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Polypharmacy- An Overview on the Challenges Faced by the Elderly with Cardiovascular Diseases

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ABSTRACT

Demographic ageing has concluded for a growing multitude of aged people living with chronic diseases(multimorbidity) consuming five or more medicaments(polypharmacy) on an everyday basis. Ageing induces major differences in the cardiovascular system and represents the most dominant, potent single cardiovascular risk element. Cardiovascular diseases comprise of the greatest implications for the elderly, the healthcare systems and the caregivers involved throughout the process. Cardiovascular pharmacotherapy in the aged is complicated and burdensome because of age-related variations in body compositions, homeostatic mechanisms, organ functioning, and comorbidities enhances the pharmacokinetic and pharmacodynamic features of cardiovascular and non-cardiovascular drugs, which are in common use. Furthermore, polypharmacy results in an increased morbi-mortality and healthcare costs due to increased risk of drug interaction and it's reaction. Lamentably, proof of drug efficacy and welfare of older citizens with multi morbidity and polypharmacy is restricted because these individuals are habitually excluded from clinical trials. In addition, clinical guidelines are written with a single-disease focus at large and only rarely addresses the issue of coordination of care, duration, and treatment discontinuation methodology, if required, or how to prioritize recommendations for patients with multimorbidity and polypharmacy. This review scrutinizes the major challenges confronting healthcare professionals when prescribing in the elderly with CVD, multimorbidity, and polypharmacy. The objective is to impart information that can contribute to improving fragmented and siloed healthcare system and drug prescribing, early and accurate diagnosis of CVDs, as well as drug adherence and clinical outcomes.

Keywords— cardiovascular diseases, drug adherence, multimorbidity, pharmacokinetic.

I. INTRODUCTION

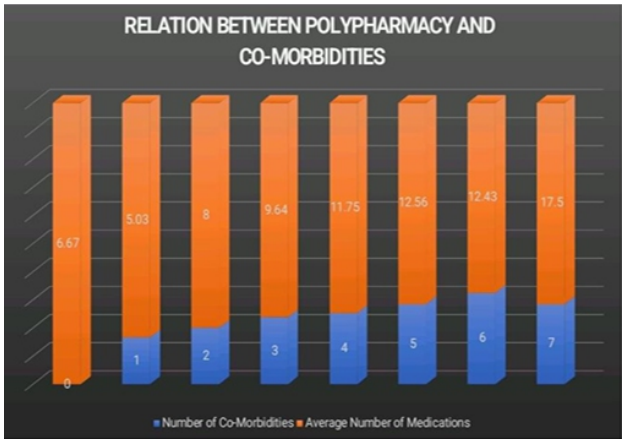
Polypharmacy is the concurrent use of multiple medications. Although there is no standard definition, polypharmacy is often defined as the routine use of five or more medications. This includes over-the-counter, prescription and/or conventional and complementary medicines used by a patient. Health care interventions are intended to benefit patients, but they can also cause harm. The nexus of processes, technologies and human interactions that constitutes the modern health care delivery system can bring notable benefits. However, it also involves an inevitable risk of patient harm that can – and routinely does – result in actual harm. Congruous polypharmacy is present, when (a) all medicines are advised for the purpose of achieving specific therapeutic objectives that have been agreed with the patient; (b) therapeutic objectives are actually being achieved or there is a reasonable chance they will be achieved in the future; (c) medication therapy has been enhanced to minimize the risk of adverse drug reactions (ADRs); and (d) the patient is motivated and able to take all medicines as intended (1). Inappropriate polypharmacy is present, when one or more medicines are prescribed that are not or no longer needed,

either because: (a) there is no evidence-based indication, the indication has expired or the dose is unnecessarily high; (b) one or more medicines fail to achieve the therapeutic objectives they are intended to achieve; (c) one, or the combination of several medicines cause ADRs, or put the patient at a high risk of ADRs or because (d) the patient is not willing or able to take one or more medicines as intended (1).

II. UBIQUITY OF POLYPHARMACY

A. Multimorbidity- It is defined as the presence of two or more long-term health conditions, which can include (a) defined physical and mental health conditions such as diabetes or schizophrenia; (b) ongoing conditions such as learning disability; (c) symptom complexes such as frailty or chronic pain; (d) sensory impairment such as sight or hearing loss; and (e) alcohol and substance misuse.

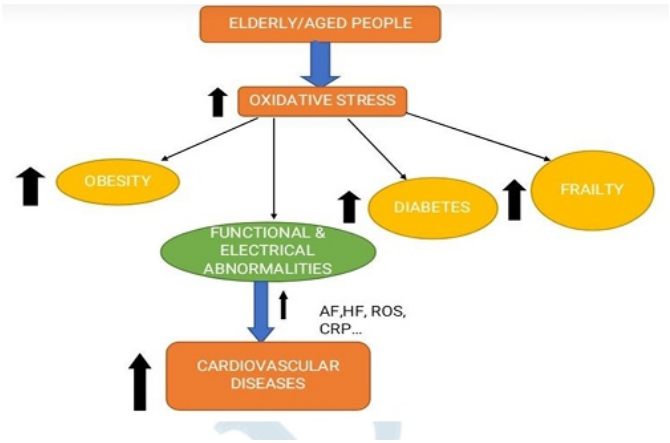
B. Facts and Estimated Data- While its true magnitude is not known, the pervasiveness of polypharmacy is expected to rise due to a multitude of factors (2). First, the global population faces a demographic shift with the proportion of older population. It has been estimated that the global population aged over 65 years will double from 8% in 2010 to 16% in 2050 (3). In 2015, approximately 5% of the population in OECD countries were aged 80 years and above, this percentage is expected to rise more than double by 2050 (3). Second, epidemiological data showcases that multimorbidity increases markedly with age. In a Scottish study, multimorbidity was prevalent in 81.5% of individuals aged 85 years and over, with a mean number of 3.62 morbidities (4). Ornstein et al. found that the most prevalent chronic conditions in primary care were hypertension (33.5%), hyperlipidemia (33.0%), and depression (18.7%) (5). The presence of multiple morbidities is associated with countless symptoms, impairments and disabilities. Multimorbidity may result in a combined negative effect on physical and mental health, and can have a major impact on a person's quality of life, limiting daily activities and reducing mobility (5). The need to take multiple medications can be just as problematic, resulting in recurring health care contacts and an increase in the plausibility of medication-related harm (6). Furthermore, it thrusts a large economic burden due to patients' complexity of health care needs and frequent interaction with health services, which may be fragmented, ineffective and incomplete.



Comorbidity refers to presence of more than one disease/condition in a person at the same time. This above graph showcases the co-relation between polypharmacy and co-morbidities.

III. CARDIOVASCULAR DISEASES IN THE ELDERLY

In the aged people, we are dealing with increased frequency of cardiovascular diseases especially myocardial infarction, stroke, isolated systolic hypertension, calcific aortic stenosis, orthostatic hypotension, and syncopal attacks due to sick sinus syndrome, complete heart block, atrial fibrillation or other rhythm disorders. Alteration in cardiovascular status in the elderly has undesirable effects on their quality of life and longevity. Diagnosis of these disorders in the elderly requires special consideration since coexistence of structural/functional changes in the old age with cardiovascular disease would alter the classic features of these disorders and result in delay in their appropriate management. Biological aging as evaluated by reduced telomere length has a strong impact on the incidence of cardiovascular disorders especially coronary heart disease and chronic heart failure. This phenomenon could possibly explain interindividual susceptibility to cardiovascular disorders (7).



This above ray diagram describes the cause of high risk of CVDs due to age factor.

IV. INTEGRATIVE TEAM APPROACH

Healthcare systems and clinical practice guidelines (CPGs) are mainly oriented towards single-disease rather than multimorbidity. (8) However, application of multiple disease-specific CPGs in patients with CVD and multimorbidity without integration may lead to contradictory recommendations and be impractical, or even harmful, and misaligned with patients' preferences and values. (9,10,11) Additionally, these patients are treated simultaneously by several specialists, which can lead to discrepancies in goals of care, drugs prescribed, and overall medical management. In these circumstances, a holistic patient care requires a multidisciplinary team for a successful comprehensive geriatric assessment and coordinated management of multimorbidity. The coordinated teamwork between the cardiologist and other medical specialists, nurses, pharmacists, social workers, family, and caregivers plays a key role in establishing the goals of cardiovascular pharmacotherapy according to the patient's preferences and values.

V. PRESCRIBING MEDICINES TO OLDER PEOPLE—HOW TO CONSIDER THE IMPACT OF AGEING ON HUMAN ORGAN AND BODY FUNCTIONS

Older people face multiple problems potentially influencing the beneficial and adverse effects of pharmacotherapy, of which the actual effects are not always easy to predict beforehand. Prescribing (selecting, informing patients, initiating, monitoring and continuation) of drugs to older people provides major challenges to many physicians. Next to changes in pharmacokinetics and pharmacodynamics

upon ageing, changes in body functions, such as visual acuity, motor functions and cognition also pose a challenge for appropriate prescribing as they may affect the correct use of the drug. To adequately address the needs of older people and their prescribers, it is important that during the drug development process sufficient information is gathered about the possible changes in pharmacokinetics and pharmacodynamics in older people, especially in patients older than 75 years suffering from comorbidities, and that this aspect requires due consideration during drug authorization. Therefore, a revision of the ICH E7 criteria is recommended so that more data in people older than 75 years will be acquired. Furthermore, it is important during this process that any practical problems that older people may experience will be addressed by adjusting the product design. (12)

VI. MAIN ADVERSE DRUG REACTIONS PRODUCED IN THE ELDERLY DUE TO FREQUENTLY PRESCRIBED CARDIOVASCULAR DRUGS

The below illustrated [Table 1], describes some of the main drug types and their adverse consequences on the aged people due to commonly prescribed cardiovascular medications.

TABLE 1. Drug category along with their main adverse effects

DRUG TYPE	MAIN ADVERSE CONSEQUENCE
Glucose-lowering drugs	Aggressive glycaemic control ↑ the risk of hypoglycaemia, dizziness, confusion, and falls. Establish individual HbA1C targets balancing any benefits vs. hypoglycaemia risk.
Alpha-adrenergic blockers	Postural hypotension, especially in patients treated with diuretics or vasodilators. Dizziness, somnolence, and dry mouth.
ACEIs/ARBs	↑ the risk of hyperkaliemia, hypotension, falls, dizziness, fatigue, acute kidney injury, and cough (ACEIs)
Lidocaine	Tremor, dysarthria, altered levels of consciousness, nystagmus, and seizures
Antiplatelets	↑ risk of bleeding
Colchicine	Diarrhoea, nausea, vomiting, abdominal discomfort, and blood dyscrasias

VII. A CORE ISSUE: DRUG ADHERENCE

Medication adherence is a growing concern to clinicians, healthcare systems, and other stakeholders (eg.

payers) because of mounting evidence that nonadherence is prevalent and associated with adverse outcomes and higher costs of care. (13) 30-75% aged population are not taking drugs that they are supposed to be taking. With increasing polypharmacy and multimorbidity rates, non-adherence also is on an increase and is in accordance with poor QoL, increased mortality rates and high medical costs. Systematic checking of drug efficacy and safety is critical to prevent ADRs and improve QoL and clinical outcomes. However, up to two-thirds of patients receiving cardiovascular drugs that require lab-based track (i.e., renin–angiotensin–aldosteronesystem inhibitors, digoxin, glucose-lowering drugs, and warfarin) are not regularly monitored. (14)

VIII. SIGNIFICANCE OF PERIODIC SYSTEMATIC MEDICATION REVIEWS

For the enhanced clinical outcomes, vigilant planning of drug regiments is required.

Identify all medications that the patient is currently using ("trust but verify")
• Prescribed, OTC, HMPs, CAM and dietary supplements
Assess patients' co-morbidities, cognition, functional status, and social support
• Review records: clinics, hospital, skilled nursing, assisted living, nursing homes • Screen for diet and nutritional state
Define overall care goals
• Based on functional status, QoL, estimated life expectancy and patients' preferences • Primary/secondary prevention, acute/chronic treatment, symptom control/management
Match each medication with patients' condition and goals of care
• Confirm that all prescribed drugs are indicated and effective* • Consider to deprescribe ineffective, unnecessary, or repeated medications • Replace any drug by a potentially safer and more effective alternative
Consider the need of new medications
• Confirm whether all recommended drugs are prescribed • Consider underlying causes to treat and the risk/benefit ratio
Document adherence and response to therapy
• Assess whether the patient follows the treatment correctly: dosage, frequency, route of administration and duration • Simplify the treatment: once daily, easy to swallow, medications with dual indications
Identify drug-related ADRs and drug-drug/-drug interactions
• Any new symptom/cognitive change should be considered an ADR until proven otherwise • Evaluate the cause and severity and discontinue culprit drugs • Assess liver and kidney function and adjust the dose accordingly
Provide drug information to patients and caregivers
• Simple verbal/written instructions for every medication • Explain the goals of treatment and the reasons to discontinue/initiate a new medication
Improve communication between health care providers
• Information should be readily available to all caregivers • Adopt a multidisciplinary care approach including GPs, pharmacists, nurses, dietitians, and other health care providers • Communication between hospital and community care providers is essential

The above medication review showcases a structured periodic review of all medications, matching each medication to the patient's comorbidities and objectives of care.

IX. ISSUES OF PRESCRIBING FLAWED MEDICATIONS

Improving prescribing for older people is an essential part of medical care and a priority for all healthcare systems. Inappropriate polypharmacy is a common practice and includes the prescription of medications when there is no evidence-based indication or the indication has expired; it fails to achieve the therapeutic goals and causes inacceptable ADRs when safer and/or more effective drugs are available or the patient is not willing or able to take the medicines as intended. (15,16,17)

Cardiovascular drug therapy optimization while avoiding the use of potentially inappropriate medications (PIMs) can enhance clinical outcomes and reduce ADRs. Several tools can help to identify PIM and/or potential prescription omissions in older people, including Beers, STOPP/START (Screening Tool of Older People's Prescriptions/Screening Tool to Alert to Right Treatment) criteria, EURO-FORTA (Fit fOR The Aged) list, and the Medication Appropriateness Index.(18,19,20) The ACOVE-3 (Assessing Care of Vulnerable

Elders-3) and GPGPA (Good Palliative-Geriatric Practice Algorithm) tools are useful in determining the need for medication continuation in vulnerable older adults who are closer to the end of life. However, no one validated tool assesses all aspects of PIMs or has been shown to be superior in improving patient-related outcomes and decreasing polypharmacy risks, and it remains unclear whether they reduce hospital admissions. (21,19,20) A simple and effective approach to systematically identify PIMs is to match each of the patient's conditions with their medications. (15)

X. CONCLUSION

Major focus on the comprehensive assessment of the risk and complexity of prescribing cardiovascular drugs is necessary to ensure that aged people with CVD and multimorbidity receive the most effective and safest cardiovascular pharmacotherapy. This review talks about the ubiquity of polypharmacy, co-relation between polypharmacy and co-morbidity, an integrative team approach, drug adherence factor, importance of periodic systematic drug review, issues of prescribing flawed drugs, and the main adverse drug reactions produced in the elderly due to commonly prescribed cardiovascular medications. Hence, it is concluded that a congruous prescription of safe and effective pharmacotherapy in aged people with CVD and multimorbidity exists as one of the greatest ultimatums in geriatric medicine and dose adjustments are required to drastically reduce the risk of ADRs. Also, certain cardiovascular drugs should be administered with caution, avoided, or closely monitored when prescribed in the elderly. There is an urgent need to evolve appropriate and specific CPGs for this growing population based on RCTs (or consensus, until trial data become available) that confers how the most common comorbidities impact the applicability of guideline recommendations and prioritize the diagnosis and treatment that optimize benefits, improve physical and psychosocial function, QoL, and outcomes, and minimize harm (ARDs and DDIs) in this population. To sum up, better clinical evidence is always welcomed regarding the efficacy and safety of cardiovascular drugs in older people with CVD and multimorbidity.

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Removing bubbles from molten glasses: A Critical Review

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ABSTRACT

during the melting process of batch materials, different types of gases from diverse sources are released, resulting in a huge amount of bubbles and gaseous inclusions in the glass melt. These bubbles have undesirable effects on the optical quality and mechanical properties of final products. Therefore, it is necessary to remove bubbles from the melt. This process is called refining. Behavior of bubbles inside the molten glass depends on factors including diameter, composition and position of bubbles which are functions of temperature. Bubbles can be eliminated from glass melts either by physically rising to the surface or by chemical dissolution of the gaseous species into the surrounding melt. Chemical agents are used to improve the fining process, but most of these common chemical agents are harmful. Although there are some alternative physical refining methods which can be used instead; in practice, bubbles can be eliminated by using combination of two methods simultaneously. In this study, the different methods of glass refining are reviewed.

Keywords: Bubbles, Chemical agent, molten glass, refining.

I. INTRODUCTION

During The investigation on glass industry in terms of raw materials and process optimization offers interesting perspective and understanding of how this industry has been progressively developed [1]. According to Figure 1, glass industry is being used for different functionalities in various environments, from mass production like glazing and containers to nanotechnology processing including hard disk drives, solar glass, amorphous semiconductors, optical fibers, coatings, cutting tools and displays. That is why different studies show that development and production of glass involve significant and interdisciplinary knowledge and expertise [2-15].

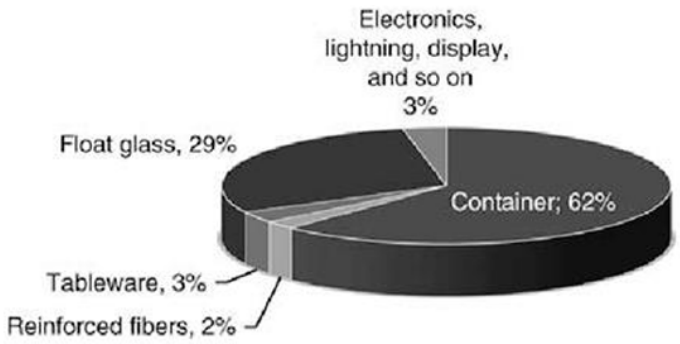

Figure 1: Market shares of major glass applications [1]

Glasses have lots of applications in dairy life and present several benefits as an industrial material [1-13] such as:

- Ability to recycle;
- Chemical inertness;
- Non-polluting nature on ultimate disposal;
- Ability to be manufactured from abundant raw materials;
- UV filtration (amber and green glass), optical and transparency qualities;
- Low gas permeability and
- High intrinsic strength.

More than 90 percent of glass industry products are sold to other industries such as building industry, car manufacturing and the food and beverage industry [12]. The most important principles behind industrial glass manufacture are as follows:

- Meltability;
- Workability;
- Refining and
- Economics.

The terms fining and refining refer to the removal of gaseous inclusions or bubbles, from the molten glass. Although the presence of bubbles in a glass sample is not necessarily detrimental for many scientific studies, bubbles are definitely undesirable in most commercial glasses. Bubbles in commercial products are almost always considered flaws and can create severe problems in practice [16-18]. Figures 2 and 3 show the trapped bubbles in the glass melt and a container, respectively[19].

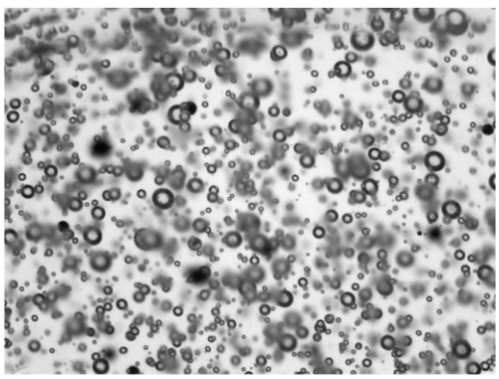

Figure 2: Glass just after batch melting [14]

Figure 3: Bubbles in the glass [19]

Bubbles can be completely removed from glass melt by chemical and physical methods. Physical methods including Buoyancy effect, ultrasonic and sound waves, applying a centrifugal force in the molten glass and employment an appropriate heat treatment procedure. Chemical methods contain dissolution of the gaseous species into the melt by using chemical refining agents (figure 3). In this study, the chemical and physical methods of refining molten glasses are reviewed.

II. PREVIOUS WORK

Ruud G. C. Beerkens [20] investigated on gas release during melting and refining stages. He proposed a method for gas evolution based on thermodynamic equilibrium condition, different significant parameters in practice, calculations and modeling. Ruud G. C. Beerkens [21] also showed several new innovative ideas related to the industrial glass melting. He analyzed effective parameters in melting process of glasses by using precise experimental data. Masataka Kawaguchi et al. [22] presented different solutions in order to improve refining process among preparation of uniformly mixed fine batch and acceleration of refining. In addition, he claimed helium atmosphere can reduce seeds in molten glasses. Kuji Fujita et al. [23] studied effects of refining agents and UV transmitting property of soda lime glass. They added a small amount of iron oxide in specific condition in order to improve the characteristics. Figure 4 illustrates comparison of the amount of bubbles in a glass sample by change in the percentage of Sb2O3 as a refining agent.

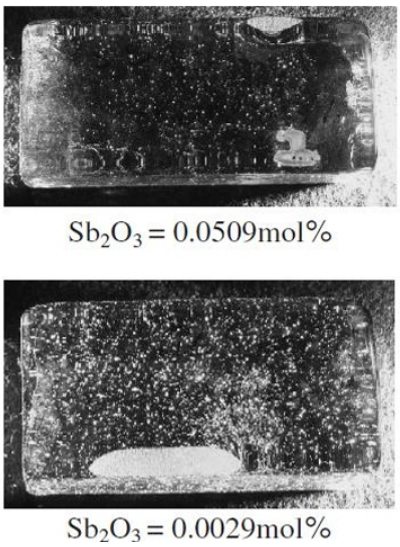

Figure 4: Photograph of bubbles in as-cast glass sample, their thickness are 20 mm [23]

Andrea Weiss Bookbinder et al. [24] illustrated new method for refining oxide glass by controlling the hydrogen permeation blistering within the vessel. Megan Aurora De Lamielleure et al. [25] proved a method of reducing gaseous inclusion in glass melting process in a patent. They designed an efficient heat treatment cycle in the correct condition for use in industrial glasses.

Jaehun Chun et al. [26] studied on melter feed viscosity during heating and correlated bubbles with the volume fractions of dissolving quartz particles and the gas phase. Also, they investigated the approaches to homogenize and equilibrate the glass melt. A group of researchers [27] demonstrates effect of additional carbon dioxide on bursting the bubble as an inclusion in molten glass. Michael Cable [28] investigated on refining of a soda-lime-silica glass with and without chemical agents. He designed a furnace based on new condition and distinct convection currents. In addition, he decreased the number of seeds at the beginning of refining process by using chemical agents and raising the temperature. Moreover, he presented two mechanisms for refining [29] as for theoretical expression and numerical calculations. Junjie Luo et al. [30] presented a series of studies to relate the periodicity of bubble formation to part scan speed, laser power and filament feed rate. Their experiments suggested that forming of bubbles has direct relation with laser power. According to Figure 5, bubbles have three different types in a glass sample as a substrate.

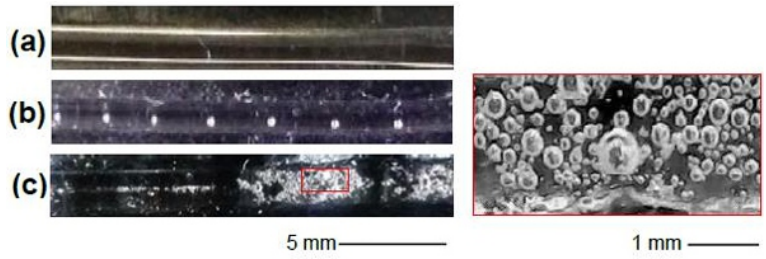

Figure 5: Dark field images of three types of bubbles (a) sporadic bubbles, (b) periodic bubble pattern, and © foam layers [30]

III. PHYSICAL METHODS

• Removal of bubbles by Buoyancy effects The principle of Buoyancy effect is based on Stoke's Law, which has relation to the velocity, *Vs*, of a solid sphere in a liquid with different density:

$$V_s = \frac{2g\Delta\rho r^2}{9\eta}$$

Where g is the gravitational acceleration, $\Delta\rho$ is the difference in density between the sphere and the liquid, r the difference in density between the sphere and the liquid, r is the radius of the sphere, and η is the viscosity of the liquid. For special cases, it has been shown that:

$$V_b = \frac{3V_s}{2}$$

Where V_b is the rate of rise of the bubbles.

These two equations show that the rate of ascent of a bubble is inversely proportional to the viscosity of a melt and directly proportional to the density of the melt. In addition, these equations predict that the rate of removal of bubbles will be proportional to the square of the bubble radius. For instance, very fine seed

cannot be impressively eliminated from a molten glass with low fluidity by simple bubble rise in the absence of any other processes. There are some solutions in order to solve this problem including upward fluid motion that can be obtained by mechanical stirring, design of a glass tank floor to produce upward currents, localized heating to produce a locally hotter and thus less dense region in the melt and finally bubbling with a gas introduced near the bottom of the melt.

However these predictions are generally dominant, there are some exceptions that these equations do not entirely predict the results of all experimental studies since the chemistry of molten glass can change this simple relationship.

Bubble radius plays a paramount role in velocity of the rate of ascent of a bubble that is function of surface tension. Both macroscopic and microscopic factors affecting the improvement of the surface tension include chemical composition of the melt, inclusions, thickness and pressure difference between the inside and outside of the bubble [16, 39].

• Removal of bubbles by ultrasonic and sound waves

Radiation of ultrasonic waves in the molten glass have a degassing effect. Of course the result of ultrasonic and sound waves on gaseous inclusion in a liquid is very complicated. Furthermore, in practice, installation of these types of devices in the refining process of an industrial tank will be very arduous [13]. For this reason, an alternative solution will be used to overcome this limitation. This process does not require addition of chemical agents or catalysts and therefore does not generate undesirable streams. In addition, this process does not have negative effect on environmental. In this method, O_2 and H_2 bubbles meet each other in molten glass and create reaction with shock waves that has a same effect as ultrasonic wave technique (figure 6) [40, 43].

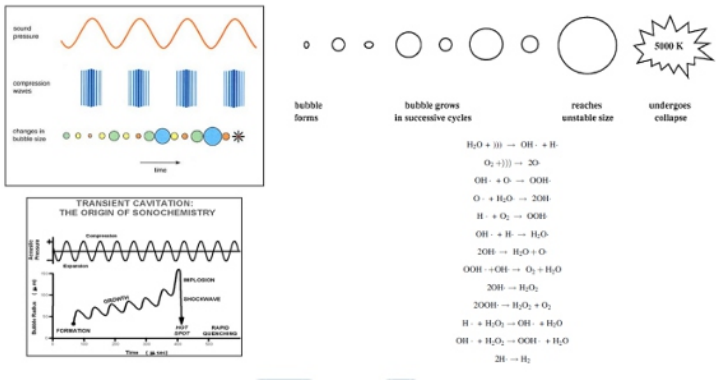

Figure 6. Bursting the bubbles through reaction O2 with H2 [42, 43]

• Employment an appropriate heat treatment procedure and optimum design

Preparing an approach to decrease gaseous inclusions and bubbles in a molten glass is very important. This method can include some steps, such as: (a) increasing the temperature of batch material to melting temperature TM within a melting vessel in order to form molten glass which contains a multivalent oxide material; (b) decreasing the temperature of molten glass within a refractory tube to a cooling temperature TC, to maintain the molten glass for a predetermined resident time; and (c) increasing the temperature of cooled molten glass within a refining vessel to a refining temperature TR >TM.

On the other hand, the content of bubbles in the melt is therefore decreased by melting under reduced pressure, exposing the melt to the pressure of an inert gas, etc [24, 33]. Furthermore, refining process may be improved by applying an additional force like a centrifugal force on bubble in the molten glass in a rotating discontinuous cylinder [44].

IV. CHEMICAL METHODS

• Removal of bubbles through common refining agents

Chemical refining agents added to molten glass can release large quantities of gases, which form large bubbles and gaseous inclusion through rising up to the surface of the melt. These large bubbles trend to carry smaller bubbles and seeds to the surface as well. In addition, some of these agents cause the absorption of oxygen atoms from the bubbles at lower temperatures, thus reducing the size of seed due to diffusion from the bubble into the melt. The seed eventually shrinks to below the critical radius, where the surface energy causes the complete disappearance of the bubble. Different agents exist due to the fact that the temperature should fit between the decay of the agents and a sufficient low viscosity of the melt. Therefore for melt with different composition, several types of agents do exist; whiles the fitting is not always optimal. Thus, for some melts a mixture of agents or additional agents could be a solution for improving the process.

Arsenic and antimony oxides are known as the most efficient chemical refining agents, chiefly when they combined with alkali nitrates in the batch. These oxides are usually added to the batch in 0.1 to 1 wt% quantities. The refining action of arsenic and antimony oxides results from a series of chemical reactions which occurs at different stages of the melting process. During batch melting, these oxides react with nitrates to release nitrogen oxides and O2, as, for example, in the reaction:

$$4KNO_3 + 2As_2O_3 \rightarrow 2K_2O + 2As_2O_5 + 4NO\uparrow + O_2\uparrow$$

These chemical reactions release abundant quantities of NO and O2 gases, which form large bubbles and rapidly rise up to the surface of glass molten. When batch decomposition is completed, melts are usually heat up to higher temperatures and soaked until completely refined. As the dissolved oxygen is consumed, oxygen from nearby bubbles will diffuse into the melt. Therefore, the process leads to reducing their internal pressure and hence reducing their diameter of bubbles. Accelerated diffusion from the bubble into the melt will increase by high internal pressure, until the bubble is completely diminished. Surface energy of bubbles plays a paramount role in the recent case. The rate of ascent of bubbles increased along increasing in partial pressure difference between the inside and outside of the bubble. However, from an environmental point of view, it would be desirable to provide alternative methods for refining process without having to employ arsenic as a refining agent.

Also sodium sulfate uses as a source of considerable gas during batch decomposition, as well as supplying a portion of the sodium for soda-lime-silicate melts. Sulfate refining is strongly affected by the reactions with furnace gases or other sources of carbon. Nitrates can also act as a refining agent even in the absence of arsenic or antimony oxides. Decomposition of nitrates releases large quantities of nitrogen and oxygen gases. In addition, halides are the most useful refining agents through their efficiency in lowering the viscosity of molten glass. Oxides of a few multivalent cations can be used as chemical refining agents by acting as sources of O2, in a manner similar to arsenic and antimony oxides.

Cerium oxide is a good example for multivalent cations:

$$4CeO_2 \rightarrow 2Ce_2O_3 + O_2 \uparrow$$

SnO_2, MnO_2, Fe_2O_3, Pb_30_4, etc., are known as other oxides of multivalent cations which can also act as minor refining agents via similar reactions. Some of these oxides are added for reasons other than their refining action [16, 34, 37, 38, 39].

• Application of Helium gas to facilitate the refining process

As mentioned before, some of refining agents have undesirable effects on environment. Helium molecules can dissolve in the interstices of a molten glass, physically. Helium has the smallest molecule size among all gases so it is able to diffuse throughout the molten glass faster than other inert gases. Consequently, dissolved helium molecules in the molten glass rapidly penetrate into seeds to enlarge them without any destructive effect on environment. In addition, since the diffused helium in the fine bubbles decreases the partial pressures of pre-existing gases in them, more refining gases such as oxygen and sulfur dioxide can be extracted from the molten glass. As a conclusion, melting process under helium atmosphere inside the furnace can contribute to refining [22]. Figure 7, shows the comparison of a glass samples which fabricated in helium and air atmospheres.

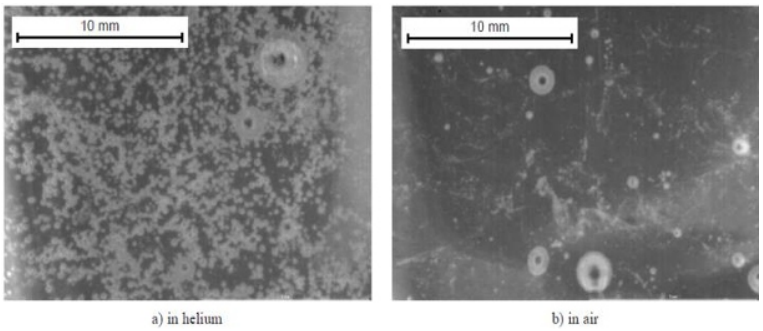

Figure 7: Seeds in Molten glass [22]

V. CONCLUSION

Using both chemical and physical methods together improve the quality of production, kinetics of melting process and refining of glass melting in the industrial glasses. Assessment of chemical composition, refining agents and especially their level of addition is one of the most difficult stages in glass melt design, because there are few significant calculation rules. It is recommended that appropriate amount of refining agents and applying physical method has been developed through laboratory trials [16, 18]. Since, there are many variations on removing gaseous inclusions and refining process, it can be noted that, in practice, several methods whether physically or chemically, are simultaneously used to reduce this dilemma. This is why in glass industry, the procedures carried out experiments based on trial and error to achieve the optimum results. After finding the most appropriate solution, by using the modeling techniques [45] based on the best results of laboratory tests, the procedure is optimized. Herein after, the optimized procedure is implemented for industrialization.

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Measuring the Role of Purchasing Decision Attributions as a Moderating Variable on Its Relationship between the Utilitarian Self-Service Technology Performance and the Customer Hedonic Experience

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ABSTRACT

This research is focusing on two perspectives, right off the bat to comprehend the connection between the utilitarian self-service technology performance (Task Uncertainty, service escape, perceived control, and the time pressure) and the customer hedonic experience and to measure the effect of purchasing decision attributions (cost, benefit, convenience, and risk) on the client's response and expectations towards the service being given. Numerous successful online organizations have made multipurpose applications and viable portable sites to enhance this growing business sector, for example, Amazon, eBay, Argos, and Auto Trader, and have created viable business systems and promoting methods. This research is focusing on the hedonic encounters connected with utilitarian self-service technology, a utilitarian part cannot be overlooked. In this way, we investigate the impact of delight and usefulness in a hedonistic setting and what these ideas at last mean for assessments.

Keywords: Utilitarian Self-Service Technology, Hedonic Customer Experience, Purchasing Decision Attributions, Cost, Benefit, Convenience, Risk, Task Uncertainty, Service Escape, Perceived Control, Perceived Time Pressure, Efficiency, Fun, Customer Delight.

I. INTRODUCTION

Applications on mobile phones are particularly the main component since they can empower a business differently (Kasiri et al., 2022). Google applications on Android are a top of its adversaries (Windows Phone and iOS, etc.) when we talked about the applications. These outcomes from its open-source nature and a variety of undertakings obtainable for the improvement of usages. There are numerous free applications similarly as various at a deal open utilizing the Web. If you have an Android or an iPhone, it is fundamental to examine all the applications on the web to support your corporate run well and even more viably (Kasiri et al., 2022).

Smart phones are the devices that can perform twofold limits, for instance, cell and handheld PC (Tossell, et al., 2018). Along these lines, what separate Smartphone from cell phone are the features of a PC, for instance, the (applications), portrayed as "little activities that abrupt spike sought after for a cell

and performed endeavours going from investment to games and website examining" (Tossell, et al., 2021). Which mark phones likely to usage for extra reasons than calling and directing texts. Past investigations have been incredibly inspired by conduct aim and general use (recurrence or portion of utilization) of Utilitarian Self-service Technology Performance, yet not many have taken a gander at real use, (Wang et al., 2019) anticipated the advanced utilization of Self-service Technology without seeing situational issues. Different researches (Wang et al., 2019) distinguished many situational features in a further subjective exploration. Along these defences, an exploration model coordinates the genuine relationship between Utilitarian Self-service Technology and situational factors.

Utilitarian Self-service Technology for example, automatic teller machines (ATMs), computerized registration, phone banking, and Internet exchanges, are getting generally acknowledged with the improvement of Internet-based application frameworks. Self-service can be defined as inspired interfaces that allow clients to build a facility free of direct facility representative association. (Demoulin & Djelassi, 2020). Nevertheless, because online customers primarily communicate with the Web-based PC platform and are unable to really touch or feel genuine goods, they practically settle on electronically provided data choices by the online store. In this way, the debate on the critical components of buyer buying behaviour in an electronic trading setting should concentrate on data accessibility (Wolfinbarger and Gilly,

2020). Data accessibility takes into account item or service information, as well as convenience and personalization for customer retention. It relies on how buyers can use knowledge to forecast their likely fulfilment with following consumptions. Like this, the achievement of web retailers would be resolute by the ability to customize their data to tackle the problems of shoppers. In any event, the prescient estimate of the data with no form of data to be reliably appreciated by all clients is determined by a few elements (Kolesar and Galbraith, 2000). Reducing the cost of data search and growing the accuracy of item quality by delivering customized data to consumers is the essential prerequisite for inciting a shopper to become an online store customer and expanding its exchange costs. While the shopper can get an unmistakable drop at the end of the web exchange, the buyer's benefits are not great in the purchased, which can have been acquired over elective networks (Kolesar and Galbraith 2021). The exciting benefits of the customer are the online based spending exchange itself, such as saving time, increased comfort, and decreased chance of dissatisfaction (Wolfinbarger and Gilly, 2001). Consequently, in planning a web shop, consumer service and innovation are significant (Jarvenpaa et al 2020).

II. LITERATURE REVIEW

available for cutting-edge iOS cells and generally expecting 1.6 million applications will be open for Android PDAs in July 2015 (Kouser et al., 2021). The omnipresence of telephone apps is growing (Tossell, et al., 2021) and people today have countless apps to explore. For example, the iPhone App Store offers more than 850,000 apps, and Google Play for Android offers more than 450,000 apps (Tossell, et al., 2021). A total of 50 billion apps have been downloaded in the Apple App Store alone from which practically 20 billion were downloaded in 2012 alone. In the Apple App Store, more than 800 apps are downloaded every second, at a rate of more than two billion apps every month, illustrating the commonality. New phone arrangements were usually about 175 million in 2019, 350 million each in 2016, and would show up at 700 million in 2022 (Kouser et al. 2021).

There were 5.9 billion PDA customers in 2019, which is contingent on an increase to 7.5 billion prior to 2020 completion. It is known that Asia is part of the versatile world. By having the most unmistakable expansion in various wireless customers, Egypt dominates the aggregate annual improvement rate (around the world), led by Oman, Sudan, Bangladesh, Mozambique, Iran, and Pakistan. To the extent of cell improvement, Pakistan positions seventh worldwide and second in Asia (Kouser et al. 2021). Progressed cells exhibited a high advancement rate in the latest years due to the availability of numerous critical PDA applications. Around 191.1 million U.S. occupants asserted a high-level cell phone in August 2015.This analyses to an invasion speed of 77.1%. The fame of cutting edge cell phones has pulled in various application creators. demonstrated that around 1.5 million applications were available for cutting-edge iOS cells and generally expecting
1.6 million applications will be open for Android PDAs in
July 2015 (Kouser et al., 2021).

Regardless, progressing investigation gives confirmation a few of these applications produce wages that grant working a specialist programming headway business. As needs are, researchers and application planners are interested in understanding the drivers of use interest and surveying demand abilities to improve assessing, advancing, and invigorating frameworks. A few elements may likewise affect an application's advantage and, for example, found verification that assessing system, customer overviews, the vital working structure, and an application's report size sway interest (Taylor et al., 2020).

Radomir and Nistor (2020) investigated the effect of a couple of adaptable application ascribes (for instance, application cost, record size, depiction length, number of screens catches, age limit) on application premium and indicated that the premium additions inside application purchase decision yet reduces inside application promotion. The makers similarly found that a worth discount is more effective in Google Play than Apple App Store. Lee and Raghu separated the effect of different segments on the perseverance of an adaptable application in the top-netting 300 layouts in 2020. They give evidence that offering applications across various characterizations are maybe the fundamental accomplishment factors. Applications without a candid expense have a higher probability of getting by in the leading 300 charts than applications with a frank worth (Taylor et al., 2020).

Self-Service technologies advancements are implemented by companies to increase their profitability while improving client fulfilment by providing fresh and helpful provision platforms (Demoulin and Djelassi, 2021). Utilitarian Self-services technologies are defined as: "innovative interfaces that empower clients to deliver a facility autonomous of uninterrupted service representative inclusion" (Blut, 2021).

In order to incorporate self-examining or self-checkout (SCO), traders have extended their self-service technology reach, whereby customers filter their purchases themselves and make instalments afterwards. Through using Self-Service technologies, consumers accomplish the facility or a portion of the operation, typically performed by the facility supplier (Taylor et al., 2020).

In some shops, Albertsons and Jewel-Osco have eliminated Utilitarian Self-service Technology to improve customer service and offer more personalized assistance by fostering more human connections. (Demoulin and Djelassi, 2021). In Canada, it is noticed a similar pattern, since none of the significant food merchants has all the earmarks of being calculators; a few retailers have even taken out some of them (Shahid Iqbal et al., 2022)

In Europe, for example, France, most consumers see the establishment of self-checkout in all stores negatively; half actually prefer customary checkouts.10-15 percent of French customers in hypermarkets are attracted by self-checkouts. Marketing managers require to consider the human, technology-arranged and situational aspects that impact clients to receive or discard Utilitarian Self-service Technology Performances throughout a spending trip (Demoulin & Djelassi, 2021).

III. THE RESEARCH HYPOTHESIS

H:1 Utilitarian Self-Service Technology Performance have A positive relationship With Customer Hedonic Experience.

The first hypothesis will be focusing on the Utilitarian Self Service Technology performance (Task Uncertainty, Service escape, Perceived time pressure, and Perceived control) and its relationship with the customer hedonic experience (Efficiency, Fun and Customer Delight).

H: 2 Utilitarian Self-Service Technology Performance Have A Positive Relationship With Customer Hedonic Experience, Within The Existence Of The Purchasing Decision Attributions As A Moderating Variable.

The second hypothesis that has been formulated is related to the purchasing decision attributions (Cost, Benefit, convenience, and risk) as a moderating variable. In the literature review, the association among the utilitarian self-service technology performance and the customer hedonic experience is still the subject of many debates within such a moderating variable.

IV. EXPLORATORY STUDY

Since the current research aims to measuring the role of purchasing decision attributions as a moderating variable on Its relationship between the utilitarian self-service technology performance and the customer hedonic experience, the pilot study was designed to:

1. Explore the relationship between variables.
2. Investigate how Utilitarian self-service technology performance might affect the customer hedonic experience.
3. Explain the most important elements in measuring Utilitarian self-service technology performance.
4. Describe the most important elements in measuring Customer hedonic experience.
5. Enlighten the most important elements in measuring Utilitarian self-service technology performance.
6. Rationalize the most important elements in measuring the purchasing decision attribution.

A Focus group has been steered, which gathered seven lecturers and fresh graduate students interested in sports and fitness. They were asked about to what extent they rely on their sports mobile application in their daily work.

V. THE RESULTS FROM THE EXPLORATORY STUDY:

1. After finishing the Focus group that gathered seven lecturers and fresh graduate students that were

interested in the field of sports and fitness, that were asked about to what extent do they rely on their mobile application in their daily workout, all companions positively perceived the realization of sports and fitness mobile application with the previous background. They considered it as a useful tool for both parties (service provider and customer)

2. Therefore, the subject is that sports and fitness mobile application is a business opportunity for marketers to reach a wide range of customers. Nowadays, it affects the Core business functionality as it allows the customer to receive the service provided not just efficiently but in a more pampered way for simplification.

3. Moreover, the respondents mentioned that they rely on their mobile application when providing functional training online sessions, via communicating with their coaches, taking from them nutrition plans, evaluating their performance, giving back comments and feedback for the athlete's performance based on the Body mass index that the athlete should input to his app.

4. When the respondents were asked about the features and benefits of the mobile applications that they would prefer to find on a daily usage, they stated that the mobile application that has an ease of use (User friendly), up-to-date with frequent interesting, new, and creative features for trainers and trainees would make them happier and feel delighted while using such an app.

5. Most of the respondents agreed on the following statements that describe the mobile application they are willing to use (free of charge, easy to use, adaptive, and reliable). All these pillars would allow them to continue using the app to facilitate the service provided within the cost attribution elements (Cost, benefit, Convenience, and risk risks).

VI. RESEARCH PROBLEM

• Is there a relationship between Utilitarian self-service technology performance and customer hedonic experience and how can purchasing decision attribution can affect the relationship between these two variables as a moderating variable?

Previous examinations on utilitarian data frameworks have explored what the segment components of Internet clients mean for their utilitarian and social cooperation points of view. They find that clients in the big-time salary bunch utilize the Web for utilitarian purposes (Fiore etal, 2021). Results led from the exploratory research that the connection between the utilitarian self-service execution and the client hedonic experience should be furtherly concentrated inside the directing variable's presence, which is the buying decision attribution.

VII. RESEARCH QUESTIONS

a. Is there a relationship between utilitarian self-service technology performance and customers hedonic experience?
b. Is there a relationship between utilitarian self-service technology performance and customers hedonic experience within the presence of the purchasing decision attribution as a moderating variable?

VIII. RESEARCH OBJECTIVES

a. To Investigate the relationship between utilitarian self-service technology performance and customers hedonic experience.
b. To explore if there a relationship between utilitarian self-service technology performance and customers hedonic experience, within the presence of the purchasing decision attribution as a moderating variable.

IX. CONCEPTUAL FRAMEWORK OF THE RESEARCH

This part of the investigation explains the relationships between the variables under focus in the study.

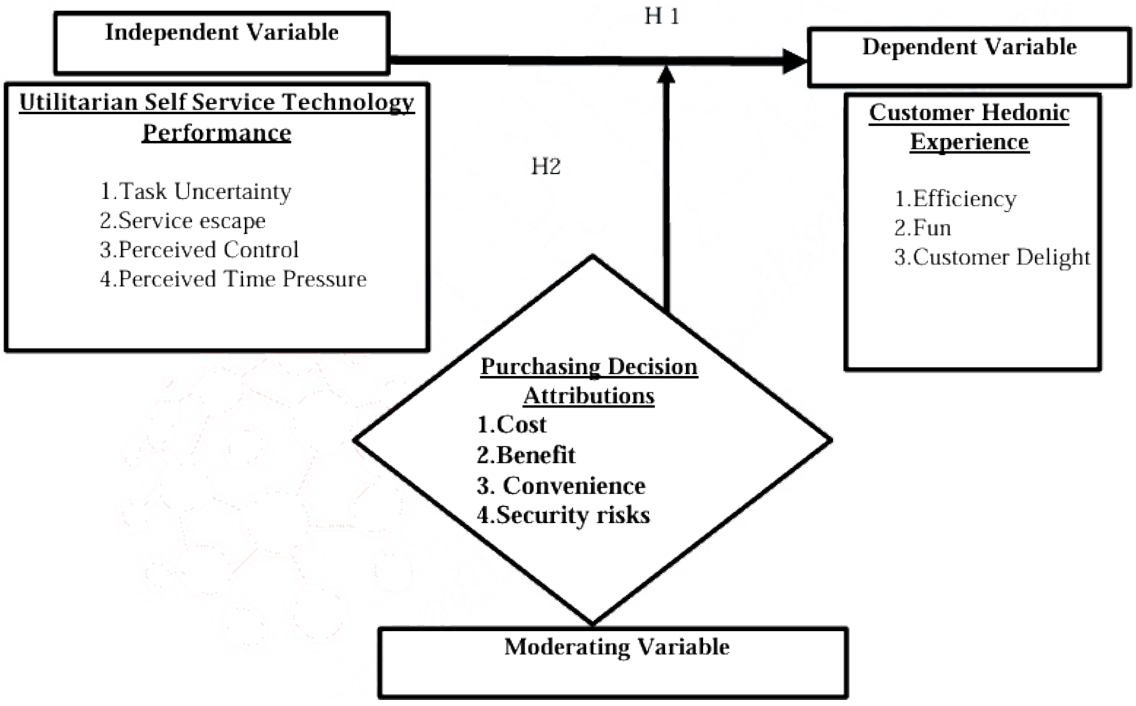

Figure (1): Research framework.

The conceptual structure of the analysis discusses one independent and one dependent variable. The independent variable sub-variables are Task Uncertainty, Service escape, Perceived Control, and Perceived Time Pressure, while the dependent variable's sub-variables are Efficiency, Fun, and Customer Delight.

X. RESEARCH METHODOLOGY

Research Methodology is "'a contextual framework' for research, a coherent and logical scheme based on views, beliefs, and values, that guides the choices researchers make". (Henseler et al., 2021)

It comprises the theoretical analysis of the body of methods and principles associated with a branch of knowledge such that the methodologies employed from differing disciplines vary depending on their historical development. This creates a continuum of methodologies that stretch across competing understandings of how knowledge and reality are best understood. (Henseler et al., 2021)

1. Research Method

This study will depend on quantitative research method.

2. Data Collection

Data collection is the process of gathering and measuring information on targeted variables in an established system, which then enables one to answer relevant questions and evaluate outcomes. (Stan, & Saporta, 2020)

Data collection is a research component in all study fields, including physical and social sciences, humanities, and business. The goal for all data collection is to capture quality evidence that allows analysis to lead to the formulation of convincing and credible answers to the questions that have been posed that consists of Secondary data and primary data.

3. Questionnaire Design

The questionnaire is adopted from several literature reviews; the content validity and the constructs validity will be conducted. All the statements in the questionnaire will be measured by using a Five-point Likert –type scale anchored at (1 = Strongly Disagree to 5 = Strongly Agree).

4. Research population

The research population will be all online e-commerce platform users who previously had the chance to go online and purchase any product or service (Bookings / Shopping / Payment gateway etc,.) from an online e-commerce platform (web site or a mobile application) in The University of Arab Academy For science, technology and maritime transport. the sampling unit for the research were students, teachers and Administrative employees of the University of Arab Academy For science, technology and maritime transport. The University of Arab Academy For science, technology and maritime transport is represented considerable authority in the maritime transport", and its declarations have been made identical to those allowed by Egyptian colleges. Their number is around 10,000 employee and understudies with a base age of 18 years of age, for the two genders (Males and females) who possess Smart cell telephones and used Utilitarian Self-service technology (Mobile application), at least once in the last six months.

5. Sample and sampling procedures

Sampling is how a few elements of a population can be chosen to fix that population (Tongco, 2007). The motive behind sampling is a sample community that helps the researcher to collect data about a whole population when confronted with time, money and energy constraints (Bostley 2019).

6. Sampling method

For the purpose of this research, probability sampling is used, as probability sampling leads to higher quality findings because it provides an unbiased representation of the population. Also, when the population is usually diverse: Researchers use this method extensively as it helps to create samples that fully represent the population.

7. Sampling type

Stratified Random Sampling will be used in the current study as it involves dividing the population into sub-population (strata) by ensuring every sub-group is properly represented in the sample.

8. Sample size

For descriptive analysis, a sample size of 6 percent of the total population 10,000 in this case is measured satisfactory (Bostley, 2019).

The sample size is constructed of 600 applicants selected according to stratified probability sampling technique within the university of Arab academy for science, technology, and maritime transportation within its two branches Cairo and Alexandria.

9. Sampling procedure

The sample will be divided into three groups (Students, Teachers, and Administrative employees) and they are all being sent a link via the internal communication network via the student portal "Moodle" or through the employees Staff Portal.

The following table previews all the Conceptual and Operational Definition for the research Variable

Variables	Conceptual Definition	Constructs	Items- refereed to
Independent Variable	Self-service technologies are defined as: "technological interfaces that enable customers to produce a service independent of direct service employee involvement" (Meuter et al., 2000, p. 50). Target population	1.1 Task Uncertainty	I clearly understood how the self-serve process worked within the mobile application I understand the sequence of steps to complete the transaction within the mobile application I understand what was required from me during the transaction to complete the purchase within the mobile application
		1.2 Service escape	I liked the layout of the web site / mobile application In general, the environment of the web site / mobile application is appealing
		1.3Perceived Control	I felt in control with the self -service option (doing the transaction without any help or support from the service provider)
		1.4 Perceived Time Pressure	I had the feeling that I need to hurry to complete the checkout process
Moderating Variable	Purchasing Decision Attributions, as pioneered by Heider (1958), Jones and Davis (1965), and Kelly (1972), attribution theory explains how people make causal explanations about events, as well as the behavioral outcomes or consequences of those explanations.	2.1 Convenience Attribution	I found no difficulty to select among different Payment methods (e.g. Credit card and cash on delivery) I found no difficulty to place Changes in my order Upon placing my order, I have received a confirmative reply I found no difficulty in accessing the online-Platform I found no difficulty in loading time
		2.2 Cost Attribution	I can easily compare prices between different online shopping platforms I can easily track my placed order
		2.3 Benefit Attribution	Using diverse web sites / mobile application made me learn how to shop online. The websites / mobile applications I use allow me to perform multiple transactions at the same time. (ex: paying electricity + internet and Phone bills on one single platform) I have access to product information and features I was able to share information with my social community via quick buttons. I had full control over my order I can reach the customer service easily

		2.4 Risk Attribution	I fear to receive a low product quality I fear sharing my personal data I fear that the ordered product/service will not arrive on time (Time risk) I fear that someone will hack my bank account (financial risk) I fear that the order will not arrive at all due to customs regulations
Dependent Variables	Customer Hedonic Experience, Forsythe et al. 2006 indicated that experiences as benefits of the online shopping is defined as hedonic, and the enjoyment aspects such as enjoyable, pleasant, and interesting experience over new experience	3.1 Efficiency	It allowed me to quickly get my good/service It requires little effort to complete my purchase transaction I find it an enjoyable experience
		3.2 Fun	I find it an entertaining experience I find it an interesting experience I find it fun while placing my order
		3.3 Customer Delight	I felt delighted after placing my order I felt happy after placing my order I felt excited after placing my order

XI. RESEARCH FINDINGS

It was found that there is a positive relationship amid the Self-Service Technology Performance and the Consumer's Hedonic Experience through the effect of both Service Escape and Perceived Control on the intervals. The Customer's Hedonic Experience; therefore, the following was shown:

H1.a There is a positive relationship between utilitarian Self-Service Technology Performance and Efficiency. Therefore, the first sub-hypothesis was accepted.
H1.b There is a positive relationship between Self-Service Technology Performance, and Fun. Therefore, the second sub-hypothesis was accepted.
H1.c There is a positive relationship among Self-Service Technology Performance, and Delight. Therefore, the third sub-hypothesis was accepted.

Main Findings
The structured model valid for use and has the following advantages:

1. The reliability of all constructs of the model measured by Cronbach's alphas has a higher degree.
2. All variables are positively correlated to each other, and there was a significant Relationship between all constructs at 0.01 level.
3. The value of both parameters of reliability and validity is more than 0.6. This means that the expressions of each variable are stable and the survey list measures what was intended to be measured and therefore well reflects the population subject to the analysis, so in the subsequent work it is possible to rely on the data. Analysis and statistical tests.
4. By measuring the median and the standard deviation, descriptive statistics of the study variables were performed to understand the general direction of the opinions and the knowledge of those variables by the respondents. The median was also calculated, and the Wilcoxon test was applied to confirm those opinions' general direction.
5. The general trend of the study sample's opinions tends to agree with all the intervals of Self-Service Technology Performance, as the values of all calculation means exceed 3.

6. The result of Wilcoxen's Test confirms this, as it was shown that the Median value of those intervals is greater than 3, and the Probability Value of the Wilcoxon test is less than the value of the significance level p - (α 50.0 = value = 0.000 <α), which confirms that the median value is more than three which expresses neutrality. Therefore, we conclude from the Wilcoxon Test that the study sample's opinions approve of Self-Service Technology's performance.
7. The general trend of the opinions of the study sample tends to agree on all the intervals of the Attributions of the Purchase Decisions, as the values of all arithmetic means exceed 3, and the results of the Wilcoxon test confirm this, as it was found that the median value of those intervals exceeds 3.
8. The Wilcoxon test's probability value is less than the value of the level of significance p-value = (α 50.0 = α <0.000), which confirms that the median value is more than three, which expresses neutrality. Therefore we conclude from the Wilcoxon Test that the study sample's opinions approve Attributions of Purchasing Decisions.
9. The general trend of the study sample's opinions tends to agree with the Customers 'Hedonic Experience, as the Arithmetic Mean's value exceeds 3, and the result of Wilcoxon's Test confirms this, as it was found that the value of the mediator exceeds 3.
10. The Wilcoxon test is smaller than the moral value (p-value=0.000< alpha=0.05) alpha, which confirms that neutrality is represented by a median value greater than 3. Therefore, infer from the Wilcoxon Test that the views of the research sample approve of the Hedonic Experience of the Consumer.

XII. PRACTICAL IMPLICATIONS

The findings of this research also provide important evidence for managers when creating and implementing utilitarian mobile apps to improve the service being provided for the clients with best delightful level of experience. The examination gives a few functional consequences to online retailers. First, online retailers should highlight the utilitarian parts of their shopping sites contrasted with passionate viewpoints. Online retailers ought to give an agreeable and easy to use site interface. A site design that is not difficult to work on urges buyers to create buy inclinations as buyers need to cash. Essential data is likewise a fundamental part of web-based shopping conduct. Definite data about the items diminishes the equivocalness that the buyers may have about the item's exhibition.

• Besides, essential data likewise urges shoppers to embrace useful assessments of the item. Saving or markdown plots upgrade the positive assessments of an item in financial investment funds, which is perhaps the primary driver of internet shopping.
• Retailers should focus on the internet shopping stages for their business that gives time and area convenience. By consolidating these practical credits, online retailers can pull in a few online customers to their web-based shopping sites to acquire an upper hand over their adversaries. Second, albeit the effect of hedonistic ascribes of internet spending sites is less noticeable than that of utilitarian credits, online traders ought not to overlook the effect of hedonic ascribes on customers, driving them to buy on the web. A few purchasers deliberate spending an agreeable encounter and concentrate happiness and fun out of this movement. In this manner, online retailers should give social communication, limited arrangements, costs, and job shopping on their shopping sites to pull in more clients.
• This current examination's outcomes offer significant down-to-earth and administrative ramifications to comprehend the client's demeanour towards using Utilitarian Self-Service Technology Performance regarding Loyalty and Behavioural Intentions. In such manner, the service associations need to pay serious actions to comprehend the elements that may fulfil or disappoint customers utilizing structures.

• Businesses should retain up exclusive risk and security procedures to accomplish more projecting inevitability over the mechanical interface. The more the self-service worth, the greater the customers' prospects of receiving the Utilitarian Self-Service Technology Performance This research's also gives bits of knowledge to Egypt's service firms to put more in new advances. As the service firms' future generally relies upon mechanical advancement, they serve their client better. As the coming time is innovative, the organizations should give escalated consideration to improve their client experience utilizing the high-level automatic interface. This would be a fundamental factor for that company's prosperity, and it will likewise improve client faithfulness and positive conduct expectations.

Practical Implications Action Plan		
Recommendations	How to implementation	With whom
1. Online retailers should highlight the utilitarian parts of their shopping sites contrasted with passionate viewpoints.	A site design has to be featured with simplicity and fun to avoid difficulty and board while shopping trying to reach the services being provided online.	Web site developers that have deep experience in the User interface and User Experience
1. Online retailers ought to give all information about the product or services being provided.	• Essential data is likewise a fundamental part of web-based shopping conduct. • Definite data about the items diminishes the equivocalness that the buyers may have about the item's exhibition.	Web site developers that have deep experience in the User interface and User Experience
2. Retailers should focus on the internet shopping stages for their business that gives time and area convenience.	• Limited arrangements for transaction fulfilment • Cost efficient than brick and mortar model	Online Users "Customers"
3. Online platforms owners should retain up exclusive risk and security procedures	This will help to accomplish more projecting inevitability over the mechanical interface.	Online Users

XIII. CONCLUSION

This research began with the experimental research to help find what was not concentrated before in the different studies. The exploratory research is not utilized to give some convincing proof yet helps understand the issue more productively. A portion of the mainstream techniques for experimental research design incorporates writing look, profundity talk with, centre gatherings, and case investigation.

This research also supports the critical and positive association between Utilitarian Self-Service Technology Performance service value and social expectations. These results are reliable, with past observational investigations introducing the positive association amid self-service worth and social expectations. The consequences are likewise sure and huge in the association among Utilitarian Self-Service Technology Performance worth and consumer reliability. The outcomes show that data satisfaction and social advantage are the huge variables influencing a purchaser's website responsibility in a web-based shopping setting. This outcome is reliable with the earlier research on duty in the assistance setting, which recognizes fulfilment, trust, and social advantages as predecessors of responsibility. Also,

data fulfilment strongly affects responsibility; along these lines, this outcome brings up the significant part of data fulfilment to building purchaser responsibility in an internet shopping setting comparative with this present reality administration.

This stretches beyond research, suggesting that fun may be a fundamental predecessor to self-service insight mentalities. Organizations have started to take advantage of implanting fun into a self-service experience, for instance, Talabat is an online application for self-serve food where customers can order their food from different options and Restaurants for others to try. The request works to make the food requesting measure enjoyable while allowing customers to trial and give companions as well.

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Renewable Energy Based, Sustainable Multifunctional Ecosystem Service

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ABSTRACT

Adapting to the challenges of global climate change requires a new way of thinking in all areas of life. The use of renewable energy sources can provide an opportunity to reverse the negative spatial processes that have occurred in the past, often as a result of careless human interventions, and to create a healthy ecosystem service. There are many uses for a site, and coordinating them requires careful development and sustainable land use planning. The case study of the Rétköz lake in northeastern Hungary illustrates a habitat rehabilitation project where several human uses have been coordinated in the conservation and restoration of the natural environment. As a consequence of climate change, the good condition of the habitat can now only be maintained artificially, with the use of renewable energy sources playing a key role. The rehabilitation and sustainable management of the Rétköz lake is a model for resolving land use conflicts and providing a rich ecosystem service powered by renewables. The pilot project has produced positive results that were not expected, which could create an opportunity to reform the water management of the Tisza Valley for multiple purposes. The welcome increase in renewable energy-based energy production technologies could provide a good opportunity for sustainable management. The hypothesis of the long-term research is that the water system of the Tisza Valley can be adapted to the expanded needs, partly by partial restoration of the former aquatic ecosystem and by modification of the existing infrastructure. The energy needs of the system can be met by locally available renewable energy sources, providing a sustainable multifunctional ecosystem service for the environment, economy and society. The aim of this research is to prove the above hypothesis.

Keywords—ecosystem service, landscape utilization, renewable energy, sustainability, water management.

I. I. INTRODUCTION – RAISING A PROBLEM

As a consequence of global warming, the Carpathian Basin is affected by increasingly extreme precipitation patterns and heat waves, causing frequent droughts, not only in summer [1]. A large part of the basin is threatened by desertification, with unforeseeable consequences, but certainly with enormous environmental, economic and social damage [2]. There is therefore a need to increase the region's resilience and contribute to meeting global climate targets [3]-[5]. Long-term research is exploring the potential for creating a complex ecosystem service based on the use of renewable energy sources to address this problem, with sustainable results.

This large-scale research concerns the Tisza valley, which is a river that carries a significant amount of water, but due to the river regulation of the last two hundred years, most of this water flows through the Hungarian Great Plain without being used. Due to changing climatic conditions, this water is now much missed by the region's wildlife and economy. The question arises as to how the former water management system, which was designed to quickly drain away floodwaters, can be reformed to serve complex purposes, i.e. to protect against flooding, while at the same time providing water storage capacity for periods of drought, to serve as a near-natural habitat and to be sustainable. This paper presents the first phase of the research and its results. This first stage was the rehabilitation of the intertidal lake, which yielded unexpected results, validated the research hypothesis, generated further ideas and thus became a pilot project for comprehensive studies.

The case study, Lake Rétköz, fell victim to changing climatic conditions in 2014. Due to drastically reduced rainfall, the lake was left without water and dried up. Human intervention was needed to save the aquatic habitat, but sustainability could only be ensured artificially, which posed significant challenges. One of the key challenges was to provide the energy needed to replenish water. In parallel to the above-mentioned problems, a process of energy transition is taking place worldwide, including the rapid expansion of weather-dependent renewable energy sources [6], whose rapidly increasing installed capacity is also taking a growing share of the Hungarian energy mix [7]. The energy surplus in favourable weather situations is simultaneously causing energy storage problems in the Hungarian energy system [8]. At the same time, the utilisation of 'surplus' electricity can offer a sustainable solution to the energy needs of water management. In this way, energy can be converted into a resource.

A. The aim of the pilot project

The objective of the long-term research is to determine the water retention capacity of the Tisza Valley based on the quantifiable results and empirical experience of the Rétköz Lake, by partial, multi-purpose restoration of the natural aquatic world and by assessing the potential other storage capacities [9]-[12]. To determine the locally available renewable energy potential, the energy demand for operation and the amount of available and to be integrated capacities for sustainable operation of the complex ecosystem service. The research, as a model project and a pilot laboratory, is based on the rehabilitation of the Rétköz lake, which has based the potential for the development of a multi-purpose aquatic ecosystem service in the Tisza valley on locally produced renewable energy sources for its long-term sustainability.

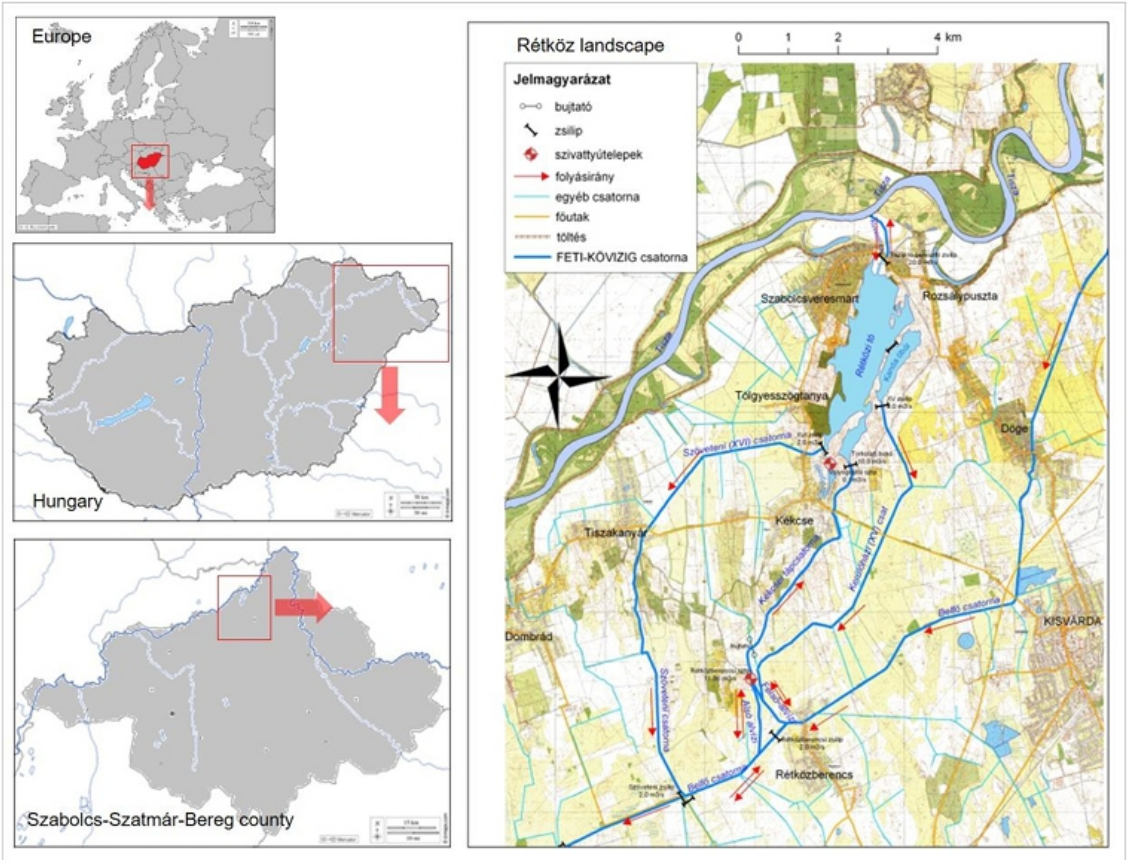


Figure 1. The examined geographical area and water management plan of the Rétköz [14]

II. BACKGROUND

A. The geographical area under study, determination of the territory

The area of the pilot project is located in the Great Plain, Upper Tisza, Rétköz, a small area of about 560 km2 [13] (Fig. 1). The area is a contiguous low-lying area, heavily dissected by water, which receives its water supply from the flood waters of the Tisza (Fig. 1). The Danube and the Tisza, the two main rivers shaping the alluvial plain of the Carpathian Basin, transport significant amounts of water to the area [15]. Historically, the fluctuating rainfall distribution in the Tisza catchment area has resulted in frequent floods on the river, which have left large areas of the basin permanently or intermittently under water [16] (Fig. 2). Extensive river regulation works, which started in the 19th century, narrowed the previously large floodplains, especially on the Tisza, and aimed at rapid drainage of the floods and increased agricultural land [17]. This has affected the loss of both surface and groundwater resources. In the second half of the 20th century, a network of irrigation canals was built to supply water to the unwatered, drained flood plains, and groundwater was intensively exploited.

In the period before the current climate change, irrigation water was supplied through the sewer system. Over the last few decades, however, water levels have been falling, threatening the water supply, while the river carries a still significant amount of water through the basin. The water management system in the Tisza Valley is therefore based on past climatic characteristics and is no longer able to meet today's challenges.

III. HISTORICAL BACKGROUND

A. Regulation of the Tisza and its tributaries

Before the regulation of the Tisza, the floodplain of the river and its tributaries, fed by floods, formed a coherent system of marshes, swamps and meadows, an aquatic habitat rich in species. As the needs of the growing population increased, more and more land was brought under cultivation. From the 1700s onwards, damming, drainage and meandercutting to speed up the flow of water were therefore undertaken. By 1879, a total of 112 dams had been completed on the lowland stretch of the Tisza. The total length of the river was reduced from 1,419 km to 962 km, i.e. by 38%, and tens of thousands of square kilometers of cleared floodplain were made arable.

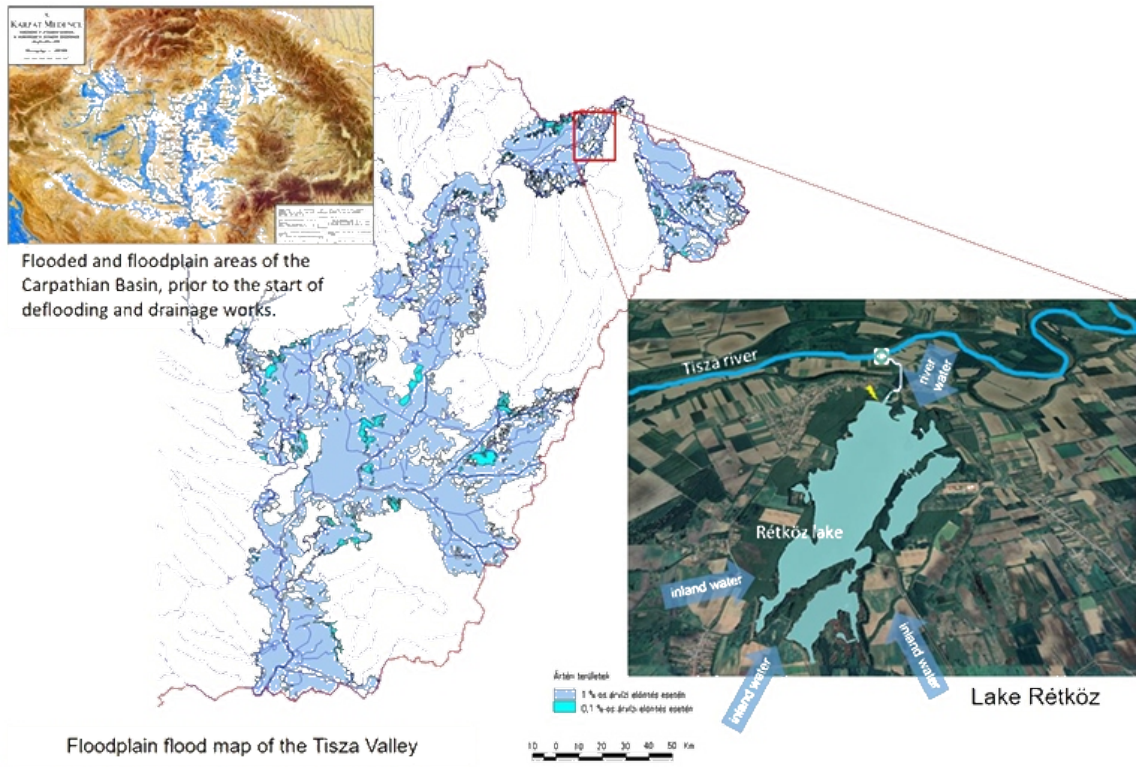


Figure 2. Water-covered and flood-prone areas of the Carpathian Basin, before the start of relief and drainage works [18].

In 1863, unlike the floods, there was a drought, which proved the need to build a network of irrigation canals. Another problem was inland flooding, as the embankments built, while protecting the area from flooding, prevented the inland waters that had accumulated behind the dams from flowing into the river. However, inland water damage was a problem until the 1970s. The area of the Rétköz lake was converted into a reservoir in 1990. Between 1998 and 2001, four consecutive record floods drained the Tisza, causing significant damage. This led to the development of the Vásárhelyi Plan, which aims to improve the water carrying capacity of the Tisza, revitalise the natural values of the floodplain and build six tidal reservoirs to break the peaks of flooding that can no longer be contained by dams by releasing water into less valuable areas. This last major plan for the Tisza represents the most complex thinking to date, with the objectives of rural development, nature and environment protection, ecotourism and recreation, in addition to flood protection and agricultural interests.

B. Regulation of the Rétköz

The watercourses and lakes of the Rétköz were drained in accordance with the regulation of the Tisza, and the Belfő Canal (the main drainage canal), built between 1860 and 1880, drained the water. The inland drainage works undoubtedly resulted in a large amount of deflooded farmland. At the same time, the drainage systems of the late 19th and early 20th centuries sought to drain the lowest-lying areas and impose inhospitable farming practices on them. As a consequence, in many areas, inland water reoccupying the areas of old lakes and watercourses during the rainy season caused problems. In 1989, the decision was taken to create the Rétközi lake (also known as the Szabolcsveresmart reservoir) as an inland water reservoir to deal with the inland water situation in the settlements of Upper Szabolcs. The conditions necessary for the protection of the wildlife of the Rétközi lake nature reserve are thus inseparable from the function of the Rétközi lake as a reservoir, since the formation and existence of this particular wildlife has been ensured for thousands of years by the presence of water in the area, i.e. inland waters.

However, the creation of the Rétközi lake in 1989 was not for the purpose of wildlife restoration, but specifically for inland water protection. As a reservoir, the lake was integrated into the Upper Szabolcs inland water protection system, so the inland water protection function could not be ignored in the design and implementation of the habitat protection project. One of the specificities of the project was that the inland water protection regime was not an obstacle to the implementation of the project, but rather a facilitator, provided that the water protection aspects were taken into account. The technical solutions of the project were therefore designed with this aspect in mind (Fig. 1).

IV. DATA AND METHODS

The research uses interdisciplinary knowledge, empirical methods, empirical and estimation methods for renewable energy production, and geospatial methods.

A. Technical parameters

Lake Rétköz is the most important reservoir in the Upper Tisza region, built in 1990. The lake has a volume of 10.2 million m3 at the working water level and a surface area of 4 km2. The lake and its surroundings are a nature reserve, which is important for the wildlife of the whole Upper-Sabolsk region.

The lake is almost entirely supplied by the Tisza river, by gravity. However, the low water level of the Tisza over the last few years has made it no longer possible to draw water from the Tisza. The less important water recharge option is the discharge of inland water from the agricultural areas in the southern foreshore of the lake into the lake. However, this option was also not available during periods of low rainfall. By 2014, the water level in the lake had steadily decreased and then dried up completely. Due to the lack of water for many years, the original aquatic and riparian vegetation was degraded, invasive and ruderal species overpopulated, gradation processes took place and the original aquatic fauna was destroyed.

B. External technical installations on the Rétköz lake

The drainage of the inland waters of the Upper-Sabolac area into the Tisza is achieved through the main channel Belfő and the Rétközi lake (Fig. 3). The Rétközi lakereservoir is located in the upper inland water catchment area of the Upper-Sabolac inland water system, behind the left bank of the Tisza, in the area bordered by the villages of Szabolcsveresmart, Kékcse and Döge. It is bordered by natural

landforms and hills, except in three sections where artificial barriers have been built. An inlet sluice is built into the Tisza flood protection embankment near Szabolcsveresmart to allow the inland water from the reservoir to be gravity fed into the Tisza, and to allow the lake bed to be filled or refreshed from the Tisza.

C. Tisza out- and inlet water lock

The lock is located at the 47+050 fkm section of the Tisza embankment. The sluice is designed for two-way water transfer under suitable water level conditions in the Tisza and its reservoir. The water transfer capacity is 20 m3/s in both directions. Its function is to discharge incoming inland waters by gravity into the Tisza River when the water level of the Tisza allows it; to exclude flooding of the Tisza River, to provide living water in the Rétköz Lake by means of a suitableopening; and to drain the reservoir to the Tisza River. The average water depth of the reservoir at operating water level is 215 cm. The ideal operating water level is between 250 and 300 cm, depending on the prevailing tidal and inland water conditions (Table 1).

Table 1. Basic data on Lake Rétköz as a reservoir

	altitude above sea level (mBf[1])	**water level** (cm)	**water mass** (millió m^3)	**water surface** (ha)
Maximum water level	100.30	350	10.26	400.21
Operating water level	99.80	300	8.31	378.18

D. Definition of the problem – Critical water shortage along the Rétköz lake

The threshold level of the Szabolcsveresmart inlet canal was higher than the current water level of the Tisza, so that the problem of ensuring a constant supply of water to the lake had already been identified (Fig 3).

When the Rétköz lake bed as a reservoir was flooded in 1990, there was no Tisza tidal surge to fill the lake throughout the year, so the lake was fed by portable pumps through the outlet canal. The first full filling took place in early 1991. Experience from the 1990s shows that, in the event of a tidal surge on the Tisza River reaching stage I readiness, the empty reservoir can be filled to operating water level in 4-5 days. The amount of water pumped into the lake depends on the hydrological situation. Between 1990 and 1996, the period was characterized by drought, so there were several years when it was not possible to release water into the lake. In the year 1997, which was richer in inland water, 5.9 million m3 , in 1998 13.0 million m3 , in 1999 25.0 million m3 and in 2000 6.0 million m3 of inland water were released into the lake.

The first critical situation occurred in 2003, when low water levels in the Tisza River prevented water from entering the lake after it was filled in early January, and the water level dropped from 250 cm to 36 cm by autumn.

From 2010 onwards, the higher water levels of the Tisza were regularly absent, so that during the period of generally low precipitation, the lake was not replenished either from the Tisza or from inland water. Water experts have been working to create fish beds by deepening the canal network. However, by June 2014, mass mortality had already begun in the channels in the lake bed. By July 2014, the lake bed had dried up completely and the water cover in the inner channel network had disappeared.

Figure 3. Processes and causes of the drying up of the Lake Rétköz

E. Conditions for restoring the lake and its wildlife

In order to meet the needs of the flora and fauna in the pond, it is essential to maintain a constant water level close to the operating water level. During low water periods, there is no possibility of gravity recharge either from the Tisza or from the surrounding agricultural land. Only the Tisza river can be considered for pumping. In the driest years, 6.0-8.0 million m3/year of Tisza water could be needed. The maximum daily evaporation and seepage losses during the critical periods, including the years 2006-2014, are 2.0-2.5 cm/day, corresponding to 87,500 m3 Figure 3. Processes and causes of the drying up of the Lake Rétköz removal of harmful silt by dredging the lake bed, restoration of embankments, embankments and protection works, and rehabilitation of the water level control structure. The project started in autumn 2015 with a budget of approximately €2.7 of water (≈1000 l/s in continuous flow).

F. Methods of physical implementation – Restoration and recharge of the Rétköz lake for habitat protection

The title of the project is "Restoration and rewatering of the Rétköz lake for habitat protection". The project was implemented by the Municipality of Döge with its consortium partners, the municipalities of Kisvárda, Kékcse, Szabolcsveresmart, the Upper Tisza Water Management Directorate (FETIVIZIG)

and the Faculty of Technology of the University of Debrecen. The aim of the project is to build a water intake and a water level control structure to ensure continuous water supply, and to stabilise the service and damage control roads leading to the structures. Rehabilitation of the facilities related to the maintenance of the lake bed, removal of harmful silt by dredging the lake bed, restoration of embankments, embankments and protection works, and rehabilitation of the water level control structure. The project started in autumn 2015 with a budget of approximately €2.7million.

During the project, the participating municipalities carried out their general administrative tasks [19], including local environmental and nature protection, water management, water damage prevention, disaster management, economic organisation and tourism. During the planning and implementation of the project, the areas surrounding the lake and its surroundings were managed on the basis of their environmental and economic use classification, and then adapted to this in the future to implement the ecotourism-related improvements that are essential for the presentation of the natural values of the lake and for scientific research.

G. Planned costs of operation

The largest share of the operating costs is the cost of water replacement. The cost used as the basis for the calculation of the operating costs for water replenishment, the cost of transferring 1 m3 of water to fill the interstitial lake, is 7 euro cents/m3. The cost includes the loss of pumps and maintenance costs, but excludes other losses such as leakage and evaporation. The data were used to calculate the cost of transferring water to fill the interluve of the Rétköz lake.

Daily, monthly and annual data were examined for the calculations (Fig. 4). The table is based on the hydrological analysis of the FETIVIZIG Hydrological and Data Analysis Department, taking into account the average and maximum water levels and water mass variations measured over the period 1991-2014.

Daily, monthly and annual water pumping costs for the Lake Rétköz

Month	The mass of water pumped into the lake – water mass reduction (m^3)	$1m^3$ water pumping cost (euro/m^3)	Water pumping cost in July (euro)	Water pumping cost / month (euro)	Water pumping cost / summer months (euro)	Total cost of annual water pumping (euro)
July	860 000	0.007	6,254	202		
Juni August (3 months)	2 277 611	0.007		180	16,564	
January-December (12 months)	6 254 265	0.007		1,353		45,486

Figure 4. Dredging of the lake bed and the installation of a pumping station at the mouth of the inlet channel to the lake. The costs of maintaining the permanent water security of Lake Rétköz.

H. Ensuring sustainable operation through renewable electricity generation

To ensure the multi-purpose use of the reservoir, it is essential to maintain a near-constant level of operating water throughout the year, which can only be achieved by the construction of a permanent pumping station. The project included the construction of a pumping station on the left bank of the Tisza river, consisting of three pumping units with a total capacity of 206 kWp, which can ensure a continuous water supply to the lake even during dry periods (Fig. 4). The project was completed by the end of 2015. In 2016, after the operational tests of the completed pumping station, the lake was filled to its operating water level in a trial run that started in mid-August.

The pumping station is operated by electricity, and its continuous operation imposes a significant financial burden on the operating water management board (Fig. 4). In order to minimise the operating costs, the possibility of providing the electricity demand of the pumping station by means of a photovoltaic system was considered. The idea proved to be a good one after careful calculations and software calculations [20]. The calculations showed that a solar PV system installed next to the lake could generate a significant part of the electricity needed to run the pumps. Since the park would also operate when the pumps are at rest, the electricity generated could be fed back into the national electricity system and sold to the universal electricity supplier. The approach towards economic and environmental sustainability has been supported by the Hungarian government [21]. The preparation of the project started in August 2016 and in June 2017 a 200.2 kWp grid-connected solar PV system with installed capacity was installed near the Rétköz lake (Fig. 4). Based on the operational experience of the past 6 years, the PV system has delivered positive results. The plant has been able to supply the electricity demand of the pumps every year and the amount of electricity overproduced and fed into the grid has generated an additional annual average income of 10,000 euro for the operator FETIVIZIG.

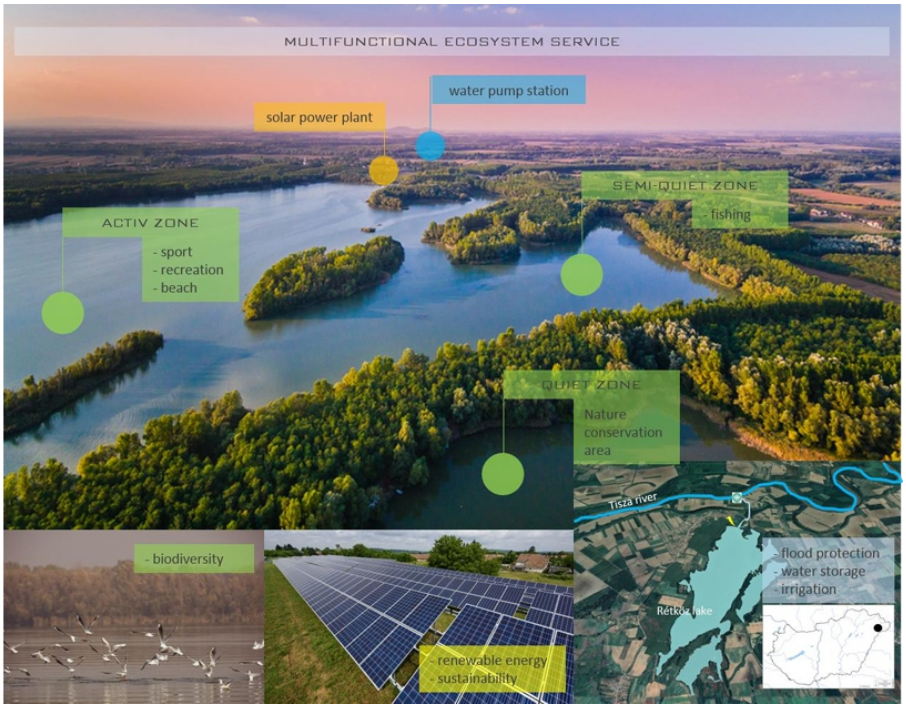


Figure 5. The Lake Rétköz pilot project. Allocation of land according to use.

I. Complex recovery without land use conflicts

To achieve multifunctional use of the aquatic ecosystem, several, often difficult to reconcile, needs had to be met in one geographical location and at one time. In order to avoid conflicts, three zones were created to take advantage of the natural divisions of the lake basin (Fig. 5):

1. The largest basin of the lake hosts the so-called active zone, where active human activity is present. These activities include water sports, beach, bicycle tourism, fishing and other recreational tourism activities.
2. the semi-western zone, the middle basin of the lake, also known as Kanda Bay, where nature is present and fishing is the only activity.
3. The third basin of the lake is the resting zone, where all human activity is prohibited, and this part of the lake is a nature reserve with a high degree of protection, closed to visitors.

V. REULTS

Having met its basic objective, the rehabilitation of the Rétköz lake has delivered results beyond expectations, in terms of water management, nature conservation and sustainability. In addition to the above, the multifunctional ecosystem service created has also generated a wide range of social, economic and cultural benefits:

A. Water management results

The water management rehabilitation of the Rétköz Lake has been completed as intended, with the installed pumps and sluices maintaining a constant operating water level. The water body of the lake, with its controllable water level control, serves regional water management purposes: flood protection, irrigation water storage, inland water drainage, nature conservation, tourism, municipal and other economic water supply.

B. Natural protection results

Thanks to successful rehabilitation, the Intertidal Lake will ensure the ecological water needs of aquatic habitats are met, the extent and integrity of the lake is maintained, habitat mosaicism is maintained, open water areas are preserved, degraded habitats are restored, and bird migration and feeding sites are restored. The project has made it possible toprovide visitors to the area and the population of the surrounding municipalities with an appropriate level of information, to promote a conservation approach and to develop and implement educational and ecotourism programs. To this end, facilities have been built to promote the lake as a place to learn about nature, such as a visitor center, a nature trail, a boat landing stage, a boathouse, accommodation and a forest school.

C. Economic results

The water management and conservation achievements are outstanding in themselves, but the restored aquatic ecosystem provides additional economic services. Inland water and the reservoir of the Tisza provide a balanced agricultural water supply, an aesthetic and high quality landscape environment for a wide range of tourism activities such as water sports, recreation, ecotourism, fishing and cycling.

D. Realizing climate targets

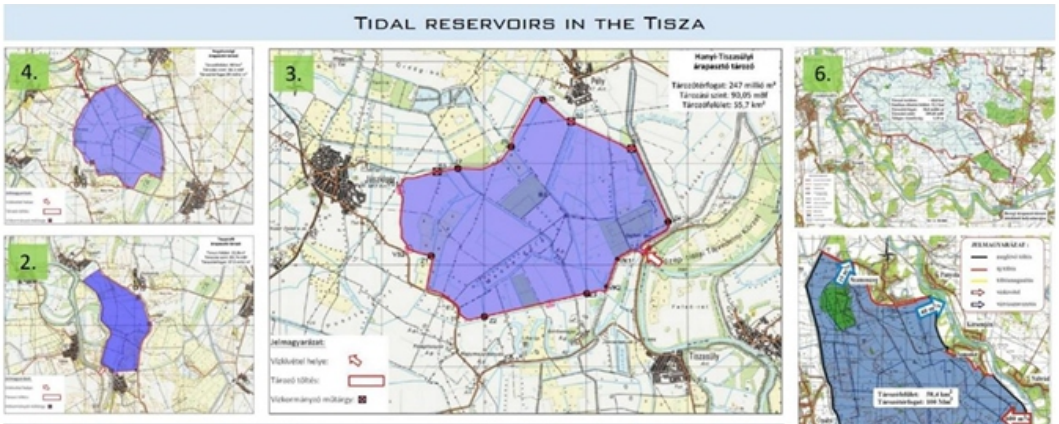
Water security and a renewed and preserved natural environment provide invaluable climate services. It has a significant CO2 sequestration and oxygen production capacity, tempering the local microclimate and stabilising groundwater levels.

E. Sustainability

The achievements listed above already contribute to environmental sustainability. However, in order for all elements of the project to operate in a sustainable manner and to provide a healthy, multi-purpose ecosystem for continued service, two essential conditions had to be met. One is to ensure a constant water level in the lake and to provide the necessary energy from renewable sources. Thus, Lake Rétköz can be considered as an economically, ecologically and energetically sustainable pilot project with a high level of success.

VI. CONCLUSIONS

Geography is characterised by complex thinking, a broad vision and a systemic approach to problems. The new perspective is a synthesis of the results of different disciplines, an extension of a concentrated disciplinary vision. Geography, with its comprehensive knowledge, contributes with its "Earth-system managerial" thinking to the development of a well-functioning system with broad benefits. It aims at a beneficial, healthy and sustainable functioning of the whole system, while providing an effective response to regional and local issues of adaptation to the adverse effects of climate change. The solution to the local problem and its unexpected positive experience could create opportunities for regional application and a rethink of water management in the whole Tisza Valley and the Carpathian Basin. Based on the positive results of the pilot project, further studies will be launched to determine how much water can be retained, how much energy is required to manage the water and how this can be achieved using only locally available renewable energy sources.



	Name of the reservoir	Area (km²)	Water storage capacity (millió m³)	Year of putting into operation
1	Cigánd-Tiszakarád	24,7	93	2008
2	Tiszaroff	22,8	97	2009
3	Hany-Tiszasüly	56	247	2012
4	Nagykunság	40	99	2013
5	Szamos-Krasznaköz	58,4	126	2014
6	Beregi	60	58	2015
7	Tisza-Túr	42	16	2022

Figure 6. Data on the tidal reservoirs constructed under the Further Development of the Tarns Plan programme.

A. Water storage options

The Tisza valley offers a number of opportunities for the retention and strategic storage of water carried by the river.

The river bed

One of the most obvious options for storing large quantities of water is the Tisza riverbed itself. Three hydroelectric power plants were planned on the Tisza from the 1950s onwards, of which the Tiszalök and Kisköre power plants were built. Both power plants are capable of retaining a significant volume of water from the riverbed through the irrigation canal system in the lowlands to the former flood plains, thanks to their damming. However, the third power plant, in Csongrád, has not been completed. If built, the power plant could retain a significant amount of water in an additional 157 km of riverbed and in the reservoir areas bordering the river. However, at present, during periods of drought and low water levels, the Tisza acts as a drainage channel, causing water-logging and further reducing groundwater levels in the surrounding agricultural areas, exacerbating water supply problems. Below Kisköre, the next power plant is the Novi Bečej hydroelectric power plant in Serbia, which has a back-pressure effect as far as Csongrád. The Csongrad dam is therefore missing from the system and its construction is justified.

Mortlakes

The Tisza was regulated by 112 cut-throughs. The river meanders that were cut and the meanders that were naturally dammed in the pre-regulation period now form some 200 mortlakes along the Hungarian stretch of the Tisza, which could provide additional significant reservoir capacity.

Tidal reservoirs

Seven tidal reservoirs have been completed under the Further Development of the Vásárhely Plan (Fig. 6). These reservoirs are mainly used to break down flood peaks. Since their construction, only the Tiszaroff reservoir has required flood protection filling in June 2010. However, these reservoirs could also be used to store water from lower tides during drought periods. During floods, water flows gravitationally into the reservoir through the sluices. However, pumping stations are needed for small-scale recharge.

Soil

By periodically flooding floodplains and reservoirs (1-2 months), significant amounts of water can be stored in the soil. This method can be used to raise the ground water table and increase soil water reserves for summer drought periods.

Irrigation canal system.

The water of the Tisza is supplied to the exempted agricultural land by an extensive system of irrigation canals. The length of the system fed by the Tisza water reaches 1000 km, providing the potential for significant additional water storage capacity.

Danube - Tisza canal.

The Danube-Tisza canal is an artificial canal in the northern part of the Kiskunság region, which was planned several hundred years ago and of which only 22 km have been built. Its extension has been considered several times for both navigation and water replenishment purposes. The gradual drying out of the Kiskunság sandflats and the changing climate have led to a significant reduction in groundwater levels, threatening the landscape with desertification. Its construction is therefore justified on both environmental and economic grounds.

Aquifer sedimentary rocks.

During the accumulation of the Carpathian Basin, several kilometres of sediment have accumulated,

which has a
significant water storage capacity. A significant part of the aquifer water stored here can be considered as fossil, due to the rate of recharge measured in human time scales. At the same time, significant quantities of water are extracted from groundwater reservoirs. If future extraction continues at current levels, these water supplies will need to be replenished to ensure sustainability. This can also be done by injecting water from the Tisza after purification.

B. Renewable energy sources options

The mechanical movement of water required for reservoir capacity utilisation and water steering is a significant energy demand. The use of weather-dependent renewable energy sources, essentially wind and solar, can put the calculations of the return on high-cost water investments on a new footing. Based on the experience of Lake Rétköz, several options should be explored in the later stages of research:

Solar and/or wind power plants installed on the water movement site

The solar power version of this option is entirely similar to the one used at the Interlake Rétköz site, where the solar power plant was installed specifically to power the pumping station. In addition to the solar plant, a vertical axis wind
turbine can be used, which does not pose a threat to birdlife. In order to avoid the adverse effects of the energy price movements in 2022 and 2023, it is appropriate to consider a combination of renewable energy sources. A solar/wind hybrid power plant could help to achieve more balanced production. The deployment of local energy storage capacity should also be considered to further strengthen off-grid and balanced generation.

Capturing energy surplus in the operation of the water management system

The share of weather-dependent renewable energy sources in the energy mix is increasing dramatically. However, they have the disadvantage of over-generation in favourable weather conditions, which poses a significant challenge for electricity system managers to capture, transmit or store. In 2023, there were several events on the Hungarian energy exchange where the energy price had a negative sign. In the water management system, especially for the transmission of water for storage, the energy demand is not "just in time". This can be an advantage when the green energy price on the energy exchange is zero or negative. This electricity can be put to good use to provide the energy needed to stockpile water reserves.

If the hypothesis of the research is confirmed, this comprehensive renewable energy-powered water management could serve as a model for many other regions of the world facing similar challenges.

VII. SUMMARY

One element of adapting to the challenges of climate change is to put water management in the Carpathian Basin, including the Tisza Valley, on a new footing. The new challenges require a multifunctional transformation of the water management system. This must be done with a complex vision that can be operated sustainably and have a positive impact on the environment, the economy and society. Locally available renewable energy sources have a key role to play in this. The first element of the large-scale research presented in this study, the rehabilitation of the Rétköz lake, has produced results beyond expectations, becoming a starting point and a pilot laboratory for research at regional level. The

pilot project has confirmed the hypothesis that the aquatic ecosystem can be managed as a near-natural landscape with sustainability considerations and with moderate and careful use. The complex ecosystem service created is also a positive response to the adverse effects of climate change.

VIII. ACKNOWLEDGEMENTS

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How can Venture Capitalist Behaviour be Learned and Trained? - The Co-Evolutionary Function of Start-up Financing

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ABSTRACT

The financing of start-ups through venture capital is a considerable challenge. In the context of entrepreneurship education and the lived practice of entrepreneurship, the topic is often not discussed enough in terms of the importance of competence development (ability and willingness). This must be done on the part of both entrepreneurs and venture capitalists at different levels of learning in order to enable a fruitful interaction between investors and founders. In order to illuminate the connections between theory and practice, the conceptual paper examines what academic basis can be laid for entrepreneurship education in order to focus on the co-evolutionary learning of start-up founders and investors at different levels. Based on a systemic-evolutionary approach, it is shown that methods in entrepreneurship education can be tailored even more specifically to the needs of the actors. In addition, a curriculum for developing investor expertise in the venture capital context is presented on this conceptual basis.

Keywords: Business Angels, Co-Evolution, Entrepreneurship Education, Evolutionary Learning, Start-up, Venture Capital.

I. I. INTRODUCTION – RAISING A PROBLEM

Joseph a. Schumpeter believed that it is possible for 'real bankers' to channel economic surplus units into innovation-related deficit units. He ascribed to them special financial entrepreneurial skills and characterised their achievements as highly specialised work in which top performance through experience as well as intellectual and moral qualities are decisive. Schumpeter also refers to the historical validity of his financing theory, using the example of the financial entrepreneurial initiative of the Pereire brothers (founders of Crédit Mobilier in the 19th century). Nowadays, however, it is undisputed that banks (now) find it difficult to finance start-ups in their early phases. Informal financing is responsible for the majority of financing in the seed and start-up phases. These pave the way (together with the possibilities of crowdinvesting and public funding) for formal financial instituitions. Based on this, the question can be asked to what extent the investor behaviour of potential venture capitalists (Vcs), respectively business angels can be learned and trained in order to strengthen the potential and thus the regional development and reproduction dynamics?

II. VENTURE CAPITAL AND BUSINESS ANGELS

The theoretical and empirical basis for business angels has only become more solidified since the 1980s. Business angels generally provide financial capital as an open investment (or in the form of mezzanine

capital) in a still rather opaque market segment. They generally operate under the radar of the financial supervisory authorities, which is why they are referred to as an informal market for venture capital. It is estimated that the informal market for venture capital is several times larger than the formal market. There are a number of studies that show that this is not a region-specific phenomenon. Furthermore, there is thus an empirically verifiable and theoretically significant complementarity between the informal and formal markets for venture capital in the ideal-typical life cycle of innovative companies. Business angels are characterised by their preference to invest smaller amounts of capital in seed and start-up phases and to help the founder in the process: "Angels not only exist, they tend to invest in precisely the areas perceived as gaps in the capital markets for entrepreneurs" [1]. With their investments, business angels generally do not aim for current income, but for future-oriented proceeds from the sale of their investments ("patient money").

They therefore utilise the specifics of venture capital as an "innovation-oriented" financial technology, provide support as a sparring partner and "doorkeeper" and realise investment returns, sometimes very high returns, when exiting the investment via the capital market, through the sale to VC companies or repurchase by the founder. The money is provided to the founder by VCs in several financing rounds - usually when agreed milestones are reached. The investment horizon is usually 3-7 years, until the company has lost momentum, has advanced to later development phases and thus becomes interesting for other investors. The "temporary marriage" is ended with the exit in order to make the sales proceeds and entrepreneurial experience available again to founders in need. Angels are only replaced or supplemented by formal financing systems as the company's lifespan progresses and capital requirements increase. Banks and VC companies often require a combination with bootstrapping or angel capital, as this creates 'trust signals' that support credible communication in a situation characterised by uncertainty and asymmetrically distributed information [2].

For a long time, business angels have led a shadowy academic existence. There are still no standardised and clear demarcation criteria and the transitions to the formal VC market can be fluid. In general, there still seems to be disagreement today as to whether and to what extent

- bootstrapping financing from friends and relatives counts towards angel status or not;
- only active or passive investors ("hands-on/ hands-off") belong to the angel circle;
- phase and innovation orientation, asset ratios, capital volume and investment frequency are relevant demarcation criteria for the angel market;
- only VC financing in the form of open investments or alternative financing variants (e.g. mezzanine capital) constitute a statistically relevant angel transaction;
- direct investments by private individuals in listed start-ups or in the context of corporate investments can (or should) be regarded as angel capital;
- the origin of the financial capital and the founding experience are constitutive for a business angel;
- industrial companies, angel syndicates and angel funds can be categorised as business angels [3].

In order to document the complexity of the angel market, a series of typologies were drawn up very early on. For example, in a highly influential pioneering work from 1989, Gaston categorises the types of angel cooperation according to whether they result in a more fruitful or conflict-laden financing relationship for the founder. Accordingly, he assigns a characterising name to each type [4]. Gaston names the following angel types that are generally recommended:

• Godfather: The reclusive, retired godfather with financial entrepreneurial ambitions;
• The Peer: Younger angels who are still active in business themselves;
• Cousin Randy: An angel who only invests within his own family;
• Dr Kildare: This type of angel belongs to the traditional professions with high income and wealth (doctor, accountant, lawyer, etc.);
• Daddy Warbuck: Angel, who acts as a wealthy industrialist with charitable intentions;
• The Stockholder: A passive shareholder with entrepreneurial empathy;
• Very Hungry Angel: This is the type of angel with very little entrepreneurial experience who is nevertheless very committed, invests smaller sums and often seeks majority shareholdings;
• Fulltime Angel: Angel who is looking for full-time employment in the financed company.

In contrast, Gaston differentiates between a few types of angels that start-ups should avoid:

• Business Devils: These quickly seize control of voting rights, are characterised by an "aggressive"share valuation and invest primarily in small companies;
• High Fliers: Angels who expect returns of at least 40 % and prefer to invest larger sums in larger companies;
• Impatient Angel: Investor who only provides his/her capital for a short term (max. three years);
• Green Angel: An investor who has no entrepreneurial experience, usually acts as a passive investor and prefers to finance established companies;
• Nickel and Dime Angels: This type never invests more than $10,000 and does not have the money required for further rounds of financing, so problems of undercapitalisation occur more frequently;
• Corporate Achiever: This type of investor is an active manager in the middle of the hierarchy with no prospects of promotion, who seeks other activities out of frustration.

In principle, this categorisation is probably still valid today, although a lot has of course changed in the meantime. With the introduction of the internet, the development of new digital currencies, the establishment of crowdfunding platforms, increased media attention ("Dragon's Eye") and digitally networked angel networks worldwide, new types and financing patterns have emerged. A distinction can now be made between coiner angels, crowd angels and social angels, who operate with specific financial technologies and a particular investment focus on (social or ecological) sustainability. There are now also initiatives that are trying to increase the proportion of women in what was previously a male-dominated domain. The "Women Angels Mission '25" is a german initiative, for example, which aims to diversify the business angel ecosystem in Germany by promoting more female business angels. By 2025 the proportion of female business angels in Germany is set to rise to 25% [5].

With a certain analogy to Gaston's typology, specific types can already be identified here today:

• Ms Angelita: Young female investors who are themselves still active in day-to-day business and are involved in various investment focusses.
• Gal Pal Beate: Female angel investor with an awareness of gender-specific (and possibly other) characteristics of entrepreneurship and a special investment focus on start-ups and teams with a high proportion of female founders.
• Mrs Ratio: Female angel investor who considers gender-specific issues to be irrelevant for her own employment biography and angel investments and who applies "pure" common sense.
Grandma Erna: Older female investor who, for example, has inherited assets from an entrepreneurial

household and makes these available for entrepreneurial projects from the extended family circle.

In view of this heterogeneous market environment, it is normal for different specialisation patterns to emerge in the course of individual learning processes. However, it can be stated that a typical angel transaction has, on average, those characteristics that do not match the interests of formal financial systems on the one hand and the interests of classic bootstrappers on the other. The investment volume is generally between 50,000 and 500,000 euros, usually provided in several financing rounds. In addition to these real seraphs, there are also cherubs, i.e. small angels who also provide small investment sums of 10,000 euros and less for the seed and start-up sector of business start-ups. Business angels are to a large extent experienced start-ups themselves and are therefore often familiar with the requirements of utilising angel investors, have built up their assets through their own entrepreneurial activities and contribute their experience and capital to their start-up portfolio companies. They enter in phases where the liquidity and profit situation is critical and thus prove to be "take-over and turn-around artists" [6]. Special mention should be made of the frequently practised strategy of collecting sufficient financial capital for several rounds of financing via syndication and the preference for regional proximity, i.e. the local orientation of the investment activities of business angels. Business angels also often favour a certain familiarity with the sector (at least for the first angel deals). These aspects have proven their worth in co-evolutionary cooperation with start-ups and other angel investors in order to arm themselves against market and behavioural risks (see Chapter IV). A further angel categorisation by Coveney and Moore has proven useful in this context, which can facilitate matching based on the requirements of start-ups and the profiles of angels [7].

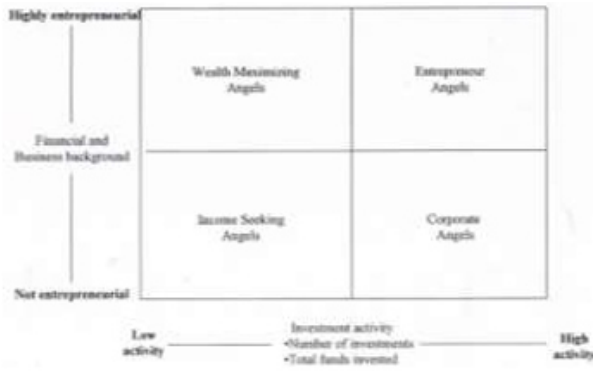

Fig. 1: Suitability of different angel types [8]

Accordingly, active angels include "income seeking angels", "wealth maximising angels", "entrepreneurial angels" and "corporate angels". Potential business angels are categorised as "latent angels" and "virgin angels". In view of the financial entrepreneurial characteristics of the individual angel types discussed above, fig. 1 provides an overview of angel categorisation with regard to their suitability for start-up-specific issues. As a systematisation approach, theamount of capital and intensity of involvement required from the founder's perspective are used to crystallise the suitability of the respective angel type for the financing relationship.

The financial assets of potential business angels have long been regarded as idle and therefore growth-relevant financial capital for start-ups. Latent and virgin angels have therefore also been discovered for theoretical and political purposes. They are "sleepers", so to speak, who have either had experience with angel investments in the past and need to be kissed awake from their slumber (latent angels) or have sufficient financial manoeuvring power and have shied away from angel investments for a variety of

reasons (virgin angels). Their investment preferences naturally differ from those of active business angels: potential angels articulate a preference for later financing phases and both latent and virgin angels primarily include direct investments in their investment calculations for diversification reasons, i.e. portfolio aspects are very much to the fore. Virgin angels in particular are generally much younger and generally less wealthy than all other angel types. In terms of financial assets and start-up experience, for example, they rank well behind the entrepreneur angel. However, they have a fundamental willingness to provide direct investments for start-ups. Latent angels are a special phenomenon in that they are basically familiar with the procedure of an angel investment, but still shy away from regular direct investments. They are older than virgin angels and younger than entrepreneur angels.

III. ENTREPRENEURSHIP EDUCATION & CO-EVOLUTION

Business angels have generally experienced a strong entrepreneurial orientation as part of their professional biography and may also have undergone processes of entrepreneurship education. Thus, entrepreneurial learning appears to be of great importance for the development of a specialisation of investors geared towards early-stage financing, even if the entrepreneurial experience must be transferred into an investor profile. This is the prerequisite for successfully dealing with particularly complex and genuinely uncertain decision-making situations [9]. In the context of teaching and training formats, for example, a combination of concepts for knowledge transfer and action orientation has proven to be effective in bringing the diversity and heterogeneity of knowledge, creativity and other potential to light and facilitating the discourse of shared learning. In addition to the integration of practitioners, who often act as role models and offer an inspiring exchange of experience, the problem-based learning approach, for example, has become established. Here, teachers and course instructors provide content input in the initial course phase and then increasingly take on the moderating and supporting role of a learning coach as the training programme progresses. In the age of digitalisation and artificial intelligence, knowledge is in principle immediately available anyway and routine questions are answered spontaneously without the

intervention of a teacher. Within the framework of formats for strengthening the skills of individuals and smaller teams, very dialogical concepts for the initialisation of solution-oriented action have also developed, which operate at the interface of knowledge transfer (consulting), assistance for self-help (coaching) and the exemplification of solution orientation in concrete action situations (mentoring). The development of entrepreneurial energy at the competence and motivation level can be described as a process of evolutionary learning that is self-created (autopoietic). This new entrepreneurial energy allows the learner more system states and ensures proactive, constructive handling of high environmental complexity. This is based on the "Law of Variety": only variety (intrinsic complexity) can master variety (environmental complexity) [10]. This is particularly relevant for companies with high growth ambitions (start-ups), as the aim here is to enable effective, coordinated teamwork in a strategic and operational context for rapidly growing team structures [11]. In the context of entrepreneurship, Röpke has worked out on the basis of systems theory arguments that entrepreneurial action can be causally derived from an interplay of the action variables "rights to act" (permission), "competences" (ability) and "motivation to perform" (willingness) [12]. Entrepreneurial energy levels (competences, motivation) are developed reciprocally, i.e. co-evolutively through social interactions and transactions [13], when entrepreneurial responses are made to environmental challenges that are accompanied by an increase in the entrepreneurial energy level on four different learning levels. Therefore, a fundamental

distinction can be made between traditional learning (learning levels 0 and 1) as a guide to static efficiency and evolutionary learning (learning levels 2 and 3) as aspects of dynamic efficiency [14].In this view,interdisciplinary processes of systemic-evolutionary, constructivist self-learning atlearning levels 2 and 3 move to the centre of entrepreneurship education. While learning level 0 represents entrepreneurial routine on a generally unconscious level and learning 1 is aimed at absorbing new knowledge and building resilience in the course of past experiences, evolutionary learning (learning levels 2 and 3) is strongly based on the active functioning of the entrepreneurial perceptual apparatus. In reality, the linking of the learning levels is probably rather chaotic and very individualistic, especially as aspects of incremental knowledge absorption through effectual principles or pivoting in lean start-ups (learning level 1) can of course also lead to the strengthening of implementation and reflection energy at higher learning levels and vice versa. A strong vision, such as in the case of Bill Gates ("A personal computer on every desk and in every household"), unleashes forces and energy for the acquisition of implementation energy (learning level 2: communication with investors, effective time management, business modelling, etc.) and new specialist and market knowledge (learning level 1: new programming language, lean analytics, etc.). In a knowledge society, the comparative advantage is increasingly shifting from the level of specialist knowledge and qualifications (learning level 1) to the level of interdisciplinary implementation energy (learning level 2) and reflexive, visionary and energetic skills (learning level 3). In order to consider the aspect of entrepreneurial energy on these evolutionary learning levels from a psychological perspective, it is worth pointing out the connection between motives (e.g. McClelland's achievement motive) as a guiding intention to act (learning level 3) and achievement motivation and volition as a form of willingness to act in a specific, challenging situation that requires courage, discipline and control of action (learning level 2). There appears to be a close connection between the development of competence and a favourable psychological disposition (see fig. 2).

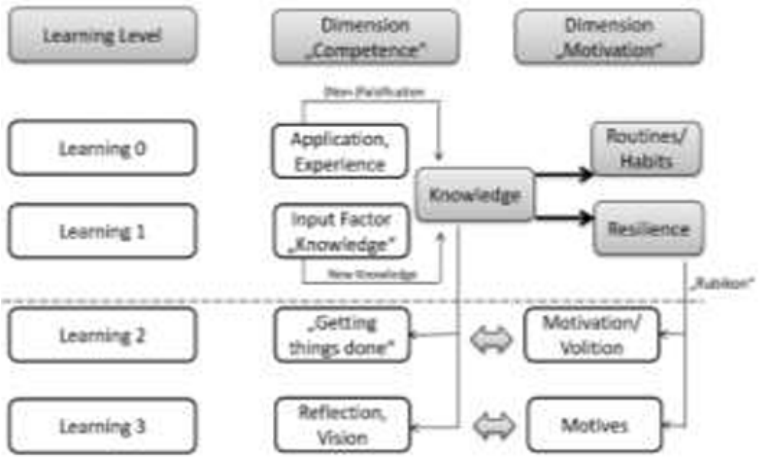

Fig. 2: Learning Level and Entrepreneurial Energy

The perception of the optimally effective, average level of challenge when assessing an action situation (convincing investors, setting up a branch, etc.) depends heavily on the underlying level of competence. Similarly, a courageous and committed approach to a challenge can remain fruitlesswithout a corresponding level of competence and thus promote frustration rather than resilience. Research has also highlighted the aspect of "volition" as an aspect that must be taken into account in the context of realising an idea and constructively dealing with internal resistance (e.g. in the form of fear of failure, procrastination), i.e. when it comes to the proverbial crossing of the Rubicon [15].

IV. ANGEL LEARNING AT DIFFERENT LEVELS

In the context of early-stage financing of start-ups, it is particularly important for virgin angels to arm themselves for the uncertainties of a decision-making situation characterised by "true uncertainty" (Frank Knight) by building up expertise. Due to the changeability of processes and events, this also applies to all other types of angels, despite their experience from their professional biographies as entrepreneurs and angels.

A. Angel learning at learning level 1 and 0

Let's start with the intuitively obvious learning level 1, which deals with experience and VC knowledge. A certain amount of knowledge about the basics and specifics of venture capital as a financial technology is required, on which the actions of potential and active angel investors can be based. For example, it is about understanding what VC is and how it differs from other forms of financing such as private equity and crowdfunding. It is also about distinguishing between different financing phases and raising awareness of the high failure rate of start-ups and the potentially high returns on successful investments. Only around 10% of all VC investments prove to be a so-called home run and generate at least ten times the invested capital on exit. This means that the total failures, underperformers or living deaths and average performers are cross-subsidised. In addition, an understanding of the methods used to value start-ups, e.g. through comparative analyses, discounted cash flow (DCF) or venture capital methods and the processes of due diligence to examine the business model, finances, legal structure, market, product and management team, must be internalised before an investment is made [16].

In addition to the many general legal aspects of business life in a VC case, there are some important legal aspects that primarily concern the term sheets and the investment agreement. Even if the actual drafting is later left to the lawyers and notaries, knowledge of the basics of a term sheet, including valuation, shares, liquidation preferences, anti-dilution and milestones, is necessary to conduct a contract negotiation. Furthermore, an understanding of various financial technologies, such as common stock, preferred stock and convertible debt, is required as they each constitute a specific legal status vis-à-vis the start-up. In connection with this, it is also useful to clarify typical shareholder agreements, as VC is typically associated with shareholder rights and VCs should therefore at least be aware of the relevance of typical clauses such as drag-along and tag-along rights, veto rights and information rights [17].

Furthermore, aspects of portfolio management and general economic activity are an essential part of a knowledge base for the VC business. This involves the basic principles of diversification, i.e. strategies for building a diversified investment portfolio to spread risk, an understanding of performance measurement using typical key figures such as internal rate of return (IRR) and multiple on invested capital (MOIC) and knowledge of possible exit strategies such as trade sales, secondary sales, buyouts and initial public offerings (IPOs). In addition, many aspects of market activity, such as network knowledge, trends and innovation cycles, are likely to be a useful addition to this knowledge base.

At learning level 0, the focus is on applying an investment strategy and comparing it with reality. At the very least, the classical venture capital cycle applies to everyday business: fundraising, investing, managing, exiting [18]. The aim is therefore to generate and screen a deal flow and evaluate promising start-ups with regard to a possible financing relationship. Portfolio decisions must be made and existing portfolio companies must be supported and supervised in the form of regular meetings and shareholder meetings in order to prepare them for exit decisions in the future. Whether and to what extent this takes

place within the framework of syndication and in what way the action practice is then coloured in a type-appropriate way ultimately results from the impulses of the higher learning levels. Inexperienced angels in particular like to make use of the co-evolutionary function in the angel network for their first steps into practice. Syndicates serve as incubators, so to speak. Ambitious but still hesitant young angels learn to negotiate and diversify, to experience the world of the financial entrepreneurial innovation function, according to "after speaking with investors who have experience co-investing with other investors might actually be the very best way for novice as 'virgin angels' investors to enter the informal capital market, for they learn valuable skills from more experienced investors. They can glean more than just lessons about how to invest; they can learn how to be more actively involved in their portfolio companies" [19]. Of course, inexperienced angels cannot rely on syndication with a lead investor being a sure-fire success, as the social relationship with other angels - also in view of the competition between them - is also characterised by imponderables in the form of information asymmetries. Furthermore, co-operation with experienced investors may also leads to illusions of control, as experienced investors can also be susceptible to availability heuristics. Decisions by experienced angels are often strongly based on intuition and therefore lead to automated processes. In addition, the availability heuristic can lead to angels [20].

For potential and experienced angel investors, however, investment controlling also plays a major role in manifesting evidence-based learning at learning levels 0 and 1. It includes both the evaluation of the performance of the individual start-up and the performance of the entire portfolio. Both qualitative and quantitative aspects are considered. Typical aspects of investment controlling include reviewing the start-up's financial reports, including the income statement, balance sheet and cash flow statement, as well as measuring performance by analysing business development using key performance indicators (KPIs) and other metrics. It also involves identifying and monitoring risks associated with each investment and developing risk mitigation strategies. With regard to the relevant KPIs for start-ups, monthly reports are used, for example, to analyse the growth rate of sales and the cash burn rate, also in order to get a feel for the "cash runway" indicator. In addition, EBITDA is an indicator of operational performance. The Customer Acquisition Cost (CAC) indicator is used to determine the costs that have to be incurred to acquire a customer and the Lifetime Value (LTV) indicator is used to estimate the revenue that a customer will generate over the course of their lifetime. Other operational key figures are the churn rate (rate at which customers leave the product or service), the conversion rate (percentage of users who carry out a desired action), the monthly recurring revenue (MRR) and annual recurring revenue (ARR) [21].

In contrast, key figures must be established for the angel investor's portfolio development in order to enable target/actual comparisons between the angel investor's objectives and actual performance. Portfolio diversification measures the spread of investments across different sectors and stages of development, while the internal rate of return (IRR) measures the annual return that an angel investor generates from the entire portfolio. Other key figures include the multiple on invested capital (MOIC) as the ratio of the current value of the investment to the capital employed, as well as the ratio of exits to investments, the follow-on investment rate or the deal flow. Angel investors generally monitor these key figures continuously in order to assess the development of their investments and the overall portfolio. Typically, most of these key figures are already known due to the employment history of angels; if necessary, they should be internalised at learning level 1. It is also important that they are in close communication with the start-ups in order to obtain the necessary data promptly and correctly. These aspects make it necessary to address learning levels 2 and 3 in parallel in order to enable effective

investor behaviour.

B. Angel learning at lerning level 3 and 2

At learning level 3, the typical questions of normative, strategic and operational management for today's and tomorrow's angel existence must be reflected upon in order to draw conclusions for the acquisition of implementation skills, specialist knowledge and application routines at learning levels 2, 1 and 0. From a normative point of view, the typical question of how to categorise one's own status quo and what image of the future one is striving for should be asked first. On this basis, a decision must also be made as to which legal form and with which partners the angel business should be established. Therefore, potential and experienced angels need to deepen their understanding of themselves as investors with a self-image. By continuously reflecting and analysing their strengths and weaknesses, they begin to take their socio-demographic characteristics - such as age, wealth and experience - into account for their strategic and operational orientation as angels and thus reflect on their influence on investment decisions. Behind this is a self-reflective, internal dialogue: Am I today an angel of the Godfather, Peer or Daddy Warbuck type (to use Gaston's typologisation)? What role model and need can and do I want to take from the perspective of start-ups, using Coveney and Moore's categorisation? Entrepreneur Angel, Corporate Angel, Latent Angel or Virgin Angel? In view of these two categorisations, which type would I like to aspire to in the future and which real business angels serve as role models for me in order to underpin the imaginary wishful thinking with a real image that serves as orientation? How can such role models be recruited as lead investors in a timely manner, for example, in order to develop learning impulses - also in co-evolutionary interaction with start-ups - at all learning levels within the framework of syndication? – Angels must therefore create orientation models for themselves, e.g. by observing lead investors in syndications in order to develop a frame of reference for their own investment approach. This type of thinking in terms of role model categories (and the associated media resonance) appears to play an important role in the context of promoting female entrepreneurs and angels.

Learning level 3 therefore also includes the development of an awareness of the role model, the individual goals and the strategic and operational portfolio management derived from this. There are also questions for self-reflection: What are the long-term and short-term goals and what resources are required to achieve them? How can the company's own resources in the form of the 3 Cs (capital, competence, contacts) be utilised to enable added value and a "skin in the game"? How can the asset class "start-ups" be integrated into your own portfolio strategy and life planning? In this context, to what extent do inquiring start-up players fulfil the objective and personal criteria for a long-term collaboration geared towards growth and exit? - In addition to proving certain, sometimes very individualised principles of success, learning from mistakes is also important. Critical rationalists such as Karl Popper and Hans Albert have repeatedly emphasised this evolutionary process of increasing knowledge. The proving of business models and specific competitive hypotheses is regularly accompanied by the occurrence and evaluation of statistical errors of the first and second kind, which can often be the result of cognitive distortions. In statistics, the first type error (also called alpha error) and the second type error (beta error) refer to the erroneous rejection of a true null hypothesis or the erroneous acceptance of a false null hypothesis. In the world of angel investing, this can be applied to investment decisions in order to develop a feeling for the occurrence and handling of such errors as part of training, coaching or mentoring, for example. The alpha error is a mistaken rejection of a good investment opportunity. For example, an angel investor decides not to invest in a start-up that is later very successful. The investor misses the opportunity to share in the success and realise a high return. The second beta error is a mistaken investment in a poor start-up.

The angel investor invests in a start-up that is not successful, even though there were many red flags indicating problems. There is a risk of losing the invested capital and tying up resources in an unsuccessful company (so-called living dead). Only by precisely analysing the failure can a distorted view of representativeness, for example, be prevented. Against the background of systemic considerations, it can be assumed that the view of entrepreneurs and angel investors with regard to value creation and entrepreneurial business opportunities (and thus also the assessment of first and second type failures) is strongly subject-dependent. The relationship between past and future investment decisions plays an important role, as angels who have ignored profitable investment opportunities (alpha error) show a certain degree of regret and tend to approach similar opportunities differently in the future [22]. Herd behaviour can also be associated with the "FOMO" (Fear Of Missing Out) phenomenon [23]. If the majority of all VCs are increasingly investing in one sector, there may be a feeling that they are missing out if they do not invest in this sector. This is also linked to the issue of reputation: if an investor makes a decision contrary to that of a larger group and this subsequently turns out to be wrong, this could result in damage to their own reputation. Adjustment heuristics should also be mentioned here, as anchor points are not uncommon for VCs. Often, certain investment criteria (location, industry, etc.) must be met for them to consider financing. If a start-up does not fulfil these criteria, it is sorted out in advance. On the one hand, this decision-making tool helps investors to decide whether it is worth the time to carry out a more detailed assessment. On the other hand, essential information that could indicate a profitable start-up is not taken into account [24].

In a more detailed analysis, there are strategies for identifying certain biases. For example, if a bias is suspected, triggered by the representativeness heuristic, it is possible to take a closer look at the conditional probabilities [25]. The conditional probability indicates how likely event A is for a given occurrence of event B. Identifications of the availability heuristic are possible, for example, through more in-depth information research and a subsequent comparison with current or perceived news or headlines. Questioning is also a solution for identification when the anchor effect is suspected [26]. However, without a corresponding awareness, no suspicion, whether founded or unfounded, can arise and ergo no enquiry can be attempted. The use of information technology tools can also be used to raise awareness. The well-known 'Decision Journal', for example, can be used as an instrument for self-reflection, in which angels not only record investment decisions, but also their personal reactions and thoughts on these decisions. The well-known 'Harvard's Project Implicit' also makes it possible to become aware of one's own prejudices, which leads to a more objective view of start-ups. This makes it possible to overcome the signals from the world of experience (learning levels 0 and 1) from the perspective of possible cognitive biases such as the representativeness heuristic or the loss or regret aversion, which could cloud the results as errors of the first and second kind. One example of this is dealing with the famous FOMO problem.

In addition to utilising traditional coaching or training measures, angels could also make use of chatbots here, as ChatGPT can be integrated as an interactive reflection tool on the basis of effective prompting. AI can then be used to structure thought processes and shape the perspective of considerations. This can demonstrably help to develop a more reflective and less biased approach in one's role as an angel investor. Furthermore, various research results illustrate the extent to which newer artificial intelligence technologies could support start-up investors. For example, it was shown how powerful today's algorithms can be. A comparison of the investment returns of 255 angels with those of an AI algorithm shows that the performance of the algorithm exceeded the returns of the BAs on average.

The only investors who performed better were those who had an extremely high level of experience and were able to suppress the effects of cognitive biases [27]. However, this technology can certainly be used to support decision-making and mitigate bias. In particular, as an analysis tool for studies in which no emotional elements come into play, such models can save time for start-up investors [28]. The cognitive apparatus is thus stimulated to avoid illusions of control and to deal with conditional probabilities reflexively and constructively in order to take precautions at learning levels 2, 1 and 0. In this context, it should also be taken into account that the cognitive and motivational basis of the investment decision also changes over time, particularly with regard to risk appetite or aversion. It is known that VC companies have moved away from early-stage financing as fiduciary financing and the associated regulatory and organisational requirements have increased (also as a result of tax policy benefits). Instead, they have specialised in the financing of later financing phases on a transactional and co-evolutionary basis. This can be described (using a term from foreign trade theory) as the "Dutch disease in financial intermediation" [29]. What conclusions can be drawn by successful business angels who have previously operated under the radar of financial supervision in the context of syndications and are now increasingly receiving requests from their personal and business environment to receive their financial resources in a fund? Question occurs then as to the underlying motives: Which key motives are then at work? How do achievement motivation, intrinsic motivation and the profit motive interact? - Research has shown that angels, as investors who are only responsible for themselves, do not place the profit motive in the foreground. Almost all studies indicate that the profitability of the investment is a rather insignificant factor when viewed in isolation. Rather, the return motive represents a hygiene factor and/or an indicator for monitoring the success of entrepreneurial action in the sense of Schumpeter and McClelland [30].

Learning level 2 is about developing implementation skills in order to pursue the objective as effectively as possible. Experienced and seasoned business angels know from their professional biographies that the complexity of angel investing - similar to the actions of a start-up entrepreneur - requires special competences at learning level 2 in order to establish "structural links" to the right players in the value creation process of the financing rounds. Well-known questions about the problem of trust in the context of early-stage financing arise due to the insufficient information base, which would be really meaningful as trust signals. Agency risks remain wherever you look: Is the self-declared entrepreneur angel what he promises for joint syndication, or a narcissistic blowhard and therefore not a good trailblazer? Is the start-up really the self-declared new "AirBNB for pets" or a new case of "Theranos"? Of course, track record, traction, bootstrapping etc. can be used, but the matter remains imponderable. As a rule, the angel does not have to raise capital from outside and adhere to financial intermediary guidelines. However, he can and must fall back on alliances and syndicates for further financing rounds and seek structural links to financial intermediaries, whose credit and investment eligibility checks are simplified by the sponsorship of an experienced angel. The same applies to the implementation of his portfolio strategy: the business angel does not have to take into account the investment guidelines imposed on a fund manager by the legislator and his sponsoring organisation. They can diversify their financial assets and invest how, when and where they want. Nevertheless, an angel must establish specific communication patterns with those start-up companies that correspond to his orientation and convince them of his potential added value.

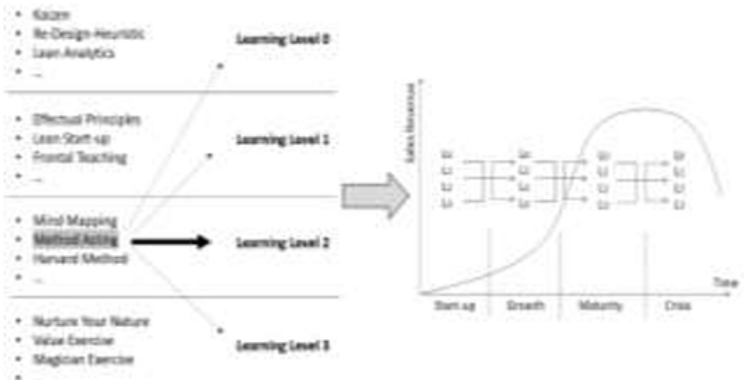

Fig. 3: Methods, Learning Level and Angel Life Cycle

Learning level 2 therefore includes, for example, an effective training on communication strategies and creativity in understanding and developing the start-up and its business model. This can be achieved, for example, through the use of "method acting" methods or techniques in the training of angels in strengthen the dynamics of their life cycle (see fig. 3) [31]. Communication is the key instrument and must be varied depending on the type of start-up - technically orientated companies may need to place more emphasis on data-based discussions, while creative ventures may need to have more visionary and future-oriented conversations. The reflection impulses of learning level 3 are of great importance here in order to effectively enable the transactional interaction of the roles. Inter-generational reflections (again at learning level 3) certainly also play a role here, as the psycho-social closeness of the relationship between angel investor and start-up team can also depend on the age difference, which sometimes determines the type of cooperation. Peer Angels, Very Hungry Angels or Fulltime Angels may have the qualities that characterise them as co-creators and co-entrepreneurs. There is perhaps a fit here between the competence and requirement profile of the contracting parties, also in the course of a certain self-similarity as a psycho-social attractor. The Godfather Angel or Daddy Warbuck types are more likely to fulfil the role of a coach, advisor or mentor due to the age difference and the associated specifics that arise for the mutual understanding of the system and thus for the social relationship with the start-up. In any case, know-it-all behaviour often proves to be a trigger for reactance, the perception of a restriction of autonomy and interference in causal attribution during the initiation of a contract or during the financing relationship. Similar aspects can also be mentioned for the external presentation: Should a pro-active communication strategy via social media channels be chosen or an existence as an "invisble angel" that relies on reputation effects? The answers to such questions are also derived from learning level 3. And in all of this, it is also important to emphasise the entrepreneurial element as a link to understanding successful early-stage collaboration [32]. Aernoudt states in this context: "It is worth noting that they never consider themselves as ex-entrepreneurs, but still as entrepreneurs" [33].

Business angels in particular could take advantage of structured coaching and mentoring programmes that support both start-ups and themselves in the learning process in order to focus on the specific issues of dealing with future portfolio companies and exercising a reflective understanding of their role. Methods of entrepreneurship education, such as method acting, can then be combined with specific methods for investors, such as reverse pitching, which is now more common. This makes it possible to look at the business models of start-ups from a new perspective and at the same time sharpen one's own persuasive skills. In addition to the structural links to the start-up and investor sphere, it is also necessary to continuously build and expand networks, i.e. the multidimensional expansion of structural links, also

in order to keep working with experts (e.g. on trend topics such as sustainability, digitalisation) and possible cooperation partners who support progress in the angel existence. It is therefore also about developing skills in relationship management and building trust and reputation. In addition, time management plays a crucial role in prioritising. With an increasing deal flow (and the associated negotiation requirements) and a growing portfolio size, business angels need to balance availability to strategically support start-ups without overstretching their own resources. Digital tools now help to organise the schedule efficiently and set up time blocks for intensive work phases, especially for the lengthy due diligence of new investments. If angels are not familiar with these tools from their own experience, then this would be an effective lever (alongside classic time management methods such as the Eisenhower method) to strengthen the effectiveness of assertiveness. It is always about harmonising the desirable and the implementation, i.e. psychologically the attitude and the behaviour, otherwise a Virgin Angel will always remain virgin or a Latent Angel inactive because the proverbial Rubicon is not crossed due to a lack of motivation and volition. The associated insights of the evidence-based approach (learning levels 0 and 1) are then not incorporated into the reflection and implementation activities to sharpen and strengthen the motives for action, understanding of roles and resilience.

V. VENTURE CAPITAL IN TEACHING

There are now a number of initiatives dedicated to the qualification of VCs through training programmes and teaching units. In addition to the Kauffmann Foundation [34] and various angel academies, there are also further education and training programmes from the tertiary education sector, with universities also offering examination services and the acquisition of credit points as part of certificate programmes. This is intended to improve the awareness and skills of business angels in relation to the investment process [35]. Taking the previous comments on entrepreneurial learning into account, it becomes clear that such training programmes should provide fundamental stimuli for the stimulation of all four learning levels. Recognising that building awareness of cognitive and emotional biases is an essential part of dealing with mistakes that occur, it is necessary to address approaches that take into account young, inexperienced Anges as well as experienced business angels. Creating such awareness early on can protect against future negative influences. Such angel academies also bring angels together and give them the opportunity to exchange experiences or even venture investments together. Didactic measures can be helpful in giving potential angels a better understanding of business processes or finances of this kind.

Programme directors could - following the criteria of action-oriented concepts in entrepreneurship education (see chapter III) - consider the following:

- The current challenges and trends in the field of science and entrepreneurship.
- The basics of VC, including definitions and key concepts such as company valuation, term sheets and capital structure.
- The basics of investment strategies, including portfolio construction, risk assessment and management, and timing and exit strategies.
- The specific areas of expertise in which the VC would like to improve (e.g. technical understanding, market assessment, due diligence, networking).
- The inclusion of case studies of successful Vcs investments.
- Workshops, pitch events, boot camps and imulation exercises for interactive training elements.

- An item on building and maintaining a network.
- A teaching unit on analysing and evaluating start-ups, including the creation of financial models, the assessment of business plans and the analysis of market opportunities.
- The current challenges and trends in the field of science and entrepreneurship.
- The basics of VC, including definitions and key concepts such as company valuation, term sheets and capital structure.
- The basics of investment strategies, including portfolio construction, risk assessment and management, and timing and exit strategies.
- The specific areas of expertise in which the VC would like to improve (e.g. technical understanding, market assessment, due diligence, networking).
- The inclusion of case studies of successful Vcs investments.
- Workshops, pitch events, boot camps and simulation exercises for interactive training elements.
- An item on building and maintaining a network.
- A teaching unit on analysing and evaluating
- An interactive workshop in which participants can evaluate real pitch presentations by founders and provide feedback.
- Peer review sessions, in which participants give each other feedback on their investment analyses and decisions.
- A learning unit on critical thinking and judgement that focuses on recognising and avoiding cognitive biases and heuristics. Tools such as 'Farnam Street Decision Journal' or 'Implicit Association Tests (IAT)" of the Harvard Project Implicit can be used for this purpose.
- Methods of skills development (formal training, mentoring programmes, practical experience or case study analysis).
- A mentoring programme, which brings the virgin angel together with experienced investors to enable first-hand learning.
- An unit on negotiation and deal structuring, including case studies and role plays.
- Sessions regarding evaluation and reflection on the exercises carried out and the content learnt, including an action plan for the next steps.
- A final project that would require participants to apply all the skills they have learnt, such as preparing an investment proposal or carrying out a simulated due diligence audit.

In organisational terms, such a programme would have to take a number of specific features into account:

- Web-based modules and exercises, which are activated at the beginning of each week and form the basis for the units.
- Regular self-assessments and feedback sessions to monitor personal progress and adjust learning objectives.
- A combination of live online seminars, interactive modules, and real-life investment scenarios integrated into a specialised learning platform.
- An online orientation phase in which participants are familiarised with the course structure, the learning objectives and the platform used.
- The use of learning diaries in which participants record their daily findings and progress. These diaries are the basis, for example as a basis for awarding credit points.
- Implementation of a self-evaluation tool (e.g. Skillometer) that is specifically designed to measure progress in terms of investor competences.

Fig. 4: Curriculum "Developing Investor Competence"

The example of a curriculum in fig. 4 contains a comprehensive training programme for angel investors that combines theoretical foundations with practical experience and prepares them for success through continuous self-evaluation and professional mentoring. The academic learning level programme has been dispensed with in order to avoid potential deterrence or reactance. The starting point was a typical teaching format of 48 teaching units spread over three weeks. This is associated with a typical certificate scope, which can award separate credit points for each of the three modules. In order to intensify the necessary practical relevance, a 20-24 hour follow-up mentoring/coaching session after completion of the programme would be useful to raise awareness of practical issues in the context of individual sessions, group workshops and further networking opportunities.

VI. CONCLUSIONS

"Business angels: should they fly on their own wings?" asks Aernoudt (1999) in a remarkable essay directed against input-logic funding initiatives. The preceding remarks have shown that, from a systemic perspective, investor behaviour can be influenced by evolutionary learning and competence building. Of course, tax incentives certainly also play a role in influencing the risk appetite of VC investors. This may work in terms of volume, but the business angel phenomenon is not so much fuelled by the quantity of capital, but rather by the underlying financial entrepreneurial quality of operating successfully and sustainably in the seed and start-up segment. Trying to lure a Virgin Angel with money in order to steer his diversification decisions in the direction of Schumpeter financing is more like the image of a gardener trying to accelerate growth by vigorously pulling on budding blades of grass. "At the outset, it must be clear that business angels do not need money. The fact that they have money make them business angels" [36]. However, by working intensively on different learning levels business angels creates a solid foundation for their basic skills, investment activities. They become an expert in making the best use of their time and communication skills while developing a profound awareness of the psychological aspects of investing, which ultimately leads to an increase in investment quality and a robust, diverse portfolio.

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