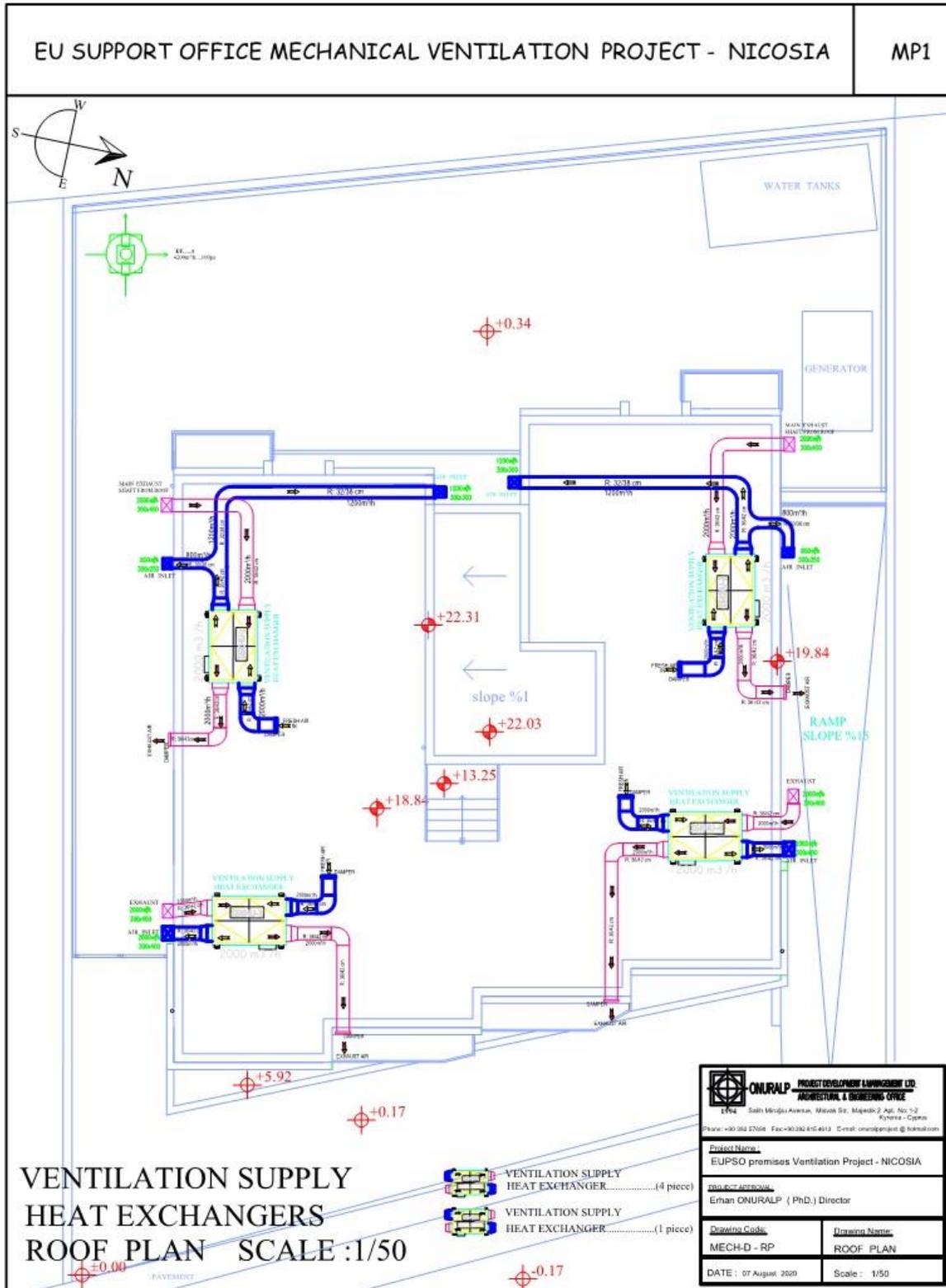


Figure 29. Roof plan with Ventilation Supply Heat Exchangers EUPSÖ project planning MP1

Correlation Between Online Assessment and Student Learning in Engineering Education

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Abstract: From early 2020, the world is struggling with the COVID-19 global health crisis. The true cost of disruptions caused by the pandemic would take decades to be properly estimated and recovered as the world is still struggling to get back to the pre-COVID normal life. One of the hardest hit areas by the pandemic is education in general and specifically engineering education. As per the United Nations Policy brief issued on August, 2020, “The COVID-19 pandemic has created the largest disruption of education systems in history, affecting nearly 1.6 billion learners in more than 190 countries and all continents.” All over the world, the education institutes have tried to minimize the impact of disruptions by quickly adapting to online education. However, this quick adoption has caused a number of challenges to educators and learners alike in all areas of learning and teaching. One such area is the online assessment which is a fundamental aspect of learning and teaching. The current paper presents the case of higher education engineering institutes in Oman. It will systematically and holistically analyse the challenges faced by the engineering academics and students with the online assessments and the impact of these online assessments methods on the students learning will be examined.

Keywords: COVID-19, Online learning, Online teaching, Online assessment, Assessment methods, Assessment challenges

Introduction

This research aims to study the impact of the E-learning system on the assessments and the corresponding student performance during the COVID-19 pandemic in the higher education sector in the Sultanate of Oman. As the most places around the world, the pandemic caused disruption to all facets of normal life and specially the education sector. It was a huge challenge to shift from conventional in-class face to face learning to e-learning in a way that guarantees the teaching and learning progress, quality, attaining intended outcomes, academic control and admin/technical support (Alqahtani & Rajkhan, 2020). Several challenges and obstacles were faced which in turn hindered the success, efficiency and quality of teaching and learning process during the pandemic. Therefore, this study is investigating the efficiency of the E-learning system during the COVID19 pandemic in engineering education sector in the Sultanate of Oman.

The major focus of this paper is to establish the correlation between online assessments and student learning. Assessment can be defined as the process of collecting information on student achievements and performances. A balanced assessment includes a variety of assessment tasks. Ongoing assessment provides information instruction and improves student performance (Angelo & Cross, 2012). An assessment process reveals the level of understanding and knowledge students have achieved and what they can do. This allows the identification of students' learning outcomes, based on collected evidence and judgments according to established assessment criteria and using various assessment techniques. Learner performance relates to a list of students' skills and cognitions that they should acquire throughout their learning processes, those enable them to do or act according to learning performance aims previously determined (Nusche, 2008). According to past researchers, performance assessment has three basic components, the learning performance, the established criteria or performance objectives and the observers' judgements or feedback (Evans, 2013). A careful reflection on the process of assessment by gauging the student performance, a teacher could adjust the teaching method to more productive ways of teaching practices. The assessment process is best utilized when it integrates the above mentioned three components into the dynamic learning and teaching process. The challenge, however, remains to develop and implement precise and adequate performance assessment criteria, as evaluation is a dynamic and ongoing process within the learning process (Taras, 2002).

It is imperative that the focus of assessment process must be on first on the learning, secondly on encouraging student effort and thirdly on grading. Timely and detailed feedback is a motivation for students and keeps them engaged and encourages them to improve their performance. In an online learning environment, both teacher and learner need to be fully engaged and better performance could be achieved by building an online learning community. There had been many challenges faced by educators and learners throughout the world both physical and emotional in transition to E-learning from in-class face-to-face learning. Regardless of all the challenges of E-learning, E-learning could be a motivating factor to reflect on and advance the existing teaching practices to more effective ones using technology.

The sudden outbreak of COVID-19 forced all in-class face-to-face learning to E-learning in the Sultanate of Oman as was the case throughout the world. This challenge also provided an opportunity to observe different aspects of E-learning in the real time setting. One such study was carried out in the Sultanate of Oman at the Military Technological College (MTC) (Siyabi, Khan, Hussain, & Rashdi, 2020). It focused on the problems and solutions of the E-learning system implementation during the COVID-19 pandemic. In the current paper, few of the important conclusions relating to the assessment's correlation to E-learning are presented:

- Impact of the E-learning system on students' performance
- Impact of the E-learning system on students' motivation
- Correlation between students' performance and motivation in the E-learning system

Method

A quantitative research method is employed to measure the student performance. Responding to the lockdown decision by imposed by the government of Oman during COVID-19 outbreak, MTC quickly adapted to the situation and started online delivery of all the modules at all levels, level 3 to level 6.

Table 5. Data Collected for Analysis from Different Levels (Siyabi et al., 2020)

	Module A		Module B	
Academic Year	1819	1920	1920	2021
Semester	Sem 2	Sem 2	Sem 1	Sem 1
Delivery Mode	Conventional	Online	Conventional	Hybrid
L3 Freshmen (1st Year)				
Average	53.85	62.06	61.60	58.31
Std Dev	20.97	14.19	6.38	7.31
Pass %	52.89	66.22	93.08	88.85
Fail %	47.11	33.78	6.92	11.15
L4 Sophomore (2nd Year)				
Average	51.08	57.28	48.83	48.93
Std Dev	12.76	7.01	8.58	9.20
Pass %	87.18	93.18	63.97	73.39
Fail %	12.82	6.82	36.03	26.61
L5 Sophomore Senior (3rd Year)				
Average	53.38	52.89	58.79	60.15
Std Dev	4.69	7.63	7.82	8.60
Pass %	100	91.38	100	95.12
Fail %	0	8.62	0	4.88
L6 Final Year (4th Year)				
Average	64.75	63.32	65.10	63.86
Std Dev	7.55	6.35	7.13	5.65
Pass %	100	100	100	100
Fail %	0	0	0	0

In case of the current study, from each level two modules were selected for analysis, one from semester 2 named "Module A" and a second from semester 1 named "Module B". Table 5 presents the detailed results' data for

selected modules at different levels of diploma and BEng students. The results' data compares the module online delivery to the conventional mode of delivery.

The modules from different levels were selected based on theoretical and analytical courses. All the modules with major laboratory element which had limitations in delivery during distance learning were only partially considered in this study. The modules selected for level 3 were theoretical with no impact on results due to practical omissions. However, the selected level 4, 5 and 6 modules had different degrees of contribution through practical work on the results.

Results

As mentioned above, data collected for two modules from each level of the study, with the online and conventional face-to-face delivery modes. However, for the brevity, only level 3 results are presented in detail in the current paper.

Performance at Level 3

As mentioned earlier, two modules were chosen for analysis, one from the second semester of the academic year AY1920 (Module A) and the second from the first semester of the academic year AY2021 (Module B). Both the selected modules had two assessment components: final exam with 70% weightage and coursework with 30% weightage.

Teaching delivery for both the modules in the two different semesters was carried out through E-learning method through MS Teams during COVID-19 period, covering all the learning outcomes. The virtual learning platform of Moodle was also used to disseminate pre-recorded voice over video-lectures, course materials and online formative quizzes and chat discussion providing much needed extra support to students with sudden change to mode of teaching delivery. The selected modules at level 3 did not have any laboratory or practical elements, therefore, it is assumed that the E-learning interruption to the delivery of modules was minimum. However, due to lockdown, an alternative assessment to the written offline exam had to be proposed. As an alternate, an online examination having numerical problems and multiple-choice questions was developed.

The results' data level 3 modules are presented in Table 6. For module A, significant improvement is observed in the second semester of AY1920, when the module delivery and assessment was online. A higher percentage of 48.6% students scored between 60% and 79% as compared to 26.67% in AY1819. It revealed that online delivery and assessment resulted in higher scores as compared to conventional delivery and assessment. A very significant drop of around 19% in failure rate was also recorded in AY1920.

Module B results' data from semester 1 AY2021 is compared with semester 1 of AY 1920 and presented in

Table 6. Results show that more than 50 students achieved between 60 and 79% in AY2021 which is closer to the results of AY1920 in this range. However, in contrast to 12.68% of AY1920, no student managed to obtain marks in the range of 80 and 100% in AY2021. These trends of higher performance at this level could be attributed to the assessment design. The assessments at this level were more focused to the understanding level and comprised majority of knowledge base questions. At higher levels, where analysis skills are assessed, the results might be different.

Table 6. Level 3 marks distribution for Modules A and B. (Siyabi et al., 2020)

Level 3 Marks distribution	Module A		Module B	
	AY1819	AY1920	AY1920	AY2021
0 – 39	23.78	4.05	2.88	1.49
40 – 59	35.56	36.68	26.8	44.24
69 – 79	26.67	48.46	57.64	54.27
80 – 100	14	10.81	12.68	0

This could also be inferred from the results analysis that the trust on the data or the reliability of the assessments results was higher when the assessment conducted under invigilation/supervision as compared to the online assessment. During online assessment strict invigilation was somewhat compromised due to technology limitations. At level 3, where contribution to the overall results was more than 60% from online examination, a specific trend in student performance was noticed. It was observed that the overall performance of students increased and there was little discrimination between good and average performers. Furthermore, the performance measured during the second online delivery had better confidence level due to lessons learnt and addressing the issues observed during first delivery. Although technologies are evolving at an unprecedented pace, it still appears that much advancement and affordability in technology is needed for 100% trustworthy adaptation of E-learning in the context of higher education. Assessment is a key part of learning and from the data presented above, it is shown that the academic management and teaching teams have learnt lessons from Module A assessments which resulted in the better confidence level in Module B results. This enhancement in confidence level was achieved by staff and student familiarization with the E-learning process.

Conclusion

A comprehensive study on the different aspects of E-learning was conducted at MTC in the sultanate of Oman. A correlation between online assessment and students learning in engineering education at foundation level is determined and following major conclusions are deduced:

- Assessment under supervision/invigilation data is more reliable compared to online assessment due to compromised invigilation
- For level 3, the overall performance increased along with limited discrimination between good and average performers
- Better confidence levels in 2nd year of online delivery and assessments than in 1st round of delivery because of some lessons learnt

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The Influence of Planck's "Devil" on the Scientific Thought of Physicists

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Abstract: While reading Planck's work, we are surprised by a fact: he considers his hypothesis a mere means of calculation and does not see all of its transformative force, the concept of "quanta of action" is not even explicitly mentioned as well as the formulation of discrete resonator energy in the potential wall. All Planck's efforts were directed towards the introduction of the Planck constant- "h", in the framework of classical physics. The failure to do so "left no doubt that the quanta of action plays a fundamental role in atomic physics and its appearance in physics was the beginning of a new era as it embodied something unheard of, with a tendency to radically transform our physical thought based on the concept of continuity of all causal connections "[1]. But when did such a radical turn occur in the consciousness of Planck and many other physicists? How did the Quanta of Action gain the "right to citizenship"? What debates and discussions have been made about his affirmation? The answer to these questions is essential to the whole history of quantum discovery, why it allows us to determine the degree of understanding of the problem as a whole at different time periods: both before the Solvay Congress (1900-1910) and after this Congress.

Keywords: Devil, Quanta of action, Continuity, Classical physics, Planck constant

Introduction

In the most detailed article of the January 7, 1901 edition of the *Annalen der Physik*, was written that the deviations discovered by Wein's formula testify for the necessity of improving the theory. The way to this improvement lies in seeking that point in the proof of Wein, which must be subject to change; in this case the change itself does not take the theory outside the framework of electromagnetic radiation theory; in this case the change itself does not take the theory outside the framework of electromagnetic radiation theory. Here, the quantum hypothesis actually appears even more clearly:

"... It is necessary to imagine ourselves U_N (U_N the energy of N -resonators) not in the form of a continuous quantity, infinitely divisible, but in the form of a discrete quantity consisting of a whole number of equal finite parts." However, again here the word "quanta", or "quanta of action" is not mentioned. But when is this term first mentioned?

In 1905 Planck wrote to Ehrenfest: "As can be seen, no doubt, that this assumption (the existence of the elementary quanta of electricity) sets the bridge to the existence of the elementary quantum of energy h ,

especially since h is of the same order as $\frac{e^2}{c}$ (e - the elementary quanta of electricity, c - the speed of light)". [3]

In 1905 Ehrenfest's article "On the physical premises of Planck's theory of irreversible radiation processes", [4] mainly spoke of Planck's application of Boltzmann's statistical method to thermal radiation. It is interesting to mention the formulation of the quantum hypothesis given by Ehrenfest: "The energy of radiation of different colors consists of very small energy particles of size $E\nu = V6.55 \cdot 10^{-27} \text{ erg} \cdot \text{sec}$, where ν is the corresponding color frequency "[4]

As can be seen this Ehrenfest formulation is closer to that of Einstein than that of Planck, despite the fact that Ehrenfest was not familiar with Einstein's formulation for the quantification of free radiation, published a few months ago. This is evidenced by the fact that Ehrenfest does not cite Einstein neither in his work of 1905 [4] nor that of 1906 [5]. There is a possibility that Ehrenfest did not distinguish between his own formulation and that of Planck, as the latter was not expressed very clearly. Ehrenfest discusses the problem of quanta in more detail in Planck's article [5], written in the form of a commentary on Planck's "Lectures on the Theory of Thermal Radiation". Below we will see in more detail Ehrenfest's views on quanta. We now turn to Planck, who in "Lectures" uses the term "quanta" for the first time.

In 1906 in the first edition of Planck's "Lectures on Thermal Radiation" we read: "There is no doubt that the constant " h " plays a defining role in the elementary oscillating processes occurring at the centers of emission; electro dynamically the present theory does not give us the initial view for explaining this assertion. And only then all the thermodynamics of radiation gets satisfactory conclusions when it realizes the full universal value of the constant h . I wanted to call this the "elementary quanta of action" or the "element of action". [4]

It follows from the above that Planck did not make any obvious conclusions from his hypothesis not only in 1906, but also in the following years until 1910, when the quanta was "affirmed" by Einstein for the discrete structure of free radiation. As well as when quanta hypothesis was widely applied in various areas of physics, and again Planck attempted how to integrate the quanta of action into the harmonic scheme of classical physics. What did these efforts bring? Planck himself states: "My careful attempts to insert the quanta of action in some way into classical theory continued for several years which cost me a lot of effort and energy. Many of my

colleagues looked at this as something tragic. I had a different opinion. For me the most valuable was the fact that I finally clarified the problem. Now I can say with confidence that the "quanta of action" plays in physics such a large role that I didn't think of at first "[1]

Evaluations of Planck's theory.

How was Planck's works defined during those years, and how did they influence other scholars?

Lorenz in 1901 first mentions Planck's formula in his work "Radiation theory and the second law of thermodynamics" [5], but does not deal with the formula itself. In 1903, in his work "On the Emission and Absorption of Metals of Large Wavelength Thermal Rays" [6], he focuses in three moments during the analysis of Planck's formula.

The first moment - like other researchers, Planck does not start from the mechanism of wave emission. From the point of view of the creator of electronic theory such a method, although acceptable, could not be considered completely satisfactory.

Second moment: to derive the formula, Planck for the first time calculated the most probable energy distribution between resonators with different frequencies, but determining the probability accepted by him was not the only possibility.

And the third moment: Introducing the hypothesis of finite energy elements. Assessing precisely this moment, Lawrence wrote: "From the above observations it follows that the hypothesis concerning the 'finite elements of energy' which leads to the introduction of the constant h is the most fundamental part of the theory; but the question of the mechanism by which the heat of bodies causes electromagnetic oscillations in the ether is tacitly avoided.

Concluding the analysis of Planck's work Lawrence writes: "the results obtained are quite essential, as long as they lead to the formula that fits well with the experiment". He is restrained regarding any assessment of the quanta hypothesis.

Completely different was Einstein's position on the quanta problem. He did not conform to the cautious views of Planck and Lawrence. Einstein clearly understood from the beginning that the quanta hypothesis in any form has nothing to do with classical imaginations, that the search for ways to insert the constant "h" into the classical electrodynamic scheme is destined to fail. According to him, "the energy of the light beam, which is emitted from a point, does not propagate continuously throughout the volume, but consists of a finite number of indivisible quanta localized in space, which are absorbed or emitted as a whole" [7]

On the other hand, Einstein showed that the elementary quanta introduced by Planck, are not necessarily related to Planck's thermal radiation formula. Based on Wein's formula, he concludes that "low-density monochromatic radiation (within the limits of the application of Wein's law of radiation) in the sense of heat theory behaves as if

it were composed of energy quanta, independent of each other and of magnitude $\frac{R}{Nbv}$, where $(\frac{R}{Nb} = h)$.

Using the results obtained in his 1903 work "Theory of the Basics of Thermodynamics", Einstein asserts that we can only arrive at Planck's formula if we assume that the resonator energy takes whole multiples of the

magnitude: $e = \frac{R}{Nbv}$. But after acknowledging this, Planck should have given up on Maxwell's electrodynamics from which no particular energy value is derived. Meanwhile, this meant giving up the foundation on which the connection between the average energy of the oscillator and the density of radiation was "conceived", which plays a fundamental role in Planck's theory. But Planck's own formula is taken based on the hypothesis of light quanta, so Einstein also claimed that this hypothesis was vaguely introduced by Planck in the theory of radiation.

Fourth Congress of Mathematics

In April 1908 in Rome convened the IV International Congress of Mathematics, in which Lawrence delivered the paper "Distribution of energy between matter and ether" [8]. The papers pointed out that when using true statistical mechanics for any system that was subject to Hamilton's motion equations the Ray-Jeans formula is taken. On the other hand this formula was taken from Lawrence for long waves from electronic theory, in which the truth of Hamilton equations was also assumed. We must therefore assume that the formula obtained for long waves is general and has the appearance of the Ray-Jeans formula. But while this formula contradicts the facts, then there is also a contradiction between electronic theory and facts.

But what would be the way out of this difficulty? Lawrence does not speak: he only found that two possible paths have now emerged: that of Jeans and Planck, and each has its own difficulties. But after the Congress and in the same year in 1908 in the article "On the theory of radiation" Lawrence was forced to accept Planck's theory as the only solution to the problem: "For a long time I hoped - he writes - that by uniting kinetic theory even with the usual imaginations of electronic theory to maintain the conclusion on the general character of Jeans theory... Now I have clarified what great difficulties we encounter in this way; I can conclude that the conclusion of the laws of radiation from electronic theory will hardly be possible without profound changes of its bases, and I must look at Planck's theory as the only possibility." [9]

So we have two assumptions: the insufficiency of electrodynamics, and the necessity of Planck's theory. Planck himself continued to remain silent, but in the letter sent to Lawrence he wrote that he considered correct the conclusion of the impossibility of saving the Jeans formula by the use of ordinary electronic theory, unless the hypothesis of energy elements $h\nu$ is introduced.

As it appears from the letters, it was at this time that Planck began to realize that his hypothesis necessarily led to the discontinuity of processes related to the interaction between light and matter. Thus in late 1908 the situation was presented in this view:

- it was clear that there is no way to 'rescue' the Ray-Jeans formula;
- it was necessary to make changes in classical electronic theory;
- -Planck's energy quanta hypothesis shows the direction in which these changes were to be made.

But on the question of how radical these changes must have been, there were divergences. Only Einstein was convinced that the acceptance of the quantum hypothesis is associated with very profound consequences on existing notions of the process of the interaction between matter and radiation. While Planck, Lawrence, Wein and other prominent physicists continued to think that these changes should not touch the foundations of classical physics and were opponents of Einstein.

Quanta is "Affirmed"

In September 1909 in Salzburg at the next meeting of the German Association of Naturalists, Einstein met for the first time in person with many physicists (Planck, Wein, Sommerfeld, etc.). His paper "On the development of our views on the essence and structure of radiation", read at the joint meeting of the section of physicists and mathematicians in the presence of 100 people, caused lively discussions. Characterizing the value of this paper, Pauli wrote after 40 years: "Einstein's paper on light radiation, read by him in Salzburg, which first appeared in front of a large audience, can be seen as a turning point in development of theoretical physics" [10].

Why did Paul find this work epochal? Remember briefly the content of the paper?

The first part was devoted to the theory of relativity. This part went smoothly. Discussions took place about the second part in which Einstein presented his views on the quanta problem. Here he identified two concepts: the "essence" of radiation and its "structure". The first was closely related to the theory of relativity.

While during the emission of light there is a reduction of the mass of the body-source according to the law

$$\Delta m = \frac{\Delta E}{c^2}$$

i.e. light itself must have mass, then the light comes out not related to the hypothetical ether, but something independent, the same as matter. But by changing the physical views of the essence of light, the theory of relativity did not touch on the meaning of the structure of radiation, it did not provide information on the spatial distribution of radiation energy. In support of his hypothesis on the independent existence of light quanta in free space, Einstein presented the results of his previous work on calculating radiation fluctuations; [11]

In this work he came to the conclusion on the dualistic wave-corpuseular nature of light and on the necessity of constructing the theory as the original connection of wave optics with the theory of flow. It was these conclusions that Pauli had in mind.

Einstein himself modestly formulated the purpose of his paper: "What I will talk about further represents most of my personal thoughts or still insufficiently controlled results. However, I will present these results here not because I have great faith in my views, but I hope that some of the listeners will be excited to deal with the issues raised." [12]

Planck emerged as Einstein's opponent. The basic ideas of his speech were that the introduction of quanta into the theory of radiation was necessary; quanta must be understood primarily as atoms of action, the difficulties of the theory are focused on the phenomena associated with the interaction of light with matter; there is still not enough basis to consider free radiation composed of light quanta. Planck also expressed these views in his lectures on "The Contemporary System of Physics Today" in the autumn of 1909: In this way it is concluded that the current theory of electrons has a fundamental flaw which makes further supplementation more than necessary. Regarding how deep these additions will penetrate the construction of the theory itself - the thought on this is now very widespread. According to the more radical view of J. J. Thomson, Larmor, Einstein, and even Stark, the propagation of linear electromagnetic waves in the absolute vacuum does not derive exactly from Maxwell's equations, but occurs with definite elements of energy $h\nu$ of energy in interaction with special resonators" [13]. Einstein's hypothesis on light quanta was further discussed by Lawrence in 1909. In his paper at the Congress of Dutch Naturalists he categorically denied the existence of light quanta. [14].

Let us now return to Ehrenfest's wonderful article "What features of the light quantum hypothesis play a crucial role in the theory of thermal radiation?", Of which Llaue writes: "Of all the work done recently on the laws of radiation, this penetrates deeper into the very essence of the ideas of the three basic laws of radiation: Rayleigh-Jeans, Planck and Wein." [15]

Contrary to commonly accepted terminology, Ehrenfest "under light quanta" understands not Einstein's assertion of the quantification of the radiation field, but the idea of energy quanta in general, regardless of where they enter. Ehrenfest does not show in his article his attitude towards Einstein's method, which was considered more radical by Lawrence, Planck, Wein and other prominent theorists; he does not refer to Einstein but only at the end does he compare the views of Planck and Einstein promising to return to the subject once more. But Ehrenfest's return to the discussion of the quantum hypothesis occurs with Einstein's influence. In early 1912 Ehrenfest's personally first met with Einstein. Recalling this meeting many years later, Einstein writes: "We both realized that classical mechanics and electric field theory were insufficient to explain the phenomena of light radiation and molecular processes (statistical theory)... Logical rift in Planck's theory of radiation it was clear to us" [16]

The basic problem that Ehrenfest set himself was: the explanation of the fact that in quantum theory radiation could be considered ultimately explicable, but that it could still be subject to change. In this case he came to the other final conclusion: the application of classical Boltzmann statistics with continuous scattering functions to radiation necessarily leads to the Ray-Jeans formula and consequently to the "ultraviolet catastrophe". Ehrenfest showed that the only way to avoid this catastrophe is to accept the distribution hypothesis, (different from Boltzmann) in the sense that it must assume different probabilities from zero only for certain points of the phase space of the system, which is same as the energy quantification assumption. The light quantum hypothesis was formulated by Einstein precisely as a result of examining the properties of radiation in the Wein area ($h\nu \gg kT$).

Attempts to base Planck's formula on final calculations inevitably led to the necessity of introducing some additional hypotheses that would allow one to take Planck's formula instead of Wein's formula. The physical basis of these hypotheses in elaborated or unexplained form was related to the understanding of the wave-particle dualism of radiation properties.

Ehrenfest in his works emphasizes two moments: the formal character of Planck's method and the necessity of distinguishing Planck energy quanta from Einstein light quanta, why the application of Boltzmann statistics to independent quanta leads to the Wein's formula and not to Planck's.

The First Congress of Physicists

On October 30, 1911, the first Congress of physicists convened in Brussels on the topic: "Radiation and quanta", which was attended by almost all prominent physicists related to the problem in question: Planck, Lawrence, Einstein, Nernst, Sommerfeld, Wein, Jeans etc. Also invited were Rutherford, M. Curry, Langevan, Perren, Knudsen, Poincaré, who, although at that time did not have important works on radiation, but whose opinions were taken into consideration.

Twelve papers were heard in Congress, the most important of which were "The Application of the Theorem of Uniform Distribution of Energy to Radiation" (Lawrence), "Laws of Thermal Radiation and the Hypothesis of Elementary Quantities of Action" (Planck), "Significance of the action quantum for non-periodic molecular processes in physics" (Sommerfeld), "On the present state of the thermo capacity problem" (Einstein).

"Discussions in the Congress," Bohr wrote, "were opened by Lawrence." He brilliantly presented arguments based on classical ideas leading to the principle of uniform distribution of energy according to the degrees of freedom of the physical system involving not only the motion of the material particles that form it, but also the normal oscillations of the electromagnetic field of related to the electrical charges of the particles. These arguments analogous to the analysis of the thermal equilibrium relay lead, however, to the well-known paradoxical result, according to which no thermal equilibrium is possible, because all the energy of the system

will gradually be given to electromagnetic oscillations of ever higher frequencies” [17].

Lawrence in his paper raised many questions, among which two most important, the answers to which were related to the mechanism of interaction of radiation with matter, namely:

- -If the metal has particles that vibrate with a defined frequency, then why are these vibrators at rest when the temperature becomes too high?
- -If instead of vibrators, we imagine irregular motion, which leads the ether to a definite state of motion, which can be decomposed into harmonic components, then how to understand that for small general energies exactly the components with high frequencies disappear?

To solve this problem, a mechanism had to be modeled, which would allow the transfer of the energy of rapid oscillations from radiation to matter, but prevent the opposite passage. It could then be deduced from the sacramental conclusion that all the energy of the oscillators had to pass to the ether with an infinite number of degrees of his freedom.

Planck introduced his paper briefly. After characterizing the state of the problem and underlining once again the "surprising contradiction between experiment and classical theory", he agrees with Lawrence's conclusions that all known theories lead to the Relay-Jeans formula. He tries to examine more deeply the physical nature of the h constant. The further construction of the theory will essentially depend on whether the sole role of h in the radiation and absorption processes will be limited or it will also extend to the motion of the field energy in vacuum. The second view defended by Einstein could not be accepted by Planck, but also by other participants in Congress. They were simply not ready to perceive those radical changes which required the photon hypothesis. But the problem was closed by giving up any electrostatics that assumes the continuous character of the electromagnetic field.

Moreover, Planck put forward the "second variant" of his theory that emission is discrete, while absorption was considered continuous. To clarify the physical meaning of the energy quanta Planck aimed to find the dynamic law of oscillator oscillation by revising the equations of electronic theory in such a way that the action quantum enters this law. But the proposed model could not satisfy this demand because being classic it led to the Relay-Jeans formula.

Although Einstein called the paper "On the present state of the problem of specific thermo capacity" he actually presented the results of the development of the last quantum theory of 1911. He analyzed in detail the difficulties of classical mechanics and electrostatics which compel us to turn our attention to the hypothesis of quanta; unconditional acceptance of this hypothesis and its consequences. Quite interesting was his remark regarding the new conception of the law of conservation of energy as a result of accepting the discontinuity of the processes "... we are obliged to give up the law of conservation of energy in its current form assuming that it can be accepted statistically, analogous to the consequences of the second principle of thermodynamics. As it

is known, Bohr, Kramers, etc, later walk on this road.

Yes, the congress had an important consequence. It was here in the circle of ideas that includes quanta problems, for the first time, the famous French mathematician Henri Poincaré was "hit", who in all his works published during the years 1900-1911, never used or discussed the concept of quanta. So in Congress he did not come up with a paper, but discussed the issues that interested him vividly with the aim of clarifying the roots of the difficulties that arose.

He categorically refuted Jeans' attempts to explain on a classical basis the divergences between the Ray-Jeans formula and the experiment, showing in this case the impermissibility of introducing into the old theory any new constants to explain any newly discovered experimental fact; intended to explain to Planck that to what extent it is necessary how he uses the division of phase space into cells to calculate the number of possible states of the oscillator and how to generalize the quantum hypothesis in the case of systems with many degrees of freedom. In the final discussion, Poincaré posed the question: on what path should the already inalienable already clear reform of the foundations of classical physics go. Should the universal continuity of physical processes be preserved, or is the introduction of the quantum hypothesis and discontinuity absolutely inevitable?

It was with the solution of this problem that Poincaré continued to deal with after Congress until his death, leaving unfinished a cycle of work on quanta. But even published results are essential. Poincaré shows that the quantum hypothesis is not only sufficient but also the necessary conditions for deriving the Planck formula proved by all the available experimental facts. These works of Poincaré influenced the common attitude of physicists towards the quanta interpretation of various physical phenomena. It became clear that the probability of constructing the theory without the inclusion of quanta was almost zero. The "atomism of action" finally triumphed.

December 14, 1900 was the "fatal" day of classical physics, as that very day, in that famous lecture by Max Planck, such a classic principle of classical physics was refuted - that of the continuity of the transition from one state to another, namely the imagination on the continuity of absorption and emission of energy.

Thus a "myth" of classical physics was overturned and a new conception was affirmed: the atomism of action, which led to the revision of all concepts and laws of classical physics. Already for the micro world we have a new way of describing it different from the classic one.

"Planck introduced into physics the "illogical", if we can put it that way," Landau said. And this he did not do willingly, but compelled because he saw no other way out. We say "illogical" because his hypothesis contradicted the usual elementary logic of classical physics which physicists of the time did not question. In physics an original situation was created — the existence of opposing reasoning: logical and illogical. In this strange situation a great progress was made in the quanta theory which from Planck's first hypothesis reached to the present day, to quanta physics.

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E-Learning Practices and Challenges in Engineering Education: Omani Perspective

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Abstract: The circumstances developed in early 2020 due to COVID 19 pandemic impacted almost every walk of life and it continues, some facing more challenges than the others. The education sector felt the impact more than any other sector, face to face or conventional method of teaching transformed to online E-learning method of learning. Educational institutes around the world faced surmounting challenges in their systems, implementations, and assessment phases in this transition. However, the major success of the E-learning system is that the learning process did not stop, teachers and students familiarize themselves with the state-of-the-art technologies for teaching and learning purposes. The sudden shift of conventional teaching to online learning poses a challenging situation for engineering disciplines. Engineering students struggled because of many reasons including due to short transition period teaching team wasn't ready for E-learning mode of education. This article provides a systematic and holistic overview of challenges faced by engineering students during this challenging time. A qualitative and quantitative survey was conducted in Omani Higher Education Institutions (HEI) which concluded majority of students around 82% faced challenges to handle technologies related problems and cancellation of practical classes.

Keywords: Online education, Engineering education, COVID-19, Teaching practices, Challenges in e-learning

Introduction

When the pandemic struck in March 2020, the academic institutions around the world faced surmounting challenges. Academic institution's building closed students were asked to stay at home, all face-to-face classes shift to online education. The Sultanate of Oman promptly responded and called on all educational institutions to go online and resort to E-learning. Following the guidelines from ministry of education in Oman, the Omani HEIs like many other HEIs around the world transformed fast from face-to-face to online and then, to a blended mode of delivery (a combination of both face-to-face and online learning). E-learning was the proposed solution to continue the learning process without causing any health issues. However, in an ideal condition, the transition period had to be followed by adapting SAMR model (Romrell, Kidder et al. 2014). Which explains the steps for smooth transition of conventional method of teaching to E-learning. The environment changed rapidly and did not afford much readiness time to academic administration, students, and teachers. Generally, teaching and learning methodology can be divided into two categories, teacher-centered, and student-centered learning (Mayer 2003). After COVID the education system fulcrumed on technology, evolving a new term "technology-centered learning". In this category the learning is so much dependent on technology that if the technology collapses e.g., computer faced malware, internet speed compromised, or any software/hardware issues occur, the real time learning and/or teaching must go to a halt.

Oman's Readiness for E Learning Pre-COVID

The Sultanate of Oman is the third largest country in the Arabian Peninsula which has oldest civilization in the region. According to 2020 census the population of the Sultanate of Oman is 4.5 million people. The Sultanate have invested heavily in ICT and provided internet access to its citizen by using state of the art wired and unwired technologies (Mpungose 2020). Oman understood the usage of Internet facilities for learning process and country's public university SQU (Sultan Qaboos University) has made significant development to adapt the internet technologies to expand their E-learning program.

E-Learning after COVID

In 2020 when the pandemic of COVID-19 stuck, the health emergency was imposed to stop a rapid spread of uncontrollable disease in the Sultanate of Oman. Beyond any doubt, the response to the COVID-19 pandemic was "the most ambitious, flexible and active disease control in human history" (People's Network, 2020). As a result, necessary actions were taken by the Omani government to fight COVID-19. In the Sultanate locked down imposed in early March 2020 to stop crowd-gathering and the suspension of on campus academic studies until further notice. The Education Ministry promptly responded the situation and instructed academic institutions across the country to adapt E-learning model. In the beginning the major challenge was which method to be

used for E-learning platform. Tech companies tried their level best to provide instant solution to fill the gap because of rapid situation developed such as Zoom, which was previously used for teleconference enhance their performance level so this can be used for synchronous E-learning. Detailed research conducted at MTC (Military Technological College) which shows that 12 different tools were used during the process.

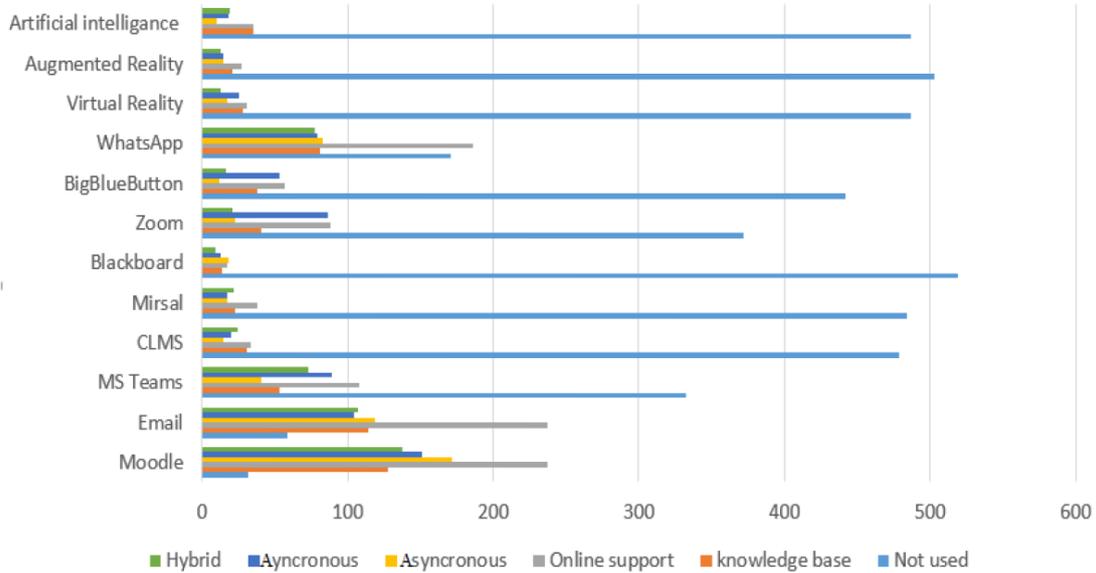


Figure 3. Use of digital tools for online learning and teaching

The detailed analysis of the data reveals that the Moodle was used as a main source of digital tool for E-learning followed by Blackboard. However, educational decision makers decided to use MS Teams for teaching and learning purpose which proved its suitability for long term solution. In the start of E-learning academic institutions faced numerous challenges to maintain efficacy and quality of teaching and learning process by adapting this new method of learning for majority of teachers and students. Therefore, this study was conducted to investigate the challenges to the teaching and learning process in higher education context in the Sultanate of Oman.

Method

Mixed research is useful method when the data is in the form of numeric and non-numeric consider the aspect of qualitative and quantitative research (Popa, Repanovici et al. 2020). In case of quantitative analysis, a representative sample from a larger group (randomly selected from foundation and post-foundation courses students) from the different Omani HEIs across OMAN was collected for reliable analysis. Qualitative analysis was conducted to generate comprehensive description data to probe the impact of E-learning to both teacher and students by interviewing them. Figure 1 explained the different phases used for data collection and analysis.

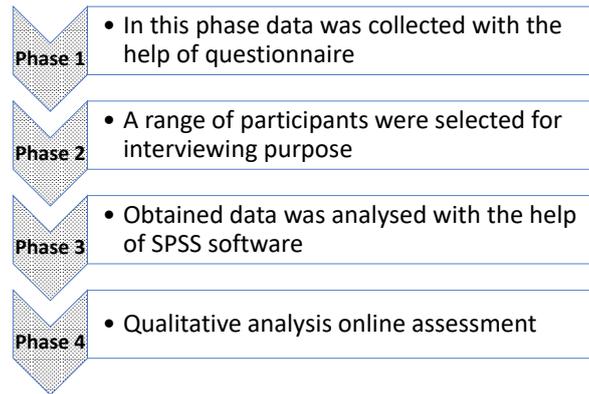


Figure 4. Different phases of mixed research

For qualitative research, twenty participants from four different Omani HEIs were interviewed, comprising four academic top management staff, seven academic HODs, two VLE specialists and seven students (L BERG 2001). All of them were eager and enthusiastic to discuss and share their ideas about the E-learning system efficiency during the pandemic in there HEIs; what and how E-learning tools were used, challenges and success factors. In every interview, the researcher started with self-introduction, and then gave a chance to the interviewee to talk about him/herself. After that, a lead in question was asked to set the tone and commence the interview in a smooth way. It was done to create a more comfortable atmosphere, reduce anxiety and build a good rapport with the interview participants. As a result of the data management process, a thematic chart with 4 main themes and 4 sub-themes were generated.

Participants (Sample Description)

Bruestle explained that the importance of gender, age, nationality, place of work and occupation of participants which can have a strong relation with E-learning system efficacy(Bruestle 2009). Figure 3 shows the age group and gender information of participants.

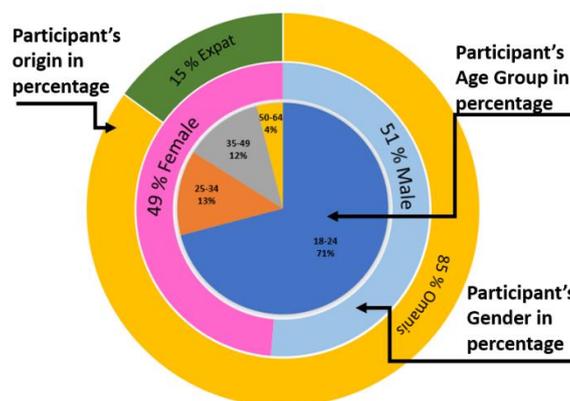


Figure 5. Participants age group, gender and origion

Research Questions

The main rationality to conduct this research was to evaluate practices and challenges during E-learning period in the Sultanate of Oman with the hope to highlight key findings and way forward.

Results and Discussion

By following the mixed research method approach first quantitative data was collected through questionnaire from different HEIs across the sultanate of Oman. The open-ended question was used to give participants a chance or more space to comment on other possible E-learning challenges that might be faced at their institutions during the pandemic. Figure 4 explains that around 81.2% of the participants faced E-learning challenges whereas 18.8% of them did not consider E-learning as a challenge.

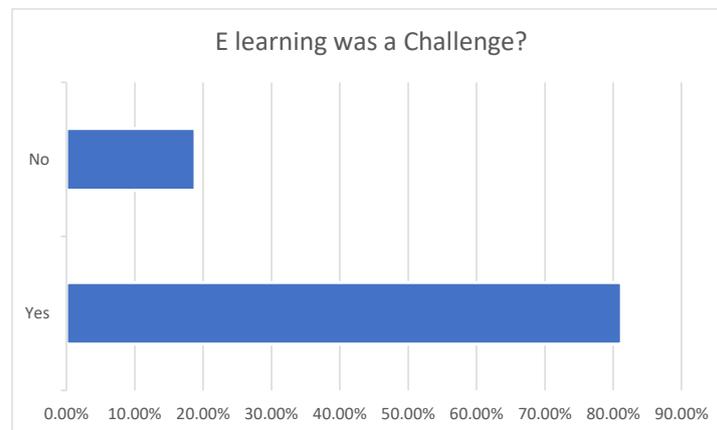


Figure 6. Proportion of participants facing E-learning challenge

Figure 5 highlights that there are nine areas of E-learning challenges during pandemic. By considering demographic of the Sultanate where most of the population lives in remote areas the key challenge was access to uninterrupted internet facility. Awareness of the latest technologies were another key challenge specially when students are studying technical subjects and important part of their learning is the practical sessions which were replaced by simulation during pandemic time. The other factors are including motivation, lack of communication because of carelessness, student's engagement and specially lack of technology resources because of financial impact.

Another key challenge students explained was the difficulty to find a calm place of study. To take online classes it is important for a student to sit in a place where he takes class without any interruption. World population review reveals that the global average fertility rate is just under 2.5 children per woman. However, in Oman the fertility rate is 2.84 children per woman. This supports the claim of students as most of the families have relatively higher numbers of children who are undergoing primary to tertiary level of education. Thus, this factor has different effects for different regions of the world.

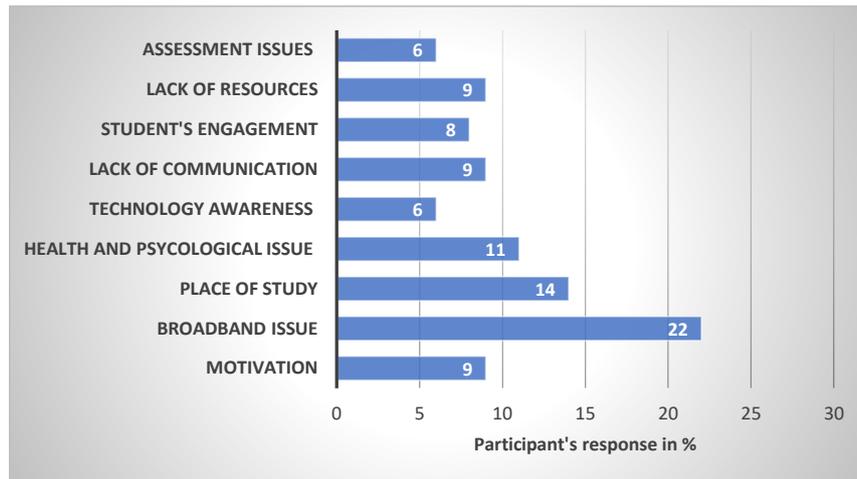


Figure 7. Types of E-learning challenges

The qualitative research was carried out by interviewing several students from different HEIs, varying disciplines and faculty members. For qualitative data collection process resulted as a big mess of raw data which was organized and structured in a meaningful way.



Figure 8. Qualitative research analysis for challenges of E-learning

A closer look at the interviews' data shown in Figure 6 indicates that there were 6 reported academic challenges resulting from the implementation of the E-learning system in the Omani HE education context during the pandemic. The academic challenges lie in the following areas: assessment, learning engagement, pedagogy, type of course module (practical), learning motivation, technology awareness. Further data analysis highlights the following points:

- Alternative assessments which were proposed on campus assessment didn't reflect student's performance
- For teachers it was difficult to keep students engaged during online sessions. They suggested that the reasons might be related to "lecturer style, approach and rhythm" which are part of lecturer online teaching pedagogical skills
- Because of rapid situation developed and lack of online teaching training, teachers' methodological ability to teach online can be considered as another area of E-learning challenges during the pandemic
- Practical sessions are integral part for few, which posed a serious challenge for teaching and learning process
- Learner motivation during the online sessions was another key challenge and that might be caused by the lack of interactivity among students in the virtual classroom
- Many of teachers and students were not ready to meet the technology centered learning needs and high-level expertise to handle technical issues without wasting time

Conclusion

This research was conducted to investigate the E-learning system effectiveness during the COVID19 pandemic in a higher education context in the Sultanate of Oman. Both quantitative and qualitative data analysis techniques were used to determine the difficulties, complications, and potential solutions of the E-learning system implemented in the Omani higher education context during the COVID19 pandemic.

In the beginning of 2020, the fear of COVID cases surging, all the educational institutions in the Sultanate of Oman were instructed by Education Ministry of Oman to use online platform for teaching and learning process. Everyone, including administration, IT staff, faculty members and learners and their parents were not ready to face this sudden challenge. In remote areas these challenges affected more than urban areas, where sometimes computers stopped working, slow internet or because of awful signal problems, learner must move around to get good signals. Although, technologies have evolved in a short period of time, still it looks like there is a long way to go to adapt to the E-learning mode with higher confidence. Teachers' comments on student attendance and attention during E-learning classes were generally observed as not very positive. It has been reported that student attendance in classes during conventional classes was not only higher but their attention during class sessions were also rated better. In the scenario of distance learning with limitations on technology, where it was not possible for instructor to simultaneously see all the students, generally the student devotion to learning was compromised. It was reported that learners were found doing other tasks while listening to teachers talk and generally, avoided discussions.

In short, the developed situation due to the COVID 19 pandemic impacted almost every walk of life, some facing more challenges than others. The education sector felt the impact more than other sectors. Educational institutes around the world faced surmounting challenges in their systems, implementations, and assessment

phases. The COVID situation appended the world of higher education, classes moved to E-learning mode. The new environment brought some sort of convenience and flexibility in the education system where students got an opportunity for self-study and in addition, involve themselves in other activities. The major success of the E-learning system is that the learning process did not stop. Teachers and students familiarized themselves with the state-of-the-art technologies for teaching and learning purposes. However, the challenge was, and continues, in ensuring that the students participated in the E-learning session with full attention which was guaranteed during conventional mode of learning.

Recommendations

The COVID-19 crisis had an unprecedented impact on academia. For successful E-learning needs continuous support of IT staff (Kolbaek 2018). Data analysis supported the argument presented in (McCoy, Pettit et al. 2015, Kolbaek 2018, Elzainy, El Sadik et al. 2020) that access to fast and reliable internet connection was one of the major apprehensions for students to access online classes. Dr Ruben explained the transition steps called SAMR (Substitute, Augmentation, Modification, and redefinition) model from conventional method of teaching to E learning.

Acknowledgements or Notes

Authors of this research article are thankful to the Department of Research at Military Technological College Muscat Oman for their support in the conduct this research.

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Reduce Traffic Congestion Using Carpooling Case Study, Tirana City

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Abstract: Albania is undergoing rapid urbanization, this means that not only that more people than ever before will be living and working in cities, but also that more people and goods will be making more and longer trips in urban areas. The costs of increasing dependence on cars is resulting in expensive road building and maintenance, congested roads, high levels of energy consumption along with its economic and environmental costs, traffic accidents and social inequities. The most widely used mode of conveyance of public transport in Tirana city are buses. as a spinal column of the transportation system. In spite of this, it does not receive any preferential treatment in terms of traffic management, dedicated lanes, and better upkeep/ maintenance of vehicles resulting in that common man who can afford even slightly is shifting from buses to their own vehicles. It may be two-wheelers or four wheelers or even bicycles, because of which, the number of vehicles on the roads are increasing which is leading to further lowering of speed, congestion, increase in pollution level etc. Several strategies are indispensable for combatting such problems, including reducing emissions per vehicle kilometer traveled and the total number of kilometers traveled. Road congestion may be reduced by the use of good public transport management, traffic management and car pools etc. This paper has done a survey based on a structured questionnaire for carpooling. By the analysis of the data collected, we found that if there is no carpooling applied in the city. The aim of the paper consists in proposing a model for reducing the fuel consumption and making the first step for lowering the traffic congestion in the Tirana City.

Keywords: Traffic, Congestion, Carpooling, Bus, Transport

Introduction

Tirana as the capital of Albania is facing an acute transport management problem. This primary problem leads to many more secondary problems such as air pollution, high-energy consumption, congestion, loss of productivity, increase in death accident rates etc. An increase in activity of day-to-day life has deteriorated the quality of life in the city. These activities are directly related to motorization. It is not just the population that has increased but, it is also the number of vehicles and their utilization that has increased at a much more higher rate. Tirana ranks as the first cities of Albania in population. There are various reasons for this, the most important of them being the physical characteristics of the city, inadequate public transportation system and the structure of the city. In the absence of an efficient public transportation system in urban areas, there has been an

increasing trend towards more and more ownership and utilization of personalized motor vehicles to commute which is not only more energy intensive and polluting, but also more expensive to the economy. While on the other hand, the vehicle mix in urban areas has aggravated the problem of congestion and air pollution. With growing traffic congestion, thousands of disappointed drivers in the urban areas are finding that rush hour traffic is slowing to a crawl, which in turn leads to higher oil consumption and emissions that are poisoning the urban areas.

Traffic Congestion in Tirana City

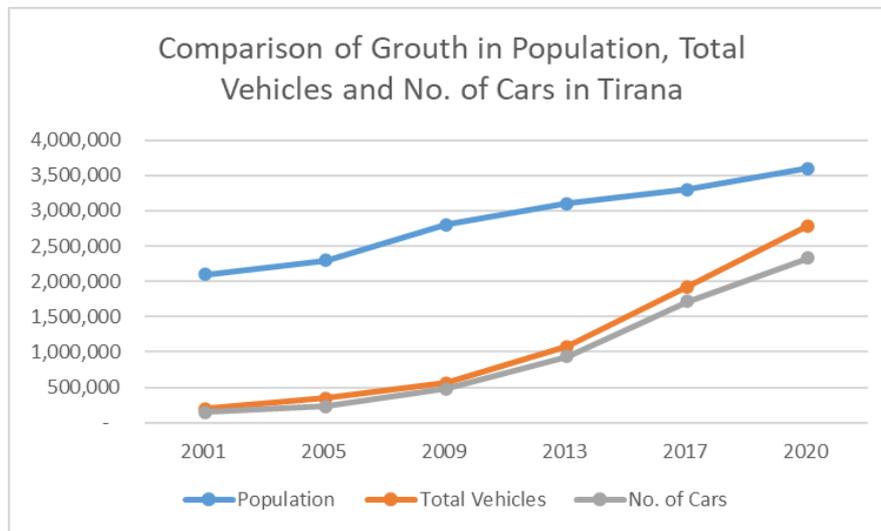
The greatest transportation difficulties are experienced while commuting between home and work place. The separation of housing from employment centers together with the rapid expansion of the urban area has created a pendulum movement between home and work that accounts for a larger volume of traffic. Traffic congestion is a major problem for the transportation professionals in Tirana. Most of the cities are suffering from medium to high level of traffic congestion. In some other cities the growth of private vehicle usage has increased at a faster rate. The roads are becoming congested at a fast rate. There has been no serious attempt to quantify the growth of congestion in different cities in Albania. The growing congestion problem has forced the urban development authorities, especially in metropolitan cities, to make serious efforts for finding tools and techniques for mitigation of congestion. Studies carried out by (Kalyan Kumar, 1995), (Linden, Eugene, 1996) (Mateen, 1990), (Srinivasan, N.S., Herur, Arun, Upadhye, M.S. and Gunasekaran, K, 1991) addressed the several issues of traffic congestion problem and emphasized the need for a thorough understanding of congestion behaviour of albanian roads under mixed traffic conditions. The problem of urban traffic congestion has already come to an acute stage for major cities in Albania like Tirana, and the problem is further growing at a fast rate. Therefore, there is an urgent need to understand the congestion behaviour and address the policy issues for mitigation of urban roads congestion. Congestion varies depending on the volume of traffic, number of lanes available for traffic, width of carriageway, type of road (i.e. divided or undivided), pedestrian activities and on-street parking. The level of congestion can be significantly different depending on the combination and level of presence of all these influences. Understanding of these influences can be achieved by applying different Mathematical Models on a large number of operating variables/ conditions. Table 1 shows the Distribution of Population and Vehicles in Tirana during 2001-2020. The figures are given in millions. The table shows that the population increased from 2.1 millions in 2001 to 3.6 millions in 2020. The number of Cars and Motor Cycles increased during the same period. The data also shows that the population of 2-wheelers is approximately two third of the total number of vehicles.

Table 1. Distribution of Population and Vehicles in Tirana (in millions)

	2001	2005	2009	2013	2017	2020
Population	2.1	2.3	2.8	3.1	3.3	3.6
Total Vehicles	0.2	0.35	0.56	1.08	1.92	2.79
Cars & Jeeps	0.06	0.09	0.12	0.2	0.42	0.63
Motor Cycles & Scooter	0.09	0.14	0.36	0.74	1.3	1.7

It was found that the growth of motor vehicles on the roads in Tirana follows a linear trend. This linear growth was studied for the year 2001 to 2020. Based on the statistics available, a linear growth curve was fitted for this data. If the variable x denotes the years and the variable y denotes the number of motor vehicles on the roads, then the linear curve that can be fitted into this data is given by

$$y = 1.82x - 3599.20$$



The above graph highlights the fact that the growth of motor vehicles is much more as compared to the growth of cars. This factor on one hand indicates that the problem of transportation and problems due to transportation can be accounted primarily to all motor vehicles other than cars. But, on the other hand, it gives an indication of increasing density of cars. This is the major cause of the increasing traffic congestion, reduction in vehicular speed and car parking problems in the commercial as well as residential areas in Tirana. In Tirana, the phenomenal increase in motorization has resulted in deteriorating quality of life in the city. Motorization is a manifestation of high mobility pattern that gets induced due to rising economic activities within the city. Mobility is measured in terms of number of 'trips' made during a day. Increasing motorization is not simply a result of population size. Several other factors determine the motorization level in the city. High levels of motorization are manifested in increasing number of vehicles and their utilization. As environmental awareness grows, people are becoming increasingly concerned about the pollution caused by motor cars. At the same time, congestion is slowly bringing traffic to a halt in the major cities.

The idea behind travel demand reduction is to reduce congestion by decreasing the number of vehicle trips on the existing road network, as opposed to expanding the road network. Travel demand reduction focuses on maximizing the movement of people, not vehicles, within the transportation system. This can be done by increasing the number of persons in a vehicle, or by influencing the time of travel. The high occupancy vehicle lanes and congestion pricing may be started to reduce congestion and air pollution problems. Among other strategies that can be considered to reduce travel demand to employment centers at peak commute time are carpooling, vanpooling, staggered work hours, compressed work weeks.

Carpooling

Car-pooling is the sharing of rides in a private vehicle among two or more individuals. It involves the use of one person's private or company vehicle to carry one or more fellow passengers. Carpooling is the easiest and most common ridesharing arrangement. It usually consists two to four persons commuting in a vehicle. Sometimes carpoolers share driving, and other responsibilities. In other cases, one person does all the driving and is reimbursed for mileage by his or her riders. The carpool driver may pick up passengers from their home or the passenger may find a way to get to the driver's home at a specified time or they may meet at a particular location. Car-pooling defined as an effort by drivers of motor cars who agree to take turn to share rides from places of residence to places of employment. As the definition implies, carpooling therefore refers only to the exercises carried out by the owners and drivers of private motor cars. For example, if two persons A and B would like to car pool, they must first be owners and drivers of cars. They will then organize among themselves as to who is to drive on which day or which route to follow, and so forth. Preferably, A and B would alternate driving on a daily or weekly basis, or on any other basis they prefer. There will not be any charges or fees involved. Excluded from the definition are those who ride share but do not own a motor car; and those who own motor cars ride share regularly but did not share driving. In these two cases, payment of fees are usually involved. If a car owner drives alone to work every day and spends approx. Rs. 5392 including fuel, maintenance and parking etc. It is assumed that on an average, he travels 40 kilometer per day. If he shares the car with three carpoolers who have their own car and drive to the same workplace. Then each of them can save Rs. 4044 per month of the total spent on commuting to the work place. All the four carpoolers have to bring their own car for a week in a month and drive themselves with other three carpoolers.

Car-pooling for Tirana

In order to conserve fuel, decrease traffic congestion during rush hours and enhance the use of existing highways and parking facilities in Tirana, carpooling is required. Government should encourage the use of car pools in urban areas by means of programmes, which include funding of car pool demonstration projects, and the encouragement of local authorities to establish schemes by various means including distribution of information. The ridesharing will only increase significantly if there exist clear incentives to the participants. The most important incentives to ride-sharing appears in practice is reserved road space and parking space, and the absence of a convenient alternative mode e.g. where there is no adequate public transport services. The reservation of road space for high occupancy vehicles is therefore essential. The ridesharing programme will reduce the vehicle miles traveled by single occupancy vehicles. To make car-pooling attractive:

- There must be clear incentives e.g. preferential parking spaces
- The personal touch is an important element in any car sharing matching service
- Efforts for ride sharing should be concentrated within recognized groups, rather than spread across the community. New pools can be largely formed with participants have a clear similarity with each other
- The employer of an organization plays an important role in promoting and making the carpool a

success

- A pool may be formed by one or more than one employer in a particular commercial complex which is equally important as the official matching service
- If the schemes are to succeed, an efficient and dynamic leadership is necessary
- To make carpooling an attractive proposition, there must be a substantial increase instead of gradual increase in the price of petrol

Data Analysis

As on August 31, 2001, the total number of vehicles in Tirana are 2,004,500 from of which the cars are 1,265,342. A survey based on a structured questionnaire was conducted. Around 500 respondents were interviewed personally and their viewpoints were brought into focus. By the analysis of the data collected through survey from various locations in Tirana, 24.8% people want carpooling with 1 person, 7.7 % people want with 2 person and 15.2% people want carpooling with 3 persons while 54.62 percent people do not want carpooling. The findings and observations of the respondents can be seen from the following Table 2.

Table 2. Findings from the data surveyed from the respondents for carpooling

S.No	Observations	Findings
1	Average mileage of vehicle	15.26 Km/Lt.
2	Average distance traveled by a vehicle per day	39.78 Km
3	Average number of working days per month	24.06 days
4	Average monthly expenditure on a vehicle	Rs. 4065
5	Standart Deviaton	1861.2

Advantages of Carpooling

- Reduced Parking Demand: Parking demand will be reduced by car-pooling
- Reduce Travel Demand: The idea behind travel demand reduction is to reduce congestion by decreasing the number of vehicle trips on the existing road network, as opposed to expending road network. Travel demand reduction focuses on maximizing the movement of people, not vehicles, within the transportation system. This can be done by increasing the number of persons in a vehicle, or by influencing the time of travel.
- Reduced Pollution: Decreasing the volume of vehicle trips is far less costly than providing new transportation facilities and the decrease in the number of trips will reduce vehicle-generated air pollution.
- Benefits of Car-Pooling For Individuals:
 - Reduced traveling expenses and the need for second car;
 - Improved travel time through use of transit lanes

- Benefit of car-pooling for the community:
 - Reductions in vehicle emissions;
 - Reduction in traffic volumes and congestion;
 - Provides an alternative, cost effective choice o Improving the environment
- Benefit for companies that arrange car pooling:
 - Maximizing use of employee parking:
 - Encouraging sociability between employees:
 - Reducing stress on driving to work:
 - Providing staff with a further benefit:
 - Improving company image
- Natural resource conservation: The resource impacts of automobile production will decline. Cars are environmentally expensive to produce even before they are driven one mile. Car-sharing recognizes this fact by making more use out of fewer vehicles.
- Social justice: Transportation access for poor people and wealthy people will become more equal. Poor people will be able to make car trips without becoming car owners

Conclusions and Recommendations for the Carpooling Policy

A systematic incremental approach should be adopted in implementing car-pooling in Tirana, beginning with promotional and advertising campaign, route feasibility studies, test project, obtaining institutional support, and so forth. It is realized that the success of this programme depends totally on the support of individuals and institutions. The promotional campaigns, advertisement and the re-education of the general public on the advantages and benefits of car-pooling are of paramount importance. The albanian government should make efforts in initiating and promoting car-pooling with the following objectives:

- To coordinate the implementation of car-pooling in Tirana
- To inform and educate the general public about the advantages and benefits that can be derived from carpooling.
- To provide the match-making service.

To promote the carpooling, the following alternatives should be enforced:

1. Only those who car pool (a driver plus a minimum of 2 passenger) will be allocated a parking space without any parking charges. For those who currently enjoy a parking space but do not car pool, these privileges will be taken away unless he/she shows that the driver already has passengers in their cars or is a member like a Chairman, a Director or a Chief General Manager of a company.
2. All employees allocated with parking spaces will be charged a parking fee except those who car pool. Parking charges will be organized in the following manner:
 - Full charges for those who do not car pool.
 - Reduced charges for those who drive with other employees.
 - No charges for those who car pool.

3. The staff can be allocated with parking spaces free of charge on certain days. The schedule is as follows:
 - Monday, Wednesday and Friday: Cars with the last figure in the number plate showing odd number.
 - Tuesday, Thursday and Saturday: Cars with the last figure in the number plate showing even number. This control measure ensures that each employee gets to use the parking space 3 times a week. Alternative arrangement will have to be made for the other 3 days. Car-pooling is hopefully, an alternative choice. Operationally, this measure will reduce the number of cars driven by half. Hence, the parking demand will be reduced to half.

In addition to that, the following incentives may be given:

1. Strategic location of parking spaces for carpoolers e.g. close to entry/exit points, basement parking, etc.
2. Incentive to Ride Home: This incentive ensures that an employee who car pools will be reimbursed for his/her taxi fare in case of an emergency requiring him/her to rush home or when required to work after normal office hours. To prevent abuse, some control on the number of claims submitted by a pooler is necessary e.g. a maximum of two claim per month, etc. The head of department must certify these claims.
3. Insurance Coverage: Carpoolers are allowed to claim for expenses paid in respect of the personal accident.
4. Premium to the insurance company for the carpoolers should be paid by the employer.
5. In addition to above, carpoolers may be subsidized for their initial car insurance policy.

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Phytoplankton as Biosensor for Climate Change

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Abstract: A study on phytoplankton as biological sensor for climate change was conducted for five years. Specifically, to determine species composition in water samples using settled volume method for quantitative microscopic analysis, calculate the total population of each species based on abundance, find out significant differences in the calculated phytoplankton abundance, describe the total population as influenced by the identified environmental factors such as surface water temperature, salinity, and pH, and statistically analyse to assess the role of phytoplankton as biosensor for climate change in a local scale. Results of quantitative microscopic analysis showed year-on-year increase in the total abundance. Abundant species indicator includes *Navicula sp.* and *Fragillariopsis sp.* Statistical analysis using ANOVA revealed significant differences in the annual total abundance at $p < 0.5$. Post Hoc Turkey (HSD) beta showed insignificant differences between any treatment mean population hence the phytoplankton population has the same over-all response to the identified environmental matrices. Further statistical results using Pearson coefficient of correlation showed strong positive correlation which means stability of the population with time. Although micro-scale climate change is yet too far to conclude based on the results, thus the response of phytoplankton assemblage manifests biological sensing ability.

Keywords: Phytoplankton, Biosensor, Abundance, Climate change

Introduction

In the photic zone of the sea water are microscopic organisms following the dynamics of the currents. This is the plankton biota which comprised a group of microscopic drifters of the marine ecosystem. Of the plankton community, phytoplankton perform vital function in the natural removal of carbon dioxide from the atmosphere. These are also considered as food source of the zooplankton which in association with other organisms form the food chain. The presence of this community assemblage may exert local environmental effect associated with climate change. Climate change as a natural phenomenon had impacted both the macro-and micro-components of the marine fauna. There are identified groups of organisms which can be used as biological sensors for climate change. These groups of organisms respond rapidly to changes in their habitat (Gale, 2018) hence can be used as biosensors. Although characteristically diverse, phytoplankton assemblage is limited by the varying environmental conditions of the ocean waters (Irigolen, 2004; Duvravka, Nenad, Tatjana & Iris, 20218) as influenced by seasonal patterns and stratification of the sea (Giovanni & Vergin, 2012).

The local abundance of phytoplankton as surface-dwelling microscopic plants as determinant of the quality of sea water. This is in addition to surface water temperature, salinity, pH, and nutrient availability. Considering its pivotal role as foundation of food chain, phytoplankton may be used as biological sensor for climate change focused on a local scale. Hence, evident changes in phytoplankton community composition relating to population may indicate direct or indirect response to local climate change.

Statement of the Problem

The research was conducted using phytoplankton as biological sensor for climate change. Specifically on the use of settled volume method for quantitative microscopic determination of the species composition in water samples, calculate the total population of each species based on abundance, find out significant differences in the calculated phytoplankton abundance, describe the total population as influenced by the identified environmental factors, surface water temperature, salinity, and pH, and statistically analyze to assess the role of phytoplankton as biosensor for climate change in a local scale.

Contribution to the Body of Knowledge

This study encompasses ecological implications based on the interlocking environmental factors that affect community structure and composition. Phytoplankton may not be familiar to many however insight is provided whether climate change has impacted the locality. As a scientific endeavor, this research utilizes the scientific process focused on ecology, macro-ecology, taxonomy, paleontology, and meteorology. Specifically provided educational, social, economic, and scientific values to the constituents of Bahrain. The educational value geared towards social information dissemination on the micro-components of the marine biota, for the local population to preserve and conserve. Whereas the economic value focused on the grazing productivity associated with fish economy which is relating to social and scientific values.

Scope and Limitation

As this undertaking is focused on the use of phytoplankton as biological sensors for local climate change, the microscopy data from 2015 to 2019 of the identified phytoplankton based on the total population were used as reference. The averages of the recorded readings of environmental indicators such as surface water temperature, salinity, and pH served to describe the relative effect on the total abundance of phytoplankton species. Statistical analysis was applied to analyze data relating the abundance of phytoplankton to the locale climate change and the role of phytoplankton as biosensor for climate change.

Method

An experimental research design was used based on the reference studies (Lumeran, 20219). The experimental

variables include the microscopy data of the identified phytoplankton from 2015 to 2019. The physicochemical factors such as surface water temperature, salinity, and pH were monitored during the sampling periods as protocol for any environmental studies. The identified factors may directly or indirectly influence the population of phytoplankton in terms of abundance. Statistical analysis assessed to determine the biological sensing capability of the organism relating to climate change in a local scale.

Field Data Gathering and Analysis

Monthly sampling was conducted on off-coast distance free of human activities 15 kilometers of the northeastern part of Bahrain Yacht Club in a motorized boat at a constant speed of 1 knot following a way-ward direction. Field data gathering procedure was adopted from the Manual of Environmental and Zooplankton Studies with modifications as used in the previous studies (Lumeran, 2019). Surface water temperature, pH, and salinity were determined *in situ* using an ecological field kit. Water samples were collected using towed method using a horizontal tow of 315 meter long to strain about 30 m³ of sea water at a constant speed of 1,853 m/h. Collected water samples in bottles were field preserved using 70% ethyl alcohol to prevent desiccation of the plankton prior microscopic analysis in the laboratory. Quantitative microscopic analysis determined the number of each species per drop sampled under the microscope (#/drop), the number of each species in a cubic meter of sea water (#/m³), the biomass (mL/m³), and the taxonomic composition of plankton in each tow in a unit volume of sea water. The number of plankton in each tow was counted microscopically at HPO6000x for the quantitative enumeration using 10 mL sample following the settled volume method. Plankton from the water samples was identified and classified taxonomically using references (Perry, 2013; Castellani & Edwards, 2017).

Statistical Analysis

Frequency count was applied for the microscopy enumeration of the identified phytoplankton in water samples. One-way Analysis of Variance (ANOVA) determined the significant differences in the total abundance relating to population count. Pairwise comparison was conducted within the ANOVA mean data with the use of Post Hoc Turkey HSD (beta) to evaluate any significant differences in the various pairs of means as determinant of the total abundance in response to the measured environmental matrices. Statistically, the role of phytoplankton as biological sensor for climate change in a local scale was analyzed using Pearson coefficient of correlation.

Results

Table 1. Annual Total Abundance of Phytoplankton

Phytoplankton	2015	2016	2017	2018	2019	Total
<i>Asterophalus sp.</i>	5	5	11	22	21	59
<i>Biddulphia aurita</i>	11	22	42	84	87	246
<i>Biddulphia mobilienses</i>	0	3	11	22	28	64
<i>Chaetoseris sp.</i>	144	159	288	290	289	1170
<i>Coscinodiscus sp.</i>	25	30	65	86	94	300
<i>Ditylium brightwellii</i>	25	35	75	91	96	322
<i>Ditylum sp.</i>	0	2	9	18	20	49
<i>Fragiliariopsis sp.</i>	180	190	266	308	320	1264
<i>Lauderia annulata</i>	97	124	184	201	205	811
<i>Lioloma pacificum</i>	47	57	107	114	121	446
<i>Navicula sp.</i>	180	189	270	307	320	1266
<i>Proboscia alata</i>	83	103	166	150	145	647
<i>Pseudo-nitzschia australis</i>	61	71	122	145	148	547
<i>Rhizosolenia sp.</i>	25	48	60	120	121	374
<i>Thalasionema sp.</i>	0	4	13	26	18	61
<i>Thalassiosira punctigera</i>	133	145	266	175	176	895
<i>Thalassiosira sp.</i>	25	35	72	82	72	286
<i>Stephanophyxis sp.</i>	0	5	11	22	19	57
Total	1036	1227	2038	2263	2300	8864

Table 2. Results of ANOVA

Source	SS	df	MS	F-value	P-value
Between-Treatments	79407.7111	4	19851.9278	2.57971	0.042999*
Within-Treatments	654108.7778	85	7695.3974		
Total	733516.4889	89			

*Significant at $p < .05$

Table 3. Summary of Post Hoc Turkey HSD (beta)

Pairwise Comparison	HSD _{.05} = 81.5010 HSD _{.01} = 98.2780	Q _{.05} = 3.9417	Q _{.01} = 4.7531
T ₁ :T ₂ M ₁ = 57.56 M ₂ = 68.17	10.61	Q = 0.51 (p = .99623)	
T ₁ :T ₃ M ₁ = 57.56 M ₃ = 113.22	55.67	Q = 2.69 (p = .32334)	
T ₁ :T ₄ M ₁ = 57.56 M ₄ = 125.72	68.17	Q = 3.30 (p = .14522)	
T ₁ :T ₅ M ₁ = 57.56 M ₅ = 127.78	70.22	Q = 3.40 (p = .12490)	
T ₂ :T ₃ M ₂ = 68.17 M ₃ = 113.22	45.06	Q = 2.18 (p = .53919)	
T ₂ :T ₄ M ₂ = 68.17 M ₄ = 125.72	57.56	Q = 2.78 (p = .29034)	
T ₂ :T ₅ M ₂ = 57.56 M ₅ = 127.78	59.61	Q = 2.88 (p = .25683)	
T ₃ :T ₄ M ₃ = 113.22 M ₄ = 125.72	12.50	Q = 0.60 (p = .99291)	
T ₃ :T ₅ M ₃ = 113.22 M ₅ = 127.78	14.56	Q = 0.70 (p = .98737)	
T ₄ :T ₅ M ₄ = 125.72 M ₅ = 127.78	2.06	Q = 0.10 (p = .99999)	

Environmental Influence on the Phytoplankton Population

Table 4. Results of *In Situ* Physicochemical Monitoring

Physicochemical Factors	Average
Surface Water Temperature	35.3°C
pH	8.0
Salinity	40.35‰/000

Results of Pearson Coefficient of Correlation

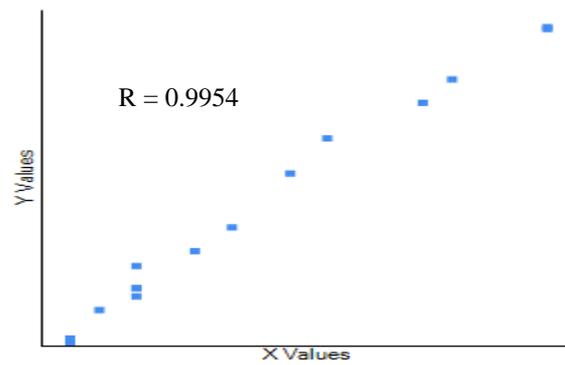


Figure 1. 2015 and 2016

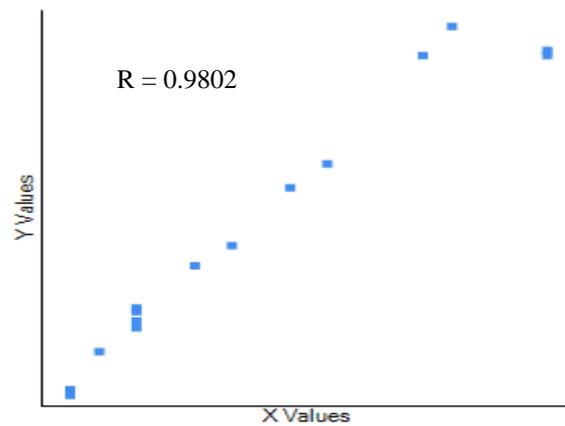


Figure 2. 2015 and 2017

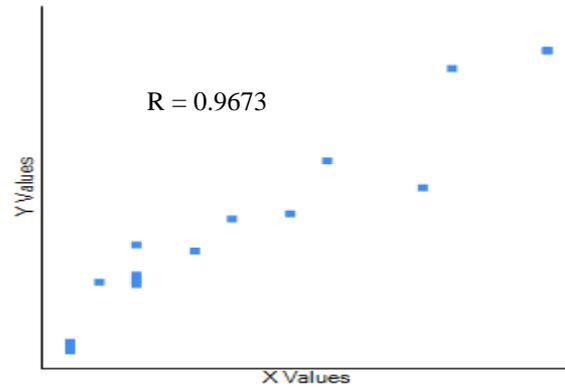


Figure 3. 2015 and 2018

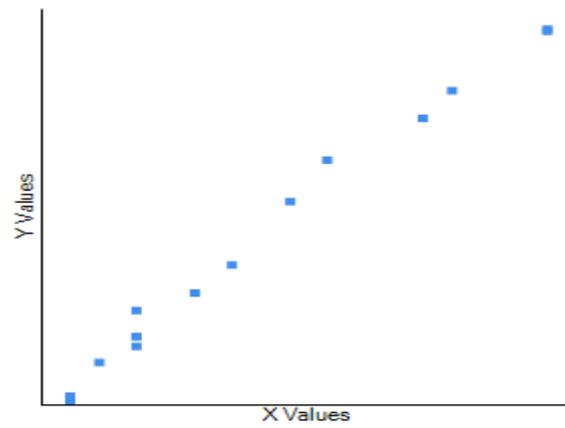


Figure 4. 2015 and 2019

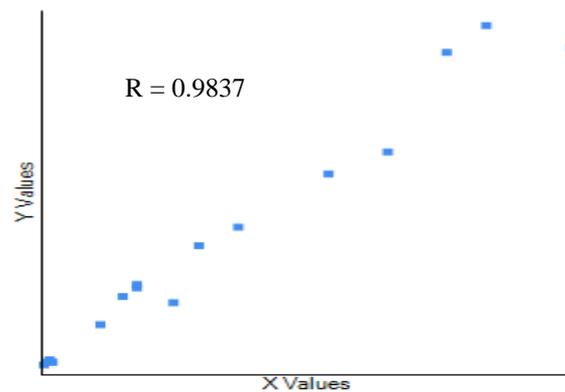


Figure 5. 2016 and 2017

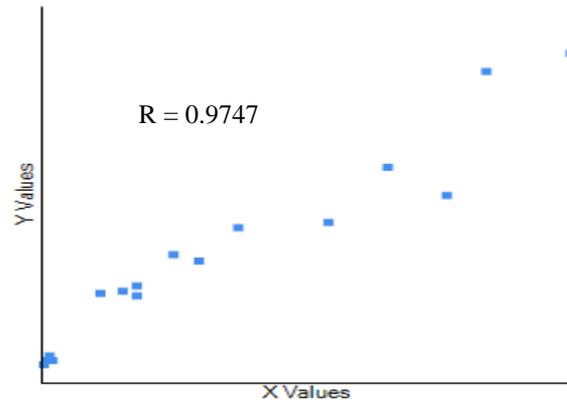


Figure 6. 2016 and 2018

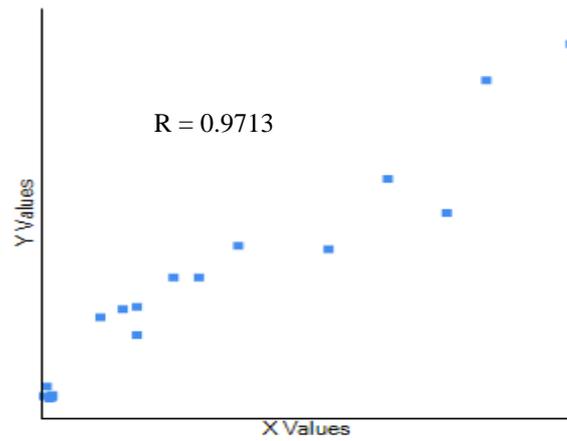


Figure 7. 2016 and 2019

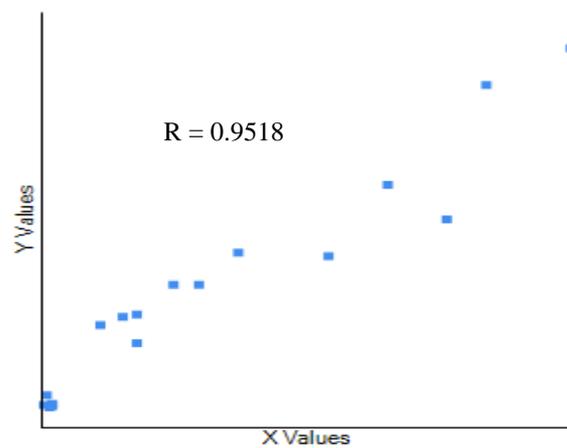


Figure 8. 2017 and 2018

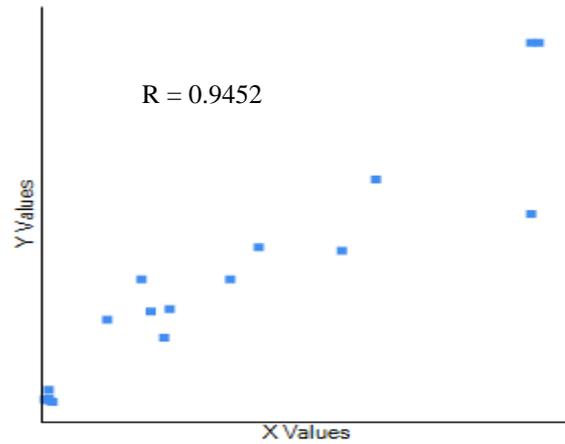


Figure 9. 2017 and 2019

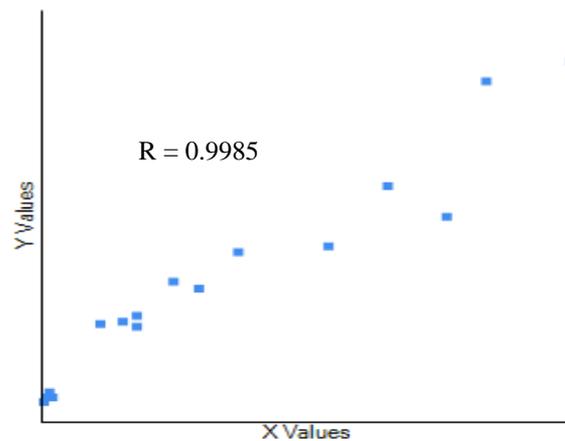


Figure 10. 2018 and 2019

Discussion

A five-year microscopy data in Table 1 showed an annual increasing total abundance of phytoplankton from 2015 to 2019. This is attributed to the environmental responses relating to variation in temperature (Ferreira, et. al. 2020) and changes in the ocean current system (Hays, Richardson & Robinson, 2005). Generally, phytoplankton abound in the vast sea which contributes to the over-all functioning of the marine ecosystem (Ibarbalz, et al., 2019). Although no new species were identified, *Navicula sp.* and *Fragillariopsis sp.* were consistently identified as the most abundant species all throughout the study period while *Ditylum sp.* remain less abundant. Conditions attributed to climate change will also change the population of phytoplankton (Geuer, 20218). In addition, Gittings, Raitson & Hoteit (2018), explained that there is climate-induced cycle that stimulates phytoplankton growth due to upwelling which transport nutrients to the surface layer of the photic

zone. Phytoplankton like *Navicula sp.* and *Fragillariopsis sp.* show dramatic changes distribution (Hays, Richardson & Robinson, 2005; Ferreira et al., 2020). It can be inferred from the results that the effect of climate change is yet far considering the bloom of these surface micro-dwellers of the sea water. Hence phytoplankton community is abundant in the sea water which play a vital role in the dynamics of the marine ecosystem as influenced by environmental occurrences.

Statistical analysis presented in Table 2 showed significant differences in the annual total abundance of the phytoplankton at $p < .05$. Results imply that the annual population of phytoplankton responded to the over-all changes brought about by fluctuating temperature of the surface water. However, this result is a still a natural biorhythmic response which is also supported by Gale (2018) that the impact is yet to assessed for an extended period. Species tend to be short-lived hence population size is less attributed to the persistence of individual in the previous time. This also shows tight coupling between the shift in environmental conditions and phytoplankton dynamics. Specifically, marine plankton cannot track optimal temperature hence assemblage undergoes restructuring (Trubovitz, et al., 2020).

Although statistically there is significant difference in the annual total abundance of phytoplankton during the five (5) years of study (Table 2), Post Hoc Turkey HSD (beta) revealed insignificant differences between any treatment mean population (Table 3). Results further show that the total abundance of the phytoplankton community has the same over-all response to the identified matrices relating to the surface water temperature, pH, and salinity. Similar findings were shown by Anjani, Davies, Erickson & Richardson (2020), and Zingone, Alelio, Grazia & Sarno (2019) however in a long-term scale covering a vast oceanic habitat.

Results showed in Table 4 that the average values of the surface water temperature, pH, and salinity are within the acceptable limit with reference to the standard as indicated in the marine water ecological kit. Climate changing-influencing effects such as temperature and salinity change the individual species assemblage (Richardson, 2008) in addition to other factors (Righetti et. al., 2019; Dango et al., 2015). As revealed in the study of Anjani, Davies, Erickson & Richardson (2020), temperature is an important environmental variable which directly or indirectly shaped the phytoplankton composition and abundance (Zingone, Alelio, Grazia & Sarno, 2019). While temperature is the main diver of changes in the ecosystem components (Agboola, Adewobe & Lawson, 2019), pH is influenced by a seasonal variability (Geuer, 2018). In a similar study conducted by Globel, Lu & Vob (2019), temperature and pH were considered environmental variables to cross check cell size and number of phytoplankton including individual cells. Hence, changes in environmental factors may be short-term or long-term that changes the species composition.

The role of phytoplankton as biological sensor for climate was determined statistically using Pearson coefficient of correlation based on the year-on-year total abundance (Table 1). The identified community structure composition did not vary statistically from year-to-year (Table 3). Results are shown in Figure 1 to 10 with strong positive correlation. The total abundance between year 2015 and 2016 (Figure 1) revealed a strong positive correlation where $R = 0.9954$; 2015 and 2017 (Figure 2); 2015 and 2018 (Figure 3), $R = 0.9802$; 2015

and 2019 (Figure 4) where $R = 0.9657$; 2016 and 2017 (Figure 5), $R = 0.9837$; 2016 and 2018 in Figure 6 where $R = 0.9747$; 2016 and 2019 (Figure 7), $R = 0.9713$; 2017 and 2018 (Figure 8), $R = 0.9518$; 2017 and 2019 in Figure 9 where $R = 0.9452$; and between 2018 and 2019 (Figure 10) where $R = 0.9985$. Considering a strong positive correlation between the identified year-on-year total abundance therefore the phytoplankton responded rapidly to changes in their habitat (Gale, 2018). This biorhythmic response indicated biological sensing capability hence can be used as biological sensor for climate in a locale scale. Although phytoplankton assemblage is characteristically diverse, they can adapt to varying environmental conditions of the ocean waters (Irigolen, 2004; Duvravka, Nenad, Tatjana & Iris, 2018). In a related study, phytoplankton abundance data was referenced in the global long-term impacts of micro-phytoplankton in the Pacific coastal region (Anjani, Davies, Erickson & Richardson, 2020). Findings revealed that temperature directly or indirectly shaped the phytoplankton composition and abundance using order of magnitude variability. The difference however is the use of phytoplankton as biosensor for climate change in the local setting as impacted by surface water temperature instead. Changes in the total abundance from time-to-time which relates to the total population of phytoplankton denotes non-alarming impact of climate change brought about by the measured environmental indices such as surface water temperature, pH, and salinity. Results show that phytoplankton can be used as biological sensor for climate in a local environmental.

Conclusion

The phytoplankton assemblage is abundant as indicated by the total annual microscopy count. The measured environmental indices relating to surface water temperature, pH and salinity exerted direct or indirect impact on the population of phytoplankton. The response of the phytoplankton assemblage to agents of climate change indicates biological sensing capability, thus can be used as biological sensors. Statistically, the varying phytoplankton abundance is a biorhythmic response to micro-scale climate change.

Recommendations

A long-term monitoring of the micro-biota of the photic zone be conducted to fully assess the abundance of phytoplankton. Quantitative analysis of the sea water focuses on grazing productivity be conducted to validate the direct and indirect effect of the identified physicochemical attributes. A thorough study on the biological sensing capability of the phytoplankton be further experimented in a laboratory setting. Further study on the biorhythmic responses to micro-scale climate change be conducted covering a wider area of interest to better assess the abundance of phytoplankton and other species that may be screened and microscopically identified. An in-depth study be undertaken on the anatomical and structural attributes of the phytoplankton to fully determine the biological sensor capability based on the organism's responses to the indicators of climate change.

Acknowledgements or Notes

The author would like to extend her heartfelt gratitude for the funding support of the management of the University of Technology Bahrain thru the President, Dr. Hassan Almulla. The assistance of Perry, Lera, and Maxi in the field sampling is highly appreciated. The opportunity afforded by ICSEST- ISTES 2021 to present the research output in a wider platform.

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Factors Affecting the Market Value of Residential Properties in Tirana City

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Abstract: Real estate is one of the most valuable assets for both the individual and the society, therefore its valuation has a special importance. There are known and acceptable differences in the values reported by different appraisers for the same property, at a given point in time and for the same appraisal purpose, because appraisal is the art of analyzing and interpreting other transactions performed on it recent past, under the optics of market characteristics and individual characteristics that each property has. When the method used for property valuation is the comparison method, it is crucial to apply adjustments based on the differences between the appraised and comparable properties. Taking into account the same characteristics and moreover according to the importance that each one has would narrow the differences in the values reported by different appraisers. This paper highlights the most important characteristics that affect the market value of residential properties. The paper confirms the importance of such factors as: location, surface area, condition of the property itself. Of interest is the finding that for properties built before the `90s is the number of rooms that affects or explains the value, while for buildings after the`90s is the surface area.

Keywords: Residential properties, Market value, Characteristics of property

Introduction

Real estate, land and buildings, represent one of the most valuable assets for both individuals and the state. For this reason, the process of determining the value of properties is of particular importance. Properties are huge in number. diverse in types, shapes and size, as well as they have different uses. If we were to look at the classification of properties using as a criterion their use, then we would divide them into four main groups: residential properties, commercial properties, industrial properties and vacant land.

The valuation of residential properties is increasingly in the focus of daily valuations required for various purposes, mainly for sale, purchase, mortgage, but in recent years also for the purpose of determining the property transfer tax, revaluation, etc. The most required in the valuation reports is the determination of the market value, which referring to the European Valuation Standards (2020) is “the estimated amount for which a property should exchange on the date of valuation between a willing buyer and a willing seller acting

independently of each other after proper marketing wherein the parties had each acted knowledgeably, prudently and without being under compulsion". The method that we use to arrive at the market value is the comparison method. The comparison method of valuation is based on the comparison of the property object of valuation, with similar properties that have been part of the market recently and the interpretation of the prices that are agreed in the open market to arrive at an opinion of value by the valuers. Accurate judgment of value requires the consideration of a wide range of variables and even a relative evaluation of them. For the same property at a given moment of time and for the same purpose of evaluation, there are differences in the values given by different appraisers which are known and acceptable, precisely because the assessment is the art of analysis and interpretation of other transactions, carried out in the recent past, under the optics of market characteristics and individual characteristics that each property has.

This paper attempts to give an answer to the questions: Which are the most important characteristics of residential properties that impact the value and which is the importance of each of them. Taking into account the same characteristics and moreover the importance that each one has, there would be a narrowing in the differences in the reported values by different appraisers.

Residential Properties and Methods of Valuation

The residential properties make up the largest number in the total stock of properties all over the world, and without a doubt, even in Albania. Residential property means real property used or to be used for residential purposes, including single family homes, dwellings for from two to four families and individual units of condominiums and townhouses.

From the five methods of valuation the **Comparison Method** is the most common approach used for the appraisal of residential properties. The most direct valuation approach is to compare the object to be valued with the prices obtained for other similar objects in the same market, at the same moment in time. The method works best if the comparable objects are identical. A property can never be absolutely identical to any other property and so the use of this method is limited (Eric Shapiro, David Mackmin, Gary Sams, 2013). Property is heterogeneous; no two are truly the same. A simple market-based comparison alone is insufficient. Comparison can be defined as 'the act of comparing' and to compare as 'to examine in order to observe resemblances or differences'. As the above definitions suggest, the valuer has to examine resemblances and differences and make appropriate adjustments to reflect these differences. In valuation, these differences can be described as the factors affecting value or the value determinants (Douglas Scarrett, 2008). The smaller the similarity between the properties being compared, the more adjustments need to be made and the greater the chance of making a mistake. It is clear that various allowances for differences in quality have to be made. The level of allowance is subjective and requires the expertise of an experienced and knowledgeable valuer. The method is simple in its general approach but is dependent on considerable valuation judgment for its application (Eric Shapiro, David Mackmin, Gary Sams, 2013). The valuer needs a good understanding of the factors affecting the value, which

can be grouped as physical factors (geographical and property-specific factors), legal factors (tenure and lease terms) and economic factors (supply and demand, time, risk and return) (Douglas Scarrett, 2008). Because there are many differences in legal, economic and physical characteristics of the assets in other transactions and asset being assessed, it may be necessary the adjustment of price information from other transactions to reflect these differences and any assumption to be adapted in the undertaken evaluation process.

What are the most representative characteristics that affect the value the most?

According to (P. Parnham and C. Rispin, 2001), the most common features that an appraiser use to make comparisons are: the address, type and style of property, the age of property, the size of accommodation, the number of bedrooms, the number of garages, or the facility for parking space, the general conditions, any additional features, etc. J.S. Dodgson and N. Topham (1990) argued that attributes which are likely to affect house prices include: physical attributes such as the numbers of rooms, the type of property (detached house, terraced house, etc) and presence of amenities such as central heating, a garage or a garden; location attributes such as the region of the country in which the property is located; and neighborhood attributes in the form of the type of area (e.g owner occupied outer suburb, industrial town, or inner city council estate) in which the property lies.

Based on the above and based also on my personal experience as appraiser and based also on the Albanian appraiser`s perceptions and experiences, the characteristics that are important and have to be taken into consideration in comparisons and adjustments are appreciated as following: the location, the surface area, number of rooms, number of balconies, the age, property conditions, flat, etc. According to the previous works, age and quality of building cannot go together as factors that explain differences in value. The assessment of the property conditions automatically takes into account the age, the quality of the building and its maintenance.

In the following, the paper tests the importance of the factors selected as the most important in relation to the impact they have on value

Analysis of the Importance of Characteristics that Affect Market Value

Hedonic Price Model

J.S. Dodgson and N. Topham (1990) argued that the heterogeneous nature of real estate properties justifies the use of the Hedonic Price Model for estimating their value. The Hedonic Price Model takes into account the properties of real estate separately and estimates prices based on the assumption that these properties could be separated into characteristics as attributes of spatial unit, location attributes, quality of design and architecture, etc. Regression analysis and related estimation approaches are common in Hedonic Price Models. According to Trojanek (2010), the purpose of using the hedonic price method is to specify the influence of the features of the property on its value. Hedonic regression is a method, thanks to which we may define the impact of the specific features of the property on its value. The hedonic pricing method allows for a fair value determination of a

property because it accounts for various external factors that can potentially influence the price of the asset, and it allows for a simplified justification for price variations due. The model is common in the [housing sector](#) because of its flexibility and ability to accommodate various factors and parameters in the determination of a fair property price. The hedonic model involves regressing observed asking-prices for the house against those attributes of a house hypothesized to be determinants of the asking-price.

After identifying the characteristics that are hypothesized to affect the value, the analysis of the importance of each of them and all at once was done using linear regression

Linear Regression

Linear regression is the simplest method that is used for prediction. It uses two things as variables which are the predictor variable and the variable which is the most crucial one first whether the predictor variable and su.

Linear regression attempts to model the relationship between two variables by fitting a linear equation to observed data. One variable is considered to be an explanatory variable, and the other is considered to be a dependent variable. The equation of the regression equation with one dependent and one independent variable is defined by the formula

$$b = y + x * a$$

where, b = estimated dependent variable score, y = constant, x = regression coefficient, and a = score on the independent variable.

The equation of multiple linear regression is: $b = y + x_1 * a_1 + \dots + x_n * a_n$

where, b = estimated dependent variable score, y = constant, x_i = regression coefficient, and a_i = score on the independent variable.

Random Forest

Random forest is a commonly-used machine learning algorithm, which combines the output of multiple decision trees to reach a single result. Its ease of use and flexibility have fueled its adoption, as it handles both classification and regression problems.

Random forest makes it easy to evaluate variable importance, or contribution, to the model.

The Data Sample

The data includes 133 apartments sold recently in 4 different areas of the city of Tirana. The data was obtained by carrying out a market survey and are summarized in Table1, which represents a fragment of the information gathered

Data Preparation

Some of the features can't be evaluated quantitatively, but only qualitatively. Property conditions are valued based on the physical inspections. They were assessed using the scoring system. Thus 5 = very good, 4 = good, 3 = fair, 2 = bad and 1 = very bad. Location is evaluated by its importance (1= very important, 2= important, 3= normal, 4= less important, 5= less more important).

Table 1. Assessment of Characteristics of apartments (Fragment)

No.	Sale Price	Location	Surface		Conditions	No. of Rooms	No. of Balconies
			Area	Flat			
1	60000	3	65	2	4	1	1
2	98000	3	110	3	4	2	2
.....
132	139400	3	164	8	4	3	2
133	45000	5	97	7	4	2	2

Result and Discussion

On the whole factors that are supposed to affect the price, we distinguish two groups of elements: internal and external. The group of interior elements includes the characteristics of the apartment itself (No of Rooms, Surface Area, No of Balconies, Flat, Conditions). The location is part of the external elements.

The price is our target variable (regression dependent variable). In accordance with the conditions of Linear Regression, the data must have a normal distribution. We control the Price distribution (Figure 1), and since this distribution has deviations to the right it is necessary to do logarithmic transformation for a better model (Figure 2).

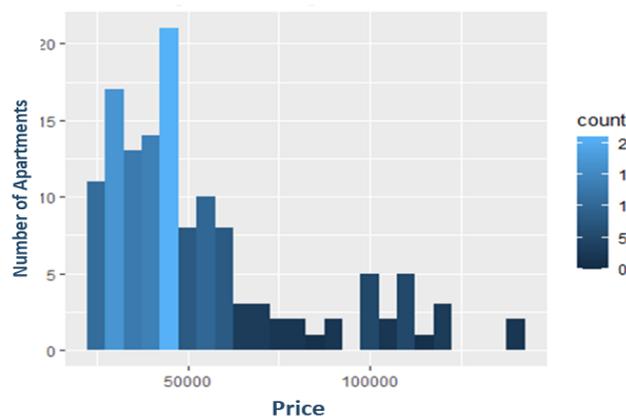


Figure 1. Histogram of “ Price”

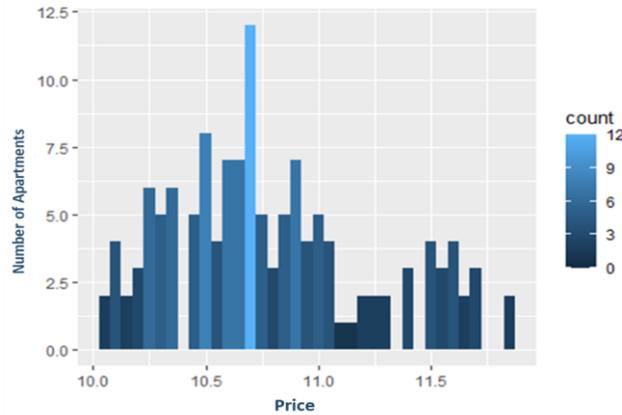


Figure 2. Histogram of "Price"

We check first the relationship that exists between "Location" and the target "Price" variable. Since the Location variable is categorical let's see how many apartments we have in each category (Figure 3).

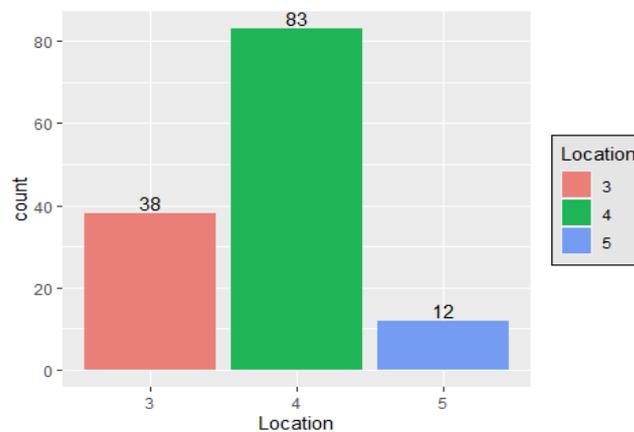


Figure 3. Distribution of "Location"

It is clear that most houses are built in Location 4, so it is also the area to which more attention should be paid in price analysis.

We add our target variable (Price) to the analysis. What does the "Price" look like for each category? The distribution of "Price" by "Location" is shown in Figure 4.

From the distribution graph of "Price" by "Location" it is seen that in zone 3 the average price is higher, while in zone 4 and zone 5 the average price is approximate.

Let's examine how the surface area of apartments relates to sales by location (Table 2).

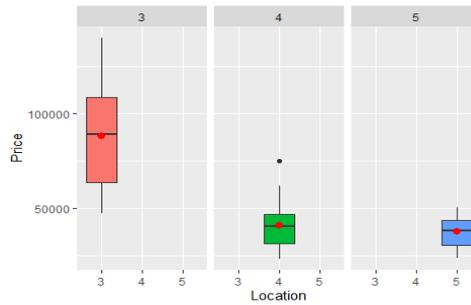


Figure 4. Box plot of “Price” by “Location”

Table 2. The study of variable “Surface”

No.	Location	Mean Surface
1	3	108.50000
2	4	88.97108
3	5	84.5000

The price analysis by location shows that the average surface area in zones 4 and 5 are approximate and have a significant detachment from zone 3, which justifies the fact that the price has been affected by the surface area of the apartment and also by the location. It was something to be expected from the above finding that in areas 4 and 5 the prices are approximate.

Continuing with the Control of the distribution of the price variable according to the Rooms, the Conditions, the Flat Number and Number of balconies we reach the conclusions that:

From the histogram of “Price” by “Rooms” we see that the number of rooms plays a “fairly important” role in determining the number of sold apartments and the price. The 3-room apartments are also the ones that determine the highest price and in combination with the price, they are also the best-selling ones (Figure 5).

The number of sales is higher for the category 3 of “Condition” and category 4 of “Condition” includes the widest range of prices accepted by the buyer. Interesting is the fact that the buyer is oriented to the average quality of apartments and has excluded extremes regardless the price (Figure 6).

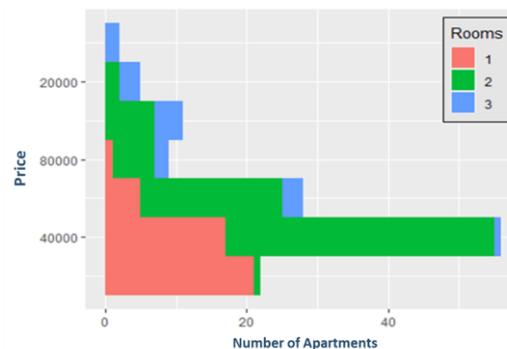


Figure 5. Histogram of “Price” by “Rooms”

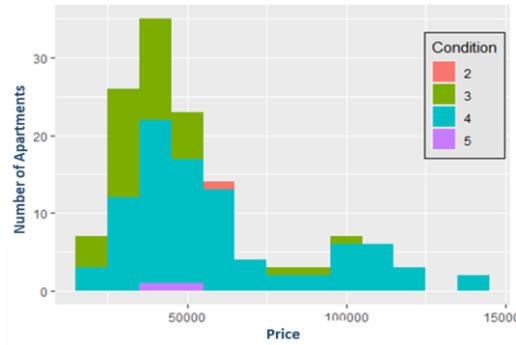


Figure 6. Histogram of “Price” by “Condition”

Buyer orientation is on floors 2-4 for apartments with low and medium stores (old buildings, built before `90). In high-priced apartments (new buildings built after `90s) we notice that the buyer has not considered the Floor as a factor (Figure 7). They are mainly apartments in new multi-story buildings with elevator.

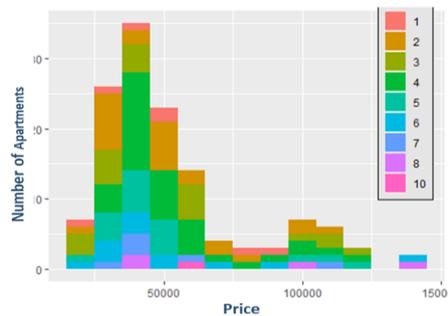


Figure 7. Histogram of “Price” by “Flat”

Price distribution control depending on the number of balconies shows that the number of apartments sold does not seem very dependent on the number of balconies (Figure 8). The apartments with a balcony, sold, in the vast majority are also the apartments with low price. However, the number of the sold apartments does not seem very dependent on the number of the balconies because for a fixed price in the range of 40000-50000, the largest number of sold apartments has only one balcony.

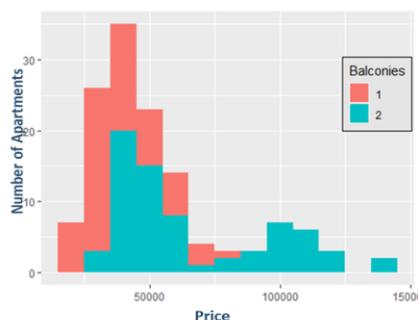


Figure 8. Histogram of “Price” by “Balconies”

Referring to the analysis of the correlation between the variables, the price and the characteristics of the property, it results that the characteristics to which we will have to pay more attention are the surface area and the number of rooms (Figure 9). In my previous works I have come to the conclusion that for the apartments built before the '90s the number of rooms and the surface area are related and therefore the number of rooms satisfactorily explains the value, while in the new apartments it is the surface area that would play such a role, regardless the number of rooms.

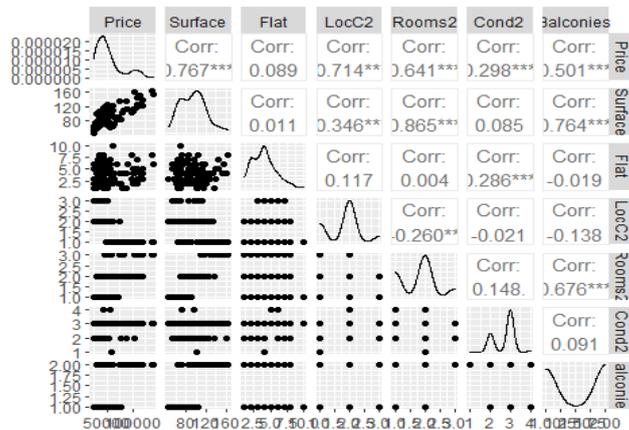


Figure 9. Correlation analysis

Using the random forest evaluate variable importance we have: (Figure 10)

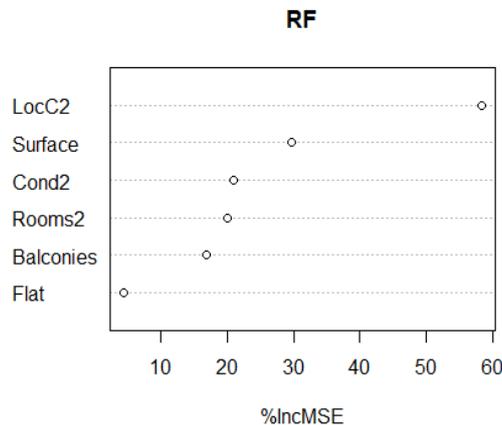


Figure 10. The classification of importance of the characteristics

Conclusion

At the end of the analysis in this paper, we come to the conclusion that the factors that have the most impact on the value strongly align with the factors that are most commonly used by Albanian valuers. These essential factors that affect the value, as of their importance are the Location, the Surface Area and the Conditions. However, there are also some other factors that impact the value in a lower scale such as the Number of rooms,

the Flat number and the Number of balconies.

What is once more proved, is the fact that the Location is the most important and essential factor in determining the value of a residential property.

The Flat Number is important for a specific category of properties such as the old ones, low buildings, properties built before the`90s, but it is not a factor that affects the value of the multi-story building apartments. The Number of Balconies doesn't appear to have a significant impact, so based on the purpose of the evaluation it can be neglected.

Recommendations

The paper recommends definitively, taking into account three factors as essential ones, in every evaluation such as the Location, the Surface area and the Conditions as they are not only essential but they also have a significant impact on the value. The Number of rooms, the Flat number and the Number of balconies, that are considered as less important factors and with less impact on value can be neglected according to the purpose of valuation or other specifics of valuation and property-object of valuation.

As in the comparison method, it is crucial to apply adjustments based on the differences between the appraised and comparable properties, I recommend the adjustments to be done, taking into account the characteristics mentioned above, according to their importance, as a way of narrowing the differences in the values reported by different appraisers.

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Effect of Heat Treatments on the Corrosion Resistance of Carbon Steel Using Salt Water

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Abstract: The aim of this research is to study the corrosion behavior of carbon steel, because corrosion is common defects that occur to the devices and machinery after manufactured. Plain –carbon steel is considered as one of the most important minerals used in industrial applications. The direct effect on the corrosion behavior of steel is heat treatments because of galvanic corrosion which building up between its microscopic phases. In three methods carbon steel has been treated thermally which the hardening, normalizing, and annealing. Used salt water as corrosive media for a period of (30,45,60) days, the steel contains chemical compounds to show its effect on the corrosion. To compare between the results and to determine corrosion rate used weight loss. The results obtained show that the lowest corrosion resistance is for the hardened steel and the corrosion resistance of the annealing steel is the greatest, while the corrosion resistance of the normalized steel is in-between them.

Keywords: Corrosion, Salt water, Plain-carbon steel, Heat treatments

Introduction

Corrosion is a damage to the metal as a result of its chemical or electrochemical reaction with the atmosphere or the surrounding corrosion medium, it is one of the most important surface failure problems that engineering establishments are exposed to it and suffer from wherever they are found. Also, it is the reverse process of extracting the metal from its ores, i.e. returning the metal to its original form the free that was in nature before it was extracted. Many damages caused by surface failure due to corrosion and all of them have a bad economic return, the losses resulting from corrosion represent a significant part of the national product of industrialized countries, as erosion causes heavy losses in the global economy, because it destroys a huge amount of installations and metal machinery. [1,2,3].

Carbon steel is more susceptible to corrosion, due to its many applications of the engineering and industrial uses, where corrosion by water plays an important role in many engineering and industrial facilities, especially

water tanks, pipes that transport oil, and water. The behavior of water as a corrosion medium is similar to that of the atmosphere in terms of the availability of an aqueous solution that conducts electricity permanently and the availability of an oxidizing agent, which is oxygen. Therefore, water corrosion is classified as a type of electrochemical corrosion [4,5]. The corrosion that we will deal with is wet type corrosion, which includes electrochemical reactions, this type does not occur except when the medium in which the metal is a conductive medium is an example of this is the corrosion of carbon steel when water is present. This type is called galvanic corrosion, the galvanic cell consists of two electrodes, one of which represents the cathode, the other is anode. The voltage vary between the cathode and the anode may occur if the poles of the cell are of two different metals or of one metal, we will use in this papers two electrodes of one metal, one of these electrodes will represent the cathode and the other electrode will represent the anode [3,6]. There are two different phases give another mechanical properties, the single phase is less susceptible to corrosion than two phases the microstructure, as the microscopic galvanic corrosion cells are formed due to the difference voltage between the two microscopic phases [4].

Many researches used ferrous and non-ferrous metals to study corrosion and its effect on the metal used, its types, the factors affecting corrosion resistance and methods of protection from it, the following are some of them:

(Corvo F.and Minotas J,2005)[7] studied the main reason for the different corrosion rates of steel in atmospheric media is varies in concentration of chloride ions Cl^- , which causes acceleration of corrosion rates, especially areas exposed to rain for continuous times, as increase in concentration of chloride ions leads to increase in the conductivity and therefor the corrosion rates increase. The researcher concluded that increasing the concentration of chloride ions will increase the weight loss of carbon steels and the conductivity also increases.(Raja V.S.2002)[8] studied the effect of carbon on the corrosion rate by using sulfuric acid in (5%) concentration as a medium for the corrosion and that the corrosion behavior increases with the increase carbon ratio in steel, due to the increase in the area of the microscopic galvanic corrosion cells represented by perlite. The researcher (Mohammed, Y. A., 2009) [9] studied the influence of the carbon percentage in carbon steel, different carbon ratios and different models were use to cover the largest part of carbon steel, includes: Hypo-eutectoid steel, and hyper- eutectoid steel. The most common water corrosion media chooses included: salt water, drinking water, distilled water, and spring water were selected for periods: one, two, three, four, five months. The results confirmed that the corrosion resistance increases with the decrease in the perlite phase and this resistance decreases, when perlite phase increase in the in the hypo-eutectoid steel, the less corrosion resistance is found in the perlite eutectoid steel. The distilled water, and spring water have the lowest corrosion rates.

Heat Treatment

It is heating the metal to a certain temperature and then holding it at that temperature for a period of time and then cooling at a specified rate. Heat treatment processes are carried out to change the properties of the metal, including: increasing hardness, increasing ductility and toughness, increasing the metal's ability to form and

working processes, removing internal stresses resulting from working processes and removing the effects of cold forming processes, heat treatment which was used in this research include: annealing ,normalizing and hardening, Figure 1 [1].

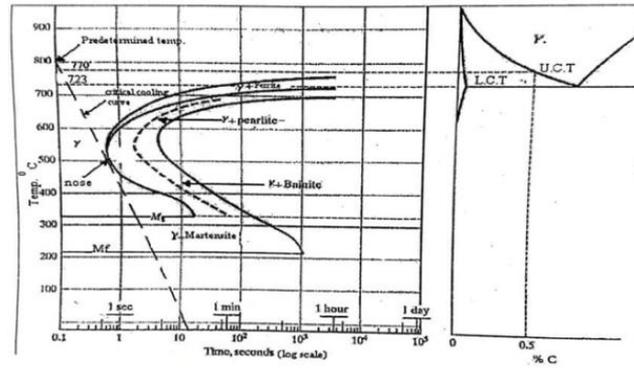


Figure1. T.T.T Curve

Practical Part

Preparing Samples

Medium carbon steel was selected for this research, microscopic examination was performed to found the carbon ratio, the carbon ratio was about (0.4-0.43), a mineral spectroscopy device was used to determine the proportions of carbon and other chemical elements , (Table 1) the chemical composition for the carbon steel.

Table 1. The Chemical Composition for the Carbon Steel

C	Ni	Cr	P	S	Mn	SI	Al	Mo
0.41	0.23	0.242	0.037	0.014	0.91	2.02	0.018	0.017

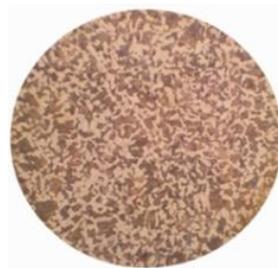


Figure 2. Carbon Steel with (0.41) C%

The choice was made on medium carbon steel for the purpose of conducting tests on it, due to its many applications, as it is used in the manufacture of water pipes, gas pipes and other engineering applications. Figure (3) shows the location of medium carbon steel on the carbon steel diagram [9].

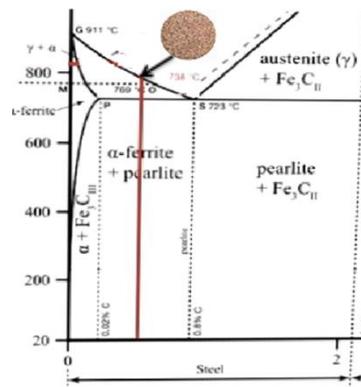


Figure 3. Location of Medium Carbon Steel on the Carbon Steel Diagram

Preparing Samples

Twenty-seven pieces were prepared, mechanical operations were performed on them, namely cutting, grinding and smoothing, The models were cut cylindrical shape with 3cm diameter and 1cm thickness, The sample was punctured from one end for the purpose of suspending it in the corrosive medium as shown in the Figure below.



Figure 4. Samples

Heat treatments of carbon steel

Thermal treatments included three treatments (annealing, normalizing and hardening), the samples were placed in an electric heating oven in the metallurgical laboratory, each nine samples were connected with a wire that has the ability to withstand high temperatures and a length of 40 cm. the samples were placed in the oven at a temperature of 850 degrees Celsius and left for a period of (15min), Samples were cooled in the following ways:
Hardening: This process consists in rapidly cooling the samples, as they were taken out of the oven and placed in water with stirring until they cool completely, as shown in figure (5).
Normalizing: this process consists of taking the samples out of the oven and placing them in the still air until they cool down, as shown in the figure (6).
Annealing: It involves slow cooling of the samples, so the samples remain in the heating oven after turning it off until it cools down for a period of twenty-four hours.as the figure below shown, figure (7)



Figure 5. Hardening Cooling Process.



Figure 6. Normalizing Cooling Process.



Figure 7. Annealing Cooling Process.



Figure 8. Micrograph for Carbon Steel which was Heat Treatment with Hardening X: 160

from each type of carbon steel which was heat treated, we took one sample after prepared it for microscopy, the figures below show the types of carbon steel which was



Figure 9. Micrograph for Carbon Steel which was Heat Treatment with Normalizing X: 160



Figure 10. Micrograph for Carbon Steel which was Heat Treatment with Annealing X: 160

All samples were weighed using a sensitive digital balance and the weight of each sample, which represents the initial weight of the samples, was recorded.

Corrosion medium

All samples were placed in a corrosive medium, which is saline (95% distilled water with 5% sodium chloride)

inside a glass basin of dimensions 60 X 40 X 45 cm. The salt water was analyzed to find out the proportion of chemical elements in it (Table 2).

Table 2. Salt Water Was Analyzed

Salt Water Ingredients	Concentration
CL- mg/l	245.05
Ca mg/l	16.032
Mg mg/	13.44
Hardness mg/l	100

Immersion process

After conducting the initial weight on the samples and recording it, the samples were suspended by threads made of insulating material (nylon) in three groups, each group contains nine samples, where each group represents a type of thermally treated steel. The samples were placed inside the basin after filling it with salt water in it. After 30 days, three samples were taken from each group, washed and then each sample was weighed, the weight was recorded, (final weight) the corrosion rate was calculated. After 40 days, three more samples were taken for each type of heat treatment, and the corrosion rate was also calculated using the same method. Also, after 60 days, the last samples for each type of heat treatment were taken out of the basin and the corrosion rate was calculated.

Calculation of corrosion rate:

The following equation shows how to calculate the corrosion rate:

$$CR = \frac{K \times \Delta W}{D \times A \times T} \quad [1]$$

C.R: corrosion rate (mm/year).

K: constant (87.6).

ΔW : loss weight (mg). = initial weight – final weight

D: metal density g/cm³.

A: The surface area subjected to erosion cm².

T : time of exposure to corrosion in hours

Results and Discussion

From Figure 11, there is a difference in the corrosion rates for different heat treatments. At time (30) days, the lowest corrosion rate was obtained for carbon steel heat treated by annealing, followed by carbon steel heat treated by hardening and finally steel treated by normalizing, after forty five days, the corrosion rates of the

heat-treated steel by annealing increased very slightly, while the corrosion rates remained constant for both the heat-treated steel by the hardening and normalizing, at 60 days, the corrosion rates differed for all types of carbon steel, as the results showed that the hardening-treated steel obtained the highest corrosion rate, then followed by the carbon steel treated by the normalizing, lowest corrosion rate for carbon steel that treated by annealing.

Table 3. The Corrosion Rate Values for the Three Heat Treatments

Time(day)	Hardening	Normalizing	Annealing
30	0.061	0.0652	0.056
45	0.063	0.065	0.062
60	0.0962	0.0823	0.08

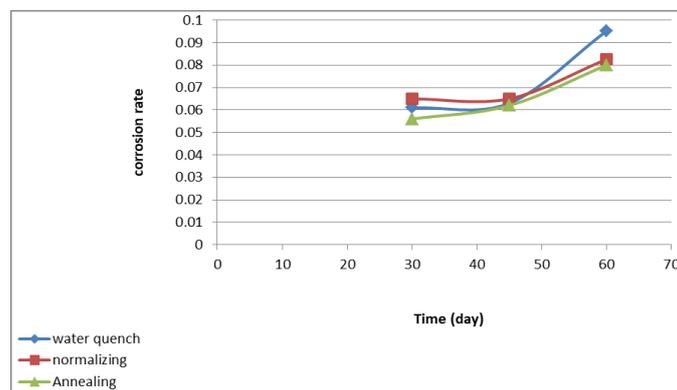


Figure 11. Diagram representing the Relationship between Immersion time and Corrosion Rate.

The main reason for corrosion is the microstructure of the medium carbon steel, which consists of ferrite, which represents the cathodes regions, and the boundaries of cells representing the anodic regions, and in the presence of the medium of corrosion, the galvanic cell is formed thus corrosion occurs, this type is called microscopic cell corrosion, perlite forms a galvanic corrosion cell between the microscopic phases due to the difference in potential difference between ferrite and cementite. The reason for the slight stability in the corrosion rates of carbon steel at the time of 45 days compared to the time of 60 days is the formation of an oxidized layer on the surface of the steel that may reduce the corrosion process. The temperature of the hardening treatment is not different from the temperature of the treatment by the normalizing or annealing, but the main difference between these thermal treatments is the method and rate of cooling, Therefore, the reason for the high corrosion rate of hardening steel is due to the many internal stresses it was exposed to as a result of its rapid cooling in water, and this makes the metal more susceptible to corrosion in this a type is called stress corrosion. As for carbon steel treated with the formula, the increase in the corrosion rate is due to its effect on the microstructure and the number of cells, as the microscopic cells are small in size and numerous in number when compared to fermentation treatment. Whenever the number of microscopic cells is many and they are small in size, the rate of erosion will be large, because the increase in the number of cells with their small sizes leads to an increase in the areas of potential difference between the cells and boundary, and thus increase the corrosion rate, The

annealing-treated steel is slowly cooled down by keeping the models in the oven, and this allows giving more time for cell growth than cooling by other methods, Corrosion medium is one of the important factors that affect the speed of corrosion rates, especially salt water, because the chloride ions present in salt increase the electrical conductivity, which leads to acceleration the corrosion process.

Conclusion

Heat treatments have an effect on corrosion rates through their effect on the microstructure and the number of galvanic corrosion cells between microscopic phases or between microscopic cells and their boundaries. Whenever the number of microscopic cells is many and small in size, the corrosion rate is high, because the increase in the number of cells leads to increase in the areas of potential difference between the cells and their borders, and thus an increase in the corrosion rates

The highest corrosion rates were in hardening steel due to the stresses it was exposed to during water quenching and the lowest corrosion rates were in annealing treated steel due to the microstructure of heat-treated steel.

Corrosion medium is one of the important factors that affect the speed of corrosion rates, especially salt water, because the chloride ions present in salt increase the electrical conductivity, which leads to an acceleration of the corrosion process.

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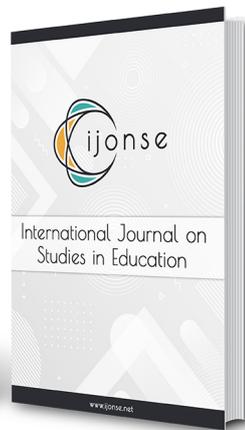
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