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Psychosocial Support and Accompaniment of Families with a Dying Member with Spinal Muscular Atrophy - Theoretical Framework

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Abstract

Spinal muscular atrophy (SMA) is a life-limiting condition with high levels of unsatisfied needs that has a wide range of consequences for the lives of people 'affected by SMA' and their families. Each person with SMA has their own unique trajectory and progression of the illness and the resulting problems (which also affect loved ones, parents and families). Patients and their families (family carers) are affected daily by the significant widespread impact of the illness on their quality of life and the associated high levels of burden they experience – these are demanding challenges they face daily. However, literature on the experience of SMA patients is – in the context of the illness trajectory and end of life – very limited. Thanks to improved medical care, including respiratory treatment, and current technological and therapeutic options, an increasing number of patients with SMA III (IV) and type II reach adulthood. Yet the nature of the illness remains 'devastating'. SMA is burdened by the 'pain paradox' – the affected person and their family (parents, caregivers) simultaneously plan for future death and the future. Psychosocial support, accompaniment and counselling should respect this aspect of SMA.

Keywords: spinal muscular atrophy – psychosocial impact – dying – family burden – accompaniment

1. INTRODUCTION

Spinal muscular atrophy (SMA) is a genetic (autosomal recessive), heterogeneous, degenerative, and life--limiting illness (LLI) leading to progressive, mainly limb-girdle muscle weakness. This neuromuscular illness has a progressive prognosis and is multiorgan/multisystemic [1, 2]. The generally progressive course of the illness is characterized by fluctuating phases with frequent exacerbations [3]. The illness is most often first seen in infants and toddlers, but can also occur in adolescents, less commonly in adults [4]. Five types of SMA are defined and distinguished in the literature (type 0 to type IV), with type 0 being prenatal, type 1 being early onset, and type II to IV having late onset. The traditional classification of SMA includes the following criteria: age of onset, age of death, achievement of motor milestones, and sitting/standing/walking independence status [5].

This type of LLI is highly disabling, it limits the independence and self-sufficiency of patients (who are very often wheelchair users). After cystic fibrosis, it is the second most common autosomal recessive illness leading to death or premature mortality [6] and the third most common neuromuscular diagnosis in children under 18 years of

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age [7]. The main symptoms of the illness include progressive muscle weakness manifested by limited and dysfunctional movements of the hands, arms, head and neck, limited ability to crawl and later to walk, as well as spinal deformities, dysphonia and dysphagia problems and others. Associated problems therefore include coughing difficulties, scoliosis, hip instability, muscle contractures, but also constipation, vomiting, reflux, higher risk of bone fractures, heart, and vascular problems or fatigue (faster fatigue). Respiratory failure with numerous complications is a common cause of death [8]. In many cases, these patients later become completely dependent on another person for 24/7 care (most often parents, siblings or close relatives). A certain 'painful paradox of SMA' complicating the perception of the burden and the experience of its effects is the full preservation of cognitive and intellectual abilities.

Until the end of 2016, no cure was available for SMA, and treatment consisted only of supportive interventions and measures – however, none of the available therapies currently allows for a complete cure of the illness. Causal therapeutic options are available from 2017 (2021) for adult patients with SMA. This results in a change in the disease phenotype, with an increase in life expectancy. Approximately 10% of cases are classified as SMA type III, a milder form of SMA. This type can begin in childhood, adolescence, or adulthood. Patients with SMA type III have normal life expectancy [9] and are referred to as 'walkers'. The distribution of frailty is like types I and II, but the progression of frailty is much slower: some may eventually become wheelchair dependent in middle age (most commonly around/after 40) [10,11]. These patients can stand or walk unaided but may have difficulty (and require assistance) getting up from a sitting position, bending over, or walking upstairs [12]. Initially, they can walk without support, but as they age, proximal muscle strength gradually weakens, and they may need help standing or walking. SMA type IV is the mildest form of the illness. In terms of phenotype, this type like type III in adults [13,14] and is considered rare [13]. It is clinically manifested in the second or third decade of life [15].

2. PROCESSING OF THE FINDINGS

This paper is a selection of findings from research work on end of life and dying in the context of selected life-limiting illnesses. The secondary research using a systematic qualitative review design with thematic synthesis (the process of qualitative knowledge/insights processing was predominantly framed by SPIDER, PRISMA and CASP) identified selected problem areas. The methodological process itself was published in the context of another life--limiting illness [16], so due to the length of the text it will not be described in detail here.

3. PSYCHOSOCIAL IMPACT AND NEEDS OF PATIENTS AND THEIR FAMILIES

Family members (predominantly in SMA type I and type II) **experience anticipatory loss**, which causes grief before the actual loss. Family members often feel physically and mentally exhausted for long periods of time, which can lead to family crises [17,18]. Anticipatory loss refers to situations where, for example, family members begin to feel lost and out of control due to the impending death of a loved person [19]. At this stage, family members are very insecure and realize that they cannot control the condition of the child (sibling) – they suffer from anxiety about the impending death of a loved one. However, they may be 'angry' with the patient and generally frustrated with the very exhausting and demanding care [17].

Regardless of the type of SMA, all patients will experience moderate to severe disability in their lifetime [20] or are sometimes 'classified' as such in the literature. The trajectory of SMA transitions between different types and therefore **it is usually not possible to predict the further development of the illness** (type, stage) and the treatment is always adapted to the current type and its symptomatology (respecting the functional and general health status). Parents experience the 'journey to diagnosis' as an emotionally challenging, exhausting, and lengthy journey accompanied by feelings of denial, stress, anxiety, and considerable worry [21,22]. When the diagnosis is confirmed, parents are usually in a state of shock: they report numbness, denial, fear, and increasing sadness [17,21, 22]. Sometimes this condition can lead to long-term grief and depression due to the confrontation with the premature death of the child and the loss of expectations for a normal, ordinary life [17].

Families (or family members, most often parents) describe **different types of (often unmet) needs**. Parents commonly report a need for information (awareness). The desire to obtain information was not limited to information about the illness and available treatment options but was also expressed in relation to supportive care services such as financial assistance, access to equipment, schooling, etc. [23]. In addition to the need for information, parents expressed the need for coordinated and integrated care that would include not only medical treatment and health interventions, but also psychological (psychosocial) or purely **practical/instrumental forms of support**. Parents **feel isolated** after their child's diagnosis and struggle to find the 'right solution' for their child, as navigating

the health care and comprehensive support system is often complex and time-consuming due to the lack of clearly defined and integrated support pathways. When sick children become severely disabled, parents feel helpless, depressed and in an existential crisis. As the (expected) death of their child approaches, they perceive a loss of resources, social support, and have a **worse/reduced quality of life**. Parents at this stage seek out any effective sources of support and accompaniment to minimize (and be able to minimize) their extreme stress and maximum burden as much as possible [24].

In addition, families may need appropriate support services such as special schooling/education or services for children and adolescents with physical disabilities but without co-existing cognitive or intellectual disabilities. In terms of the **burden of the caring role**, one of the main aspects may be prioritising the needs of the child over their own self-care or meeting the needs and wishes of other family members. **However, the needs of children with SMA at the end of life are not well researched and defined.** Multidisciplinary care for the child with SMA and the family is provided by a palliative care team soon after confirmation of this serious, life-limiting diagnosis. As a result, families usually have to make difficult decisions about the **future care** of their child in a short period of time (especially for types ending in death in the early months or within a few years of birth). Future care planning, even for this life-limiting illness, can be summarized using the available definition as a (systematically organized and ongoing) 'communication process to ensure that patients receive medical care that is consistent with their values, goals, and preferences throughout the course of a serious and chronic illness' [25]. It aims to involve patients (here older children to adults with SMA) in decisions about (future) care before they become cognitively or communicatively incompetent [26,27]. However, future care planning is underused in both non-neurological and neurological conditions [28]. On the other hand, the final act of turning off a ventilator, for example, is a profoundly shattering experience.

'Facing premature death' is one of the most unimaginable and very difficult consequences and challenges of the illness for patients with SMA and their families. This is not only the case for SMA type I, but such concerns are commonly expressed by parents of children with SMA type III. Parents and patients with SMA describe their lives with constant fear of **deteriorating physical functions** (increasing as the illness progresses) and the sadness associated with these losses. For many parents and patients with SMA, this means learning to cope with the conflicting feelings of deep love and sadness that the illness has brought into their lives. Some studies suggest that patients and their families experience **lower quality of life and higher levels of stress** [21,29,30]. Parents and patients may describe that their ability to socialise and engage in activities outside the home was limited for several reasons: some children needed numerous aids to help them breathe or move, so preparing for activities outside the home was time-consuming and overwhelming. Or patients may be frustrated, for example, by the lack of access to the 'handicapped' or the limited possibility of socialisation due to present weakness and fatigue. Most studies examining quality of life in SMA focus on the patients and use the parents' perspective only for a proxy-report approach [31,32]. Available studies on the quality of life and economic and social burden in families show that most parents of children with SMA report high financial burden, high number of hours spent daily caring (≥10 h), reduced working hours, and overall poorer quality of life [33,34].

Achieving independence can be a big concern for parents and patients with SMA. Other concerns include feelings of insecurity and powerlessness, especially when it comes to **the question of the future**. Indeed, 'forward planning' is made much more difficult by the uncertain trajectory of functional decline or life expectancy. Parents of children and adolescents with SMA are exposed to multiple sources of psychosocial stress, facing the burden of the caregiving role and various unmet needs (expressed to varying degrees) of the individual and the family [23]. In addition, parents report being burdened with never-ending caregiving tasks, causing fatigue, exhaustion, and severe sleep deprivation due to limited free time [35]. Similar findings were presented in a systematic review by Brandt et al. [23], which demonstrates that **the psychosocial impact and burden on parents** was caused by lower health-related quality of life, caregiver burden, caregiver time, as well as (indirect) costs to the family, parental stress, symptoms of anxiety or depression, social support, coping, family needs and satisfaction, and possibly burnout. Non/participation in social and leisure activities was detected as a significant predictor of caregiver burden, depression and anxiety symptoms, or life satisfaction. Higher (better) quality of life was – in line with the severity of SMA types – more likely to be observed among parents of children and adolescents with SMA type III.

Regarding **palliative and end-of-life care**, a retrospective study by Di Pede et al. [36] found that children with SMA type I involved in the research required more intensive medication in the last three days due to intractable breathlessness and pain, and 15 children (out of a total of 17) died at a place chosen by their parents. At the same

time, the authors 'remind' that the basis of care for these children and adolescents at the end of life is not only effective symptom management, but also psychological support for parents of dying children. All parents participating in a study by Higgs et al. [37] expressed concerns about their child's suffering, with some describing **death as the end of suffering**. Parents were grateful to be allowed to decide **how and where their child would die**. Paediatric patients are most often given active palliative care but not long-term ventilation (non-invasive ventilation or tracheotomy) [38]. A retrospective study of nine records of type I SMA patients and their families [39] demonstrates that all but one child died at home and in four cases were accompanied by a palliative care team at the time of death. **Communication patterns between bereaved parents after the death of their child** due to illness vary. Bereaved parents who openly shared their grief, provided comfort to each other, and remembered their deceased child together, experienced greater relational closeness, trust, and security [40]. Bereaved couples who avoided conversations about the loss of their child and tried to remain strong in each other's presence experienced grief more [41].

4. CONCLUSIONS

SMA is characterized by a wide age range of onset and course, as well as severity of symptoms and manifestations of subsequent complications. Until recently, the classification of SMA was based on age of onset and motor milestones achieved, and five forms were distinguished: 0, I, II, III and IV. However, the introduction of treatment has changed the natural course of the illness, and the existing classification has become less relevant. SMA is a progressive neurodegenerative illness that places a significant and complex burden on patients and their families. The challenging SMA 'illness journey' begins with the lengthy and traumatic process of confirming a diagnosis and continues with a lifelong pilgrimage accompanied by the overwhelming physical, emotional, psychosocial, and financial burden of coping with a debilitating and incurable life-limiting illness.

The psychosocial impact of living with SMA can be expressed in areas that can be summarized as follows: (1) confrontation with premature death and difficult treatment choices, (2) fear of loss of functional ability and coping expectations, (3) sleep loss and stress and limitations in social activities, (4) independence, uncertainty, and helplessness, (5) family finance, and (6) stigma.

In addition to people with SMA type III (IV), an increasing number of patients with SMA type II are reaching adulthood thanks to improved medical care, including respiratory treatment. Persons with SMA need long-term multidisciplinary medical/health and comprehensive psychosocial supportive care to maintain functional mobility/mobility, the longest possible independence, and the highest possible quality of life without greater or more rapid deterioration.

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Social Participation of Children and Adolescents with Progressive Neuromuscular Disease in Leisure and School: Theoretical Background

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Abstract

Severe progressive neuromuscular diseases (NMD) such as spinal muscular atrophy (SMA) and Duchenne muscular dystrophy (DMD) are progressive neuromuscular diseases that significantly affect the quality of life and social participation of children and adolescents. The aim of this paper is to present findings on social participation of children and adolescents with NMD, to identify barriers to social participation of this population and to propose recommendations for improving their psychosocial functioning and social participation. The results of studies show that successful involvement in peer groups and support from family, teachers and peers contribute significantly to increased self-esteem, independence, and quality of life. Based on the analysis of research studies, barriers to social participation of these children and adolescents were identified, including environmental barriers, differences based on neuromuscular conditions, lack of peer and environmental understanding of the specifics of NMD, fatigue, low self-esteem, and limited opportunities to participate in leisure activities. In the conclusion of the paper, the authors present recommendations for school practice that can optimize the promotion of social participation and strengthen the self-confidence and autonomy of children with NMD so that they can best function in everyday life and meaningfully engage in activities with their peers.

Keywords: children, adolescents, spinal muscular atrophy, Duchenne muscular dystrophy, social participation

1. INTRODUCTION

Severe progressive neuromuscular diseases (NMD) such as spinal muscular atrophy (SMA) and Duchenne muscular dystrophy (DMD) are rare childhood diseases judging by their incidence1 [1; 2]. SMA is caused by a defect in the SMN gene on chromosome 5 and is divided into 5 subtypes (type 0, I, II, III, IV) according to the ontogeny of symptoms and severity of the disease [3]. DMD is caused by a mutation on the X chromosome in the gene that codes for the dystrophin protein (which is why it primarily affects boys) [2]. Muscle weakness in both diseases typically begin to manifest in childhood or adolescence and its progression leads to a general deterioration of the condition [4; 5; 6; 7]. It is often accompanied by physical comorbidities and often ends in premature death [2; 8; 9; 10; 11].

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[1] Incidence of SMA 1:6–10,000 [1], incidence of DMD 1:3,600–9,300 [13].

The symptomatology of the disease varies between children with SMA and DMD, ranging from mild muscle weakness to complete paralysis. Common symptoms include delayed motor development, difficulty sitting and standing, walking independently, and the inability to jump and run [12]. Often, these children become wheelchair dependent during their lives. Respiratory and cardiac functions are impaired, scoliosis and joint contractures are typical for these children [2; 12; 14]. Boys with DMD tend to have delayed speech development and an increased risk of associated specific learning disabilities, cognitive impairment, autism spectrum features, or mental retardation [14].

Modern medical, surgical and rehabilitation care can optimize the physical health of these individuals and potentially extend life expectancy into adulthood [15; 16]. Various studies show that their quality of life (QoL) and well-being is affected by empowered autonomy and supported social participation rather than the diagnosis itself [17; 18]. For children with NMD, adolescence is often associated with increasing dependence on a caregiver, which can lead to the loss of important socialization experiences [19]. The aim of this paper is to present the findings regarding social participation of children and adolescents with NMD, to identify the barriers that hinder them in this area, and to propose recommendations for school practice based on these findings.

To understand and operationalize social participation in the context of this paper, a multidimensional approach was adopted based on the following two definitions. Levasseut et al. (2010, p. 2148) [20] define social participation as 'a person's involvement in activities that provide interaction with others in society or the community'. Koster et al. (2009) [21] defined social participation in the school context, which includes four dimensions: social acceptance by peers, self-perceived social acceptance, social relationships, and social interactions among children.

2. METHODOLOGY

This paper is primarily based on studies [19; 22; 23; 24; 25; 26; 27] that were retrieved as part of an initial literature search on the topic of 'psychosocial functioning' of children and adolescents with progressive neuromuscular disease. Full texts were searched in the EBSCO Discovery Service using a combination of selected keywords 'neuromuscular disease OR neuromuscular disorder OR neuromuscular illness OR spinal muscular atrophy OR muscular dystrophy OR dystrophy' (TI) AND 'psychosocial* OR social* OR well-being OR wellbeing' (TI). The text is further supplemented with findings on the topic from grey literature and other relevant studies that were retrieved from the reference lists of the literature included.

3. SOCIAL PARTICIPATION OF CHILDREN AND ADOLESCENTS WITH NMD

In studies, children and adolescents with NMD reported that social participation and involvement in meaningful activities allowed them to achieve some independence from their families and provided opportunities to gain new experiences and skills, which had a positive impact on their self-confidence [19; 22]. However, the progression of the disease generally made it difficult for adolescents with NMD to participate in various activities [27]. Study results show that, on average, children and adolescents with NMD score lower in the areas of leisure and social participation compared to their intact peers, raising some concerns [26; 28; 29]. A study involving boys with DMD found they often suffered from isolation and poor peer relationships [30]. Similarly, a study by Hinton et al. (2006) [31] reported that boys with DMD had more problems with social behaviour than their non-disabled peers and children with other physical disabilities.

In a study by Mazzella et al. (2021) [32], a similar number of respondents with SMA (n = 85, age 12-25 years) reported that SMA had either significantly affected or had no effect on their schooling or socialisation. In their systematic review, Travlos et al. (2017) [26] presented the results of studies on social participation in young people with NMD (n = 411; age 12-22 years; 91% boys/82% with DMD; SMA, CMD, MyoD); in one study, two younger NIV (non-invasive ventilation) users rated their social and school functioning in the PedsQL test well above the average of all comparison groups. In contrast, in another study, ten slightly older NIV users scored 31% worse in the SF-36 social functioning test compared to a normative population. Four studies found that emotional and social functioning scores were lower in younger participants with DMD compared with adolescents with DMD in late adolescence (two studies), young men with DMD using NIV (two studies), and adolescents with a relatively severe but non-progressive form of NMD (one study).

This review also presented the future aspirations of individuals with NMD. Many of them wanted to get a job, study, get married, or have children. One of the parents revealed that their child wanted to travel after study. In one research study, 83% of 24 men with DMD (NIV, n=3) aged 8-19 years attended compulsory school, 89% played

a sport and 92% were engaged in a leisure activity; 66% of these men were engaged in some form of employment [26].

In three qualitative studies, older participants (18-21 years) showed ambivalent feelings and expectations about independent socialisation. In one study, these participants avoided interviews as well as considerations and practical preparation for the future. In another study, to maintain a positive mental state, they chose to focus on experiencing the present and leading a good life 'here and now' [26].

Social participation and relationships with peers

Studies show that peer acceptance and successful integration into a peer group are key factors influencing satisfaction of children with NMD, as well as their self-esteem and willingness to repeatedly engage in activities [24; 25]. In a study by Stroobach et al. (2023) [24], classmates and assistant teacher often played a supportive role in engaging children with NMD in classroom and playground activities. This support consisted mainly of physical and practical help, as well as adapting games to enable children with NMD to fully participate. Parents described that social interaction with peers often acted as the main motivation for their children's participation in activities. One of the parents said: *the social aspect is just as important because the people around him are what makes his experience great*. Trust in the social environment also played a key role in engaging in group activities. It was this feeling of safety that gave the children the courage to explain their health condition to others and ask for appropriate help or modification of activities.

On the contrary, in a Canadian study by Chatur et al. (2024) [33], children and adolescents with NMD (n=14; 10 boys; DMD 50%, MyoD 21%, other NMD 29%) aged 10-19 years reported experiences of bullying. However, all of them mentioned having at least one or more friends. Yet many of them experienced discrimination stemming from their differences related to neuromuscular conditions such as requiring mobility support, differences in their body weight or stature, or the inability to speak aloud due to tracheostomy. Where the child with NMD was of different nationality (n=6), the excuse for bullying was often that English was not their first language. One participant said that children with neuromuscular diseases tend to be perceived as different from 'normal' children, which can cause fear or insecurity in some people. Such people then try to humiliate children with differences to make themselves feel superior or better. Also, schools that did not have equivalent accessible entrances created potential and actual situations of bullying by peers and teachers for these young people with NMD.

The negative interpersonal interactions faced by children with NMD in the study often stemmed from a lack of understanding of their differences and not knowing how to engage them in shared activities. Participants in the study described situations where they were not invited to events such as skating or swimming, or to games during school breaks, because their peers assumed they could not participate in these activities. Although children did not believe that their friends had acted with intent to harm, they felt excluded and hurt. These experiences underline the importance of raising awareness about the inclusion of children with differences in mainstream activities to avoid unwanted isolation and unnecessary pain [33].

Despite repeated experiences of bullying, participants were able to cope with these situations thanks to the support of their surroundings, their own strategies, and resilience-building programmes. They developed problem--solving skills, learned to react less emotionally and to seek support from the family, friends, or teachers. Some choose to ignore bullying, confront it or focus on the positive aspects of their lives. Understanding the motives of bullies, for example, that their behaviour often stems from their own problems, helped participants better manage negative interactions. Although many were able to reduce their sensitivity to bullying and find ways to cope, some continued to show emotional vulnerability and difficulty regulating their reactions. According to participants, helpful support included the school (teachers and directors), peer support, parents, and external support through health care institutions. Interestingly, participants mentioned that educating their peers about their neuromuscular conditions prevented, mitigated, or stopped bullying in many cases [33].

Interesting insights on social participation were provided in a study by Oldford et al. (2022) [22], in which all nine participants (13-19 years) spoke about their experiences with socialization. Two participants specifically mentioned the use of technology for online socializing, for example through video games or social media. Four participants reported spending their free time alone doing their favourite activities. The most frequently mentioned persons with whom participants socialized daily were members of their family, which is quite expected given their age and place of residence.

Similarly, in a study by Travlos et al. (2019) [25], engagement in 'relationships' was most reported through 'online communication' (29 out of 37 aged 13-22 years, 78%) and 'providing support to friends or family during

difficult times (e.g., by listening and supporting them)' (n=24, 65%). In contrast, 'spending time with a boyfriend or girlfriend' was the least reported activity (n=6, 16%).

Various studies monitored the experiences of participants with NMD who grew in their sense of identity and self-confidence through social groups of people with similar difficulties [19; 26]. In a study by Parkyn & Coveney (2013) [19], boys who were part of the MD Mafia group2 emphasized the importance of interactions and relationships with peers with the same type of illness and a sense of belonging to a group. The group also defined itself by the activities it undertook together, such as attending a football match, 'a night out at the casino', and playing video games. Participants appreciated that all these activities were offered for free. Similarly, in a study by Mazzella et al. (2021) [32], participants agreed on the high importance of peer support groups. One respondent elaborated, 'A group where we can just talk to each other about the issues we have, how we deal with them, joke with each other, and just connect over it' (boy with SMA, age 18).

4. BARRIERS TO SOCIAL PARTICIPATION OF CHILDREN AND ADOLESCENTS WITH NMD

Barriers to social participation for children and adolescents with NMD suggested by studies include unsuccessful attempts to participate in activities that were accompanied by a lack of support from those around them. This situation led to the child's loss of confidence, frustration and avoidance of further participation in the activity. The consequence of such a negative experience for some children was the formation of a negative relationship with their health and body. Children said things like: *'I hate my feet'* or *'Why don't they want to work?'* [24].

Another key role is barrier-free accessibility of the environment and services [23; 24; 32; 33]. Children and adolescents with NMD in studies often faced significant challenges in accessing social leisure activities. In a study by Stroobach et al. (2023) [24], access to restaurants, parks, swimming pools and community events was often described as difficult or limited. Parents described that the barrier of friends' houses, transportation3, or public spaces limited their child's interactions with peers and thus their child's self-esteem [22; 24].

Not only external environmental barriers, but also internal barriers related to the personality traits of children with NMD can be an obstacle to social participation. In a study by Parkyn & Coveney (2011) [19], parents gave examples of their boys lacking confidence in activities that should be easy for an average teenager. For example, when buying ice cream in a shopping centre or crossing pedestrian crossings. Developing the independence and social skills needed to interact in the wider community was identified as a huge challenge for the families involved in the research. In a study by Parkyn & Coveney (2013) [19], boys with DMD did not feel comfortable asking friends or strangers for help to use the toilet, which significantly limited the social activities they could participate in.

A study by Qian et al. (2015) [23] identified other barriers to social participation such as weakness and fatigue in children with NMD or exhaustion caused by the time required to prepare for activities, especially when patients needed breathing support or many aids. Some parents involved in the study limited social activities, including school attendance, to protect their child with NMD from respiratory infections.

In a study by Mazzella et al. (2021) [32], the impacting socialization factors included activity limitations, communication difficulties, and feeling judged or misunderstood. One girl with SMA said: *SMA affects my social life very much. I never want to go out because everyone stares at me everywhere I go* (aged 12). Also, in a study by Yang et al. (2021) [27], a girl with SMA expressed concerns about being accepted by her classmates because of her dependence on others: *I do not like it when other people feed me at school because many of my classmates are there. I get embarrassed. I feel that it does not matter; it is just a meal. We always need someone to help us, but I feel that no one will like me because there are always adults around*.

Finally, attitudes of community members towards persons with disabilities were identified as a barrier to social participation [23; 24]. Studies by Chatur et al. (2024) [33] and Stroobach et al. (2023) [24] reported that greater education and awareness of society of the specificities of NMD and ways to involve children and adolescents with NMD in social events would probably promote their socialisation. One parent stated that peers and community members *...don't always know how to help him with another saying that ...everyone should have some disability training... I think it's good for their, people with disabilities', sense of belonging* [24].

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[2] MD Mafia is a group for boys with muscular dystrophy aged 12-18. They get to go out and do lots of stuff they do not normally do.

[3] Also, a case where an NMD child cannot take the bus with his/her friends but has to be driven by parents.

5. CONCLUSIONS

Social participation is the key factor affecting the quality of life of children and adolescents with NMD. Although these individuals face several barriers, appropriate support from family, friends, school and the wider social environment can significantly mitigate the impact of their condition and help to boost confidence, reduce social isolation, and promote overall well-being. To effectively integrate these children into society, it is essential to create a barrier-free environment and to support peer and wider public education about NMD. It is also essential to promote access to peer support groups and modern technologies, which are often an important tool for establishing and maintaining social ties. Emphasis on an individualized approach and support for natural socialization opportunities can contribute to an overall improvement in psychosocial well-being and enable children with NMD to participate in social life.

6. RECOMMENDATIONS NOT ONLY FOR SCHOOL PRACTICE

Based on the findings of the studies analysed, the following recommendations for educational practice were formulated:

- **Educating children and teachers about NMD**: Raise awareness of the specifics of neuromuscular disease among children, teachers and school staff. Focus on removing prejudice, promoting empathy and the ability to engage children with NMD in mainstream activities. Initiate trainings and workshops where children and teachers learn how to practically help children with NMD and adapt activities to be inclusive.
- **Creating a safe and inclusive environment**: Schools should provide the necessary equipment and technological tools to enable children with NMD to participate fully in learning and leisure activities, while adapting the environment to their physical needs. Promote trust and a sense of safety among children so that learners with NMD feel comfortable sharing their needs and asking for help with activities. Take active action against bullying and discrimination, promote mutual respect and acceptance of diversity.
- **Supporting peer interactions**: Create opportunities for interaction and collaboration between children in lessons, breaks, and leisure activities. Motivate peers to play a supportive role in engaging children with NMD in activities. Strengthen their role in preventing isolation.
- **Adapting activities**: Adapt school activities and games to allow all children to participate, regardless of their physical abilities. Consider employing assistant teachers to provide practical and organisational support for children with NMD in and out of the classroom.
- **Preventing social isolation**: Actively involve children with NMD in all school and extracurricular activities. Avoid their exclusion on the assumption that they cannot participate (e.g. swimming, school trips).
- **Promoting peer-support groups**: Encourage the formation and participation in peer support groups (e.g. community groups or online meetings) where children with NMD can share their experiences, gain a sense of belonging and build confidence.
- **Supporting psychosocial well-being of children with NMD**: Strengthen the independence and social competence skills of children with NMD. Give them choices, e.g. choose how they want to do a particular thing or activity, even if they cannot physically participate in all activities. This will strengthen their autonomy and self-confidence.
- **Individual self-management plans**: Create plans with children with NMD and their families that focus on self-care and independence. These plans should reflect children's personalities, include simple tasks and support their physical and mental abilities. For example, supporting and educating children with NMD in body awareness, recognising signs of fatigue and planning targeted rest can help them regain their strength and actively participate in social activities with their peers.
- **Cooperation with professionals**: Collaborate with external organisations and professionals who can provide additional support to the school for the inclusion of these children in society, such as special educators, psychologists, speech therapists, social workers, occupational therapists, physiotherapists, medical staff (e.g. school nurses), inclusion counsellors.

These measures not only improve the quality of life of children and adolescents with NMD, but also support their participation in social life, school culture, and group activities, which is essential for their overall development.

Involving the family and professionals increases the chances of successful inclusion and helps create an environment where children can feel accepted and supported.

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The Impact of the Choice of Asset Valuation Techniques on the Valuation of Agricultural Entities: A Case Study

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Abstract

Research aim is to analyse the impact of the choice of asset valuation methods on the financial performance of agricultural entities. Research problem: different methods can be used to value the assets of an agricultural entity in its financial statements. The choice of valuation method affects not only the accounting for all transactions relating to the use of assets, but also the financial position of the enterprise and its current and future performance. Therefore, there is a need to determine which valuation methodology reflects a more realistic representation of the financial position of the agricultural entity and provides users with true and fair information. In order to analyse the impact of asset valuation techniques on the financial performance of the enterprise, a simulation model was developed based on the data AC X. It was found that the valuation of fixed assets at revalued amount and of biological assets at fair value less point-of-sale costs has a significant impact on the financial performance of AC X. The application of fair value based methods results in an increase in the value of total assets, equity and liabilities on the company's balance sheet, and also increases the company's profits, which in turn leads to an increase in the profitability of sales. The return on assets and return on equity decrease. Indebtedness ratios are also reduced, making the company more attractive to creditors.

Keywords: asset valuation, historic cost, fair value, financial results

1. INTRODUCTION

The actual financial position of an entity is critical to the correct decision-making of external and internal users of information and is linked to the presentation of true and fair information in the financial statements. To present true and fair information in the financial statements, it is important to make the appropriate choices and apply the required methods of measuring financial items, both in recording items at initial recognition and in preparing the financial statements. One of the elements of financial statements is assets. The consequences of an inaccurate valuation of an asset may be felt for several periods. The structure of the balance sheet, the income statement, the amount of depreciation expense and tax calculations will all depend on the valuation of assets. Therefore, the valuation of assets in corporate accounting needs to be given considerable attention.

Research problem: different methods can be used to value the assets of an agricultural entity in its financial statements. The choice of valuation method affects not only the accounting for all transactions related to the use of assets, but also the financial position of the enterprise and the current and future performance of the enterprise. Therefore, there is a need to determine which valuation methodology reflects a more realistic view of the financial position of the agricultural entity and provides users with true and fair information.

The object of the study is valuation methods.

Research aim: to analyse the impact of the choice of asset valuation methods on the financial performance of agricultural entities.

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Study objectives:

1. identify the advantages and disadvantages of the cost and fair value methods of valuing assets,
2. to determine the impact of cost and fair value measurement techniques on the financial position and performance of AC X.

Research methods: analysis of scientific literature, comparison, case study.

2. THE ADVANTAGES AND DISADVANTAGES OF COST AND FAIR VALUE MEASUREMENT TECHNIQUES

Valuation is commonly understood in accounting as the process of determining the value at which items in the financial statements are presented in the financial statements. The laws on corporate financial reporting in the Republic of Lithuania outline the rules for the valuation of corporate assets. These laws require companies to value assets in their financial statements in accordance with generally accepted accounting principles and business accounting standards. Since 2007, Lithuanian companies can choose between International Accounting Standards (IAS) and Business Accounting Standards (BAS), except for listed companies, which have to prepare their financial statements in accordance with IAS. Both IAS and IAS provide a number of main options for the valuation of assets: historical cost and fair value.

According to Bužinskienė, Montrimiene (2023), (IAS 12, 2016), Arjunan (2022), Barker et al. (2022), Modria et al. (2022), the most common method of valuing assets in practice is the acquisition cost method. According to the Accounting Standards for Business Enterprises (IAS 12, 2016), and Bužinskienė, Montrimienė (2023), Rudžionienė, Lukošiūnaitė (2020) „*cost is the amount of cash or cash equivalents paid or payable, or the value of other assets given or consumed in exchange, at the time of the asset's acquisition or construction*“. Bužinskienė, Montrimienė (2023), Arjunan (2022), Barker et al. (2022), Modria et al. (2022), Rudžionienė, Lukošiūnaitė (2020), Candra et al. (2022), Li et al. (2024), Jang, Yehuda (2021) argue that the main purpose of this approach is to correctly value the asset by attributing to the value of the asset the full amount of the principal costs of acquiring and producing it. Kalčinskas, Kalčinskaitė-Klimaitienė (2017) state that „the basis for the valuation of tangible fixed assets should always be the actual cost of acquisition (in other words, the 'cost to oneself'), which is also referred to as the acquisition (production) value". However, it should be noted that, although the cost method is simple, widely used and labour-intensive, it does not always reflect the true value of an asset. Table 1 highlights the advantages and disadvantages of valuing assets at cost.

Table 1. Advantages and disadvantages of the cost method (compiled by the authors from Bužinskienė, Montrimienė (2023)

Benefits	Disadvantages
Cost is easy to calculate. A simpler and more stable way	The fair value of assets, which changes over time as the business situation changes, is not reflected, resulting in a misstatement of the entity's financial results
An entity can reliably measure cost because the acquisition of an asset is evidenced by the relevant purchase or exchange transactions, which are the basis for measuring it.	Making it harder to compare assets
No additional cost, as the company's specialists can determine this value themselves from the acquisition documents	

To summarise the data in Table 1, the cost method, although simple and labour-intensive, does not always reflect the true value of an asset. And it is very important for company managers to know not only how much it cost to acquire an asset, but how much it is worth now. Therefore, over time, it has become apparent that it is no longer sufficient to use double entry accounting, recording all transactions and events at cost, but that other methods must be used to give a true and fair view of the financial position and performance of the company and its cash flows. This becomes particularly important when everything around you is changing: resource prices, wage rates, interest rates, real estate and other commodity prices. The analysis of the academic literature shows that an increasing number of authors refer to the fair value approach in their articles. According to Rudžionienė and Lukošiūnaitė (2020) fair value accounting is based on market equilibrium with a perfect competitive environment. This theoretical ideal consists of the same expectations of all market participants, the availability of all commodities, the absence of transaction costs and taxes, and the same interest rates for money invested and borrowed in capital markets. Under these conditions, the fair value of an asset is its objective market value, and it is then easy to determine the fair value of an asset because it is simply the market price, which is independent of the individual conditions in a given company. However, such ideal conditions do not exist in reality - firms operate in markets that are not perfect and where neither market equilibrium nor objective market value exist. Therefore, it is argued that the determination of the fair value of an asset is quite complex and that fair value can only be defined as an approximation rather than a specific value.

However, it should also be noted that the initial valuation of assets also distorts the true financial position and performance of an entity as prices change. Thus, the academic literature has shown a debate about which valuation method a company should choose to value its assets, and whether historical prices are better than certain varieties of present value.

According to Rudžionienė and Lukošiūnaitė (2020) „the choice of asset valuation method is particularly relevant for the valuation of long-lived assets, as valuation at historical cost usually leads to impairment of the asset's value, thereby reducing the availability of long-term credit. Valuing short-term assets at cost can lead to a reduction in costs and an increase in taxable profits". According to DeFond et al. (2020), the future financial reporting framework should include only fair value-based information, which will make the financial statements more informative and transparent. Thus, according to all the authors who have analysed asset pricing issues, companies that use only historical prices in their accounting records are presenting in their financial statements a state of affairs and performance that is out of line with market conditions rather than the true state of affairs. Therefore, in the opinion of the author of the study, today's management needs require timely information on the financial position of the company, which would nevertheless be better reflected by the use of current values.

In the author's view, fair value can be defined as the amount for which assets or services can be exchanged. The fair value of an asset can be measured reliably if fluctuations in its fair value are insignificant or if the likelihood of the results of different valuations varying can be accurately determined or estimated.

Table 2 highlights the main advantages and disadvantages of the fair value option.

Table 2. Advantages and disadvantages of fair value measurement (compiled by the authors based on Rudžionienė, Lukošiūnaitė (2020), Ahn et al. (2020), DeFond et al. (2020)

Benefits	Disadvantages
Allows for an objective assessment of cash flows	Difficult to assess in the absence of active market share
Shows how efficiently assets are used	Indicates the notional value, which may nevertheless differ from the transaction price
Makes it easier to compare the value of assets, making it easier to assess and analyse	Requires additional costs and good professionals
Financial reporting reflects a more realistic view of the company's financial position	Because it is new and rarely used in practice, there is a lack of specialists and methodological information. There is no specific guidance in the Financial Accounting Regulations on how to reliably determine this value.

The analysis of cost and fair value approaches shows that there are advantages and disadvantages to both approaches, making it difficult for managers to decide which approach to use when valuing assets.

An analysis of articles by various authors in this decade and the last decade on cost-based and fair value-based methods of valuing assets shows that almost all of the authors are of the same opinion, recommending that companies should choose the fair value method of valuing assets. According to Rudžionienė, Lukošiūnaitė (2020), Ahn J. et al. (2020), DeFond et al. (2020), Fukui et al. (2022) and other authors, the fair value approach is more promising as it allows for a more realistic value of assets and more reliable performance and financial indicators. It also simplifies accounting by eliminating the need to calculate the cost of all types of production. According to the authors, the fair value of assets reported in the balance sheet is consistent with the real value of the assets at the reporting date, and the fair value of assets is consistent with the accounting prudence principle and provides valuable feedback to users.

According to Rudžionienė and Lukošiūnaitė (2020), in order to increase the reliability of accounting and reporting data, it is necessary to abandon the tradition of valuing only at acquisition cost, as such valuation is in many cases biased. In his view, the fair value method should be used to value assets. The author also recommends this method for agricultural holdings with biological assets, as the fair value method provides a more reliable and realistic valuation of assets.

Foreign authors also support the view that assets should be measured at fair value. Sharma et al. (2024) argue that applying the fair value approach internationally would increase the comparability of corporate financial information. DeFond et.al. (2020), Alharasis et al. (2022), Mahieux (2022) argue that fair value measurement is important for the decisions of creditors, investors as it reflects a company's true financial position. The cost method also influences decision-making as long as the carrying amount is reasonably consistent with fair value. When cost deviates from fair value, the influence of cost-based decision making decreases. According to Fukui, Saito (2022), the world needs to phase out the historical cost approach and adopt the fair value approach. According to him, fair value accounting provides more information for management functions. According to Blecher (2019), companies adopting the fair value measurement approach will generate greater social welfare, and a financial statement based on fair value is more useful in assessing the performance of the company in calculating financial ratios.

However, there are other opinions. Kalčinskas, Kalčinskaitė-Klimaitienė (2017) consider that the historical cost method is flawed because it focuses on the past, but reflects the costs actually spent to acquire the asset. The author argues that fair value does not indicate anything because it focuses on the real price of the asset, which can only be

the case in one instance: at the time of sale-purchase. Cahyani, Firmansyah (2023), Nguven, Tran (2023) are also not very positive about the fair value method of valuation. They consider that fair value measurement is less objective and verifiable, and that the size of the entity affects the relevance and reliability of the fair value effect in financial statements. Alharasis et.al. (2022) argue that fair value measurement is more like a forecast than a reality. Zhang et al. (2020) also doubt that fair value measurement of assets provides any benefit. Blecher (2019) argues that the choice of valuation method depends on a variety of factors that influence the use of one or the other method. As companies can choose which valuation method to use, this author believes that the choice of valuation method may be influenced by factors such as the size of the company, the composition and durability of the assets held, the tax system of the country, etc.

In summary, one of the most pressing issues in corporate accounting is the choice of how to value assets, because the valuation of assets determines the reliability of information about the assets and financial position of an entity. IAS and IAS prescribe that assets should be measured at historical cost or fair value. Both methods have advantages and disadvantages, making it difficult for managers to decide which method is appropriate. The literature review shows that many authors favour the fair value approach and suggest it for companies that have a large number of fixed assets with a long useful life and a high degree of market volatility. They consider that the fair value of assets provides a more accurate assessment of financial ratios, such as the liquidity of the company and the profitability of assets. This information is particularly relevant for capital formation, bank borrowing and other purposes. For small, young companies that have no plans to borrow, are saving money and do not want to incur additional costs, the authors suggest that the cost approach should be used, as the costs of accounting for assets at fair value may exceed the benefits, thus violating the requirement of optimality.

After analysing the advantages and disadvantages of valuation methods, the author proposes that companies should value assets at fair value. Although more complex and labour-intensive, this method provides a more accurate reflection of the company's financial position and performance, and more accurate financial ratios, which are essential for true and fair information.

3. THE IMPACT OF ASSET VALUATION TECHNIQUES ON THE FINANCIAL PERFORMANCE OF AC X

Calculations have been carried out to justify that the use of fair value provides a more reliable and realistic financial valuation of the company. The author has selected the data from the financial statements of the agricultural company X for the calculations. The calculations were based on the company's balance sheet, profit and loss account, accounting policies and information provided by the company's accountant.

AC X was established in 2015 and its main activity is crop farming: cultivation of cereals (wheat, barley), storage and marketing of cereals. The company has 400 ha of cultivated land.

The assets of AC X comprise fixed assets, biological assets and current assets. Fixed assets consist of tangible assets, biological assets consist of crops, agricultural produce consists of grain, and current assets consist of inventories, receivables within one year and cash equivalents. Inventories are stated at the lower of cost and subsequently cost or net realisable value when acquired; receivables and cash equivalents within one year are stated at cost. There are no alternatives to change the valuation methods for current assets and therefore the value of these assets remains the same in the following calculations.

The valuation of tangible assets in the financial statements may be based on the historical cost or revalued amount method. Many authors argue that it is appropriate to measure tangible assets on a fair value basis because these assets represent the largest proportion of a company's asset structure and, therefore, changes in the value of these assets have the greatest impact on the company's financial performance.

For the purposes of the financial statements, AC X measures its property, plant and equipment at cost and applies the straight-line method of depreciation to these assets.

The revalued amount of the fixed assets of AC X was determined on the basis of the active market price. If there is no active market, the fair value is determined by reference to the market price of identical assets. If it is not possible to determine the market price of an identical asset, then the value of the asset is determined by reference to the market price of a similar asset. When the fair value of an asset cannot be determined in the market because it does not exist or because of significant improvements in technology, the asset is carried at cost.

Tangible assets

The fixed tangible assets of AC X comprise: land, buildings and structures, equipment and vehicles. As already mentioned, the company owns 400 ha of arable land in Prienai district. The land was purchased in 2015 for EUR 400 000. As the land is not depreciated, the carrying amount at 31 December 2023 remains the same as at the date of purchase, i.e. EUR 400 000. In order to find out what the land is currently worth on the market and how it differs from the balance sheet, a market price analysis was carried out. The revalued value of the land according to the active market price was established on the basis of data from the agricultural land values map of the registry centre

(http://www.registrucentras.lt/masvert/). According to the data of the Centre of Registers, the value of land in the Prienai district ranges from EUR 3801 to 4500/ha. The highest price of agricultural land, i.e. EUR 4 500/ha, as reported by the Register Centre, has been selected for the calculations (see Table 3).

Table 3. Value of tangible fixed assets of AC X as at 31.12.2023

Tangible fixed assets	Carrying amount, EUR (estimated cost less depreciation)	Market value, EUR (revalued)	Difference between carrying amount and market value, EUR
Land (400 ha)	400.000	1.800.000	1.400.000
Building (900 m)^2	38.240	190.000	151.760
Tractor Case magnum 310	1	32.700	32.699
Harvester Massey Ferguson Cerea 7278	1	35.000	34.999
Drill Kongskilde	1	9.500	9.499
Iveco 35c15 truck	1	9.800	9.799
Total:	**438.244**	**2.077.000**	**1.638.756**

Table 3 shows that the revalued value of the agricultural land is as much as 4.5 times (EUR 1 400 000) higher than the carrying amount as at 31 December 2023, calculated on the basis of the cost method. As the difference in value between the balance sheet value and the revalued value of the land is sufficiently large, it is appropriate for the land to be revalued at the market price.

AC X has one building which houses the company's administration and the company's ancillary facilities (200 m^2) and grain storage (700 m^2). The building was purchased in 2017 for EUR 71700. The depreciation standard for buildings in AC X is 15 years (Appendix 1 to the Law on Corporate Income tax).

The revalued amount of the Company's buildings is based on the active market price of similar buildings offered for sale in similar locations on websites. The price of the building 900 m^2 is based on the price of a similar building found on skelbiu.lt (https://m.skelbiu.lt/skelbimai/parduodamos-gamybines-patalpos-prienu-rajone-patalpos-76840559.html).

Table 3 shows that the carrying amount of the building at 31 December 2023, calculated at cost (less depreciation), is EUR 38240. The revalued value of the building is EUR 190000, which is EUR 151 760 higher than the carrying amount at 31 December 2023. As the difference between the revalued value of the building and the carrying amount calculated on the basis of the cost method is very significant, it is appropriate for the AC X to revalue the building on the basis of the market value. The revaluation of the building will allow a more realistic view of the value of the building in the company's financial statements.

The group of machinery and equipment of AC X consists of: a Case magnum 310 tractor, a Massey Ferguson Cerea 7278 combine harvester, a Kongskilde Demeter Combiseed drill. The company's depreciation allowance for the tractor, combine harvester and seed drill is 5 years (Appendix 1 to the Law on Corporate Income tax). The agricultural machinery was purchased by the company in 2015 and has a carrying amount of EUR 1 each as at 31 December 2023. The fair value of the tractor, combine harvester and drill can be estimated using active market prices.

The price of a Case magnum 310 tractor (made in 2009) is calculated on the basis of the price of a similar tractor found on the website skelbiu.lt (https://m.skelbiu.lt/skelbimai/parduodu-traktoriu-case-magnum-310-76614327.html).

The price of the Massey Ferguson Cerea 7278 harvester (made in 2008) is calculated on the basis of the price of a similar combine harvester found on the website autoplius.lt (https://autoplius.lt/skelbimai/fendt-8350-massey-ferguson-cerea-727-kombainai-17173857.html).

The price of the Kongskilde Demeter Combiseed drill (made in 2006) is also calculated on the basis of the price of a similar drill found on the website autoplius.lt (https://autoplius.lt/skelbimai/kongskilde-demeter-combiseed-3-m-sejamosios-sodinamosios-25781384.html).

As the difference between the revalued value and the carrying amount of agricultural machinery is very large, it is appropriate to revalue this machinery at market prices. The revaluation of the agricultural machinery will provide a more realistic view of the value of the company's machinery in the financial statements.

X has an Iveco 35c15 truck (made in 2009). The depreciation standard for trucks is 4 years (Appendix 1 to the Law on Corporate Income tax). The market price of the truck is calculated on the basis of the price of a similar truck published on the autoplius.lt website (https://autoplius.lt/skelbimai/iveco-35c15-savivarciai-26780593.html).

As the difference between the revalued value and the carrying amount of the truck is significant, it is appropriate to revalue the asset at market prices in order to present a true and fair view in the financial statements.

In summary, the prices of real estate, agricultural machinery and vehicles can change significantly over time, depending on the economic situation of the country. As can be seen from the data in Table 3, the valuation of assets at cost does not always accurately reflect their true market value, and it is therefore appropriate to revalue assets

periodically, especially those with a high value and a long useful life, as these assets are likely to have the most significant impact on the company's financial performance and the values of financial ratios.

Biological assets

The biological assets of the agricultural company X consist of crops and the agricultural production consists of cereals. The Company's accounting policy provides for the valuation of biological assets at acquisition (production) cost. In order to present a true and fair view in the financial statements, it is appropriate to measure biological assets at fair value less costs at point of sale. The fair value of the agricultural production (grain) of agricultural company X is determined by reference to the purchase prices of grain on 29-31 December 2023 (see https://www.linasagro.lt/matif-birzos-kainos), less costs at the point of sale.

The differences between the value of biological assets and agricultural production when valuing biological assets at cost and fair value less point-of-sale costs are shown in Table 4.

Table 4. Value of biological assets and agricultural production at 31 December 2023

Assets	At cost, EUR	Fair value measurement, EUR
Agricultural production	512.500	683.282
Crops	73.900	73.900
Unfinished production	43.600	43.600

Table 4 shows that the value of biological assets at cost is lower than their fair value less costs to sell. Although the differences in the value of the biological assets between the valuation methods shown in the table are small, the author considers that it is appropriate to value the biological assets at fair value less costs to sell.

In order to understand the impact on the financial position and performance of AC X of the valuation of fixed assets at acquisition cost and revalued amount, and of biological assets at cost and fair value less point-of-sale costs, a simulated balance sheet and profit and loss account has been developed (see Tables 5, 6).

Table 5. Balance sheet of AC X at 31 December 2023

Article from	Assets measured at cost, EUR	Fixed assets at revalued amount; biological assets at fair value, EUR
Fixed assets	**512.144**	**2.150.900**
Tangible assets	438.244	2.077.000
Biological assets (crops)	73.900	73.900
Short-term assets	**621.172**	**791.954**
Stocks:	556.100	726.882
Agricultural production	512.500	683.282
Unfinished production	43.600	43.600
Receivables within one year	51.232	51.232
Cash and cash equivalents	13.840	13.840
TOTAL ASSETS:	**1.133.316**	**2.942.854**
Shareholders' equity	**495.166**	**2.033.273**
Authorised or share capital	200.000	200.000
Revaluation reserve	0	1.538.107
Mandatory reserve	25.445	25.445
Retained earnings (losses)	269.721	269.721
Provisions for income tax	**0**	**271.431**
Accounts payable within one year and current liabilities:	**638.150**	**638.150**
Debts to suppliers	303.050	303.050
Income tax liabilities	47.598	47.598
Employment-related liabilities	127.100	127.100
Other payables and current liabilities	160.402	160.402
TOTAL EQUITY AND TOTAL LIABILITIES:	**1.133.316**	**2.942.854**

Table 5 shows that the revaluation of property, plant and equipment at revalued amount and the valuation of biological assets at fair value less point-of-sale costs resulted in a significant increase in the value of all assets. The difference in the value of total assets on the balance sheet amounted to EUR 1 809 538 (160 %). The increase in the revalued assets resulted in a revaluation reserve in the balance sheet (EUR 1 538 107) which led to an increase in

equity. The revaluation reserve is recorded at the amount resulting from the increase in the value of the assets resulting from the revaluation of the assets less the provision for income tax. The revaluation of the asset resulted in the carrying amount of the asset being higher than its tax base, giving rise to a taxable temporary difference which resulted in a deferred income tax liability. The provision for corporation tax (EUR 271,431) is calculated by multiplying the taxable difference by the corporation tax rate (15%). The deferred income tax liability has increased the company's total liabilities.

Table 6 shows an example of a simulated profit and loss account. As at 1 January 2023, the company's agricultural production balances had a balance sheet value of €184,800 and a fair value of €26,640. The carrying amount of crops at 1 January 2023 was EUR 45000 and the value of work in progress was EUR 20000.

Table 6. Profit and loss account of AC X as at 31 December 2023

Indicator	Assets measured at cost, EUR	Fixed assets at revalued amount; biological assets at fair value, EUR
Sales revenue	1.118.589	1.118.589
Change in the value of agricultural production	327.700	498.482
Change in value of biological assets	28.900	28.900
Change in value of work in progress	23.600	23.600
Gross production	1.498.789	1.669.571
Variable and fixed costs	1.181.470	1.181.470
Profit from typical activities	317.319	488.101
Corporate income tax (15%)	47.598	47.598
Net profit	269.721	440.503

Table 6 shows that the company's variable and fixed costs and income tax are unchanged as a result of the revaluation of the assets on 31.12.2023, and are the same as when the assets were valued at cost. However, it should be noted that next year, when depreciation will start to be calculated on the significantly higher value of the property, plant and equipment, the costs will increase. Net profit increased by EUR 170,782, i.e. 63.3%, as a result of the increase in gross production.

The analysis shows that the fair value measurement of assets has a significant impact on the financial position and performance of AC X. The valuation of assets affects not only the level of assets, equity and profits, but also the financial ratios (see Table 7).

Table 7. Financial indicators of AC X in 2023

Relative indicators	Assets measured at cost, EUR	Fixed assets at revalued amount; biological assets at fair value, EUR
Profitability indicators		
Operating profitability, % (VP/PP*100)	28,37	43,64
Net profitability, % (GP/PP*100)	24,11	39,38
Return on assets, % (GP/T*100)	23,8	14,97
Return on equity, % (GP/NK*100)	54,47	21,66
Liquidity (solvency) ratios		
Total liquidity ratio (TT/TL)	0,97	1,24
Critical liquidity ratio (TT-A)/ CI	0,1	0,1
Net working capital, EUR (TT-TOU)	-16.978	153.804
Turnover rates		
Asset turnover ratio (PP/T)	0,99	0,38
Indebtedness indicators		
Leverage (I/NK)	1,29	0,45
Indebtedness ratio (I/T)	0,56	0,31

As can be seen from the data in Table 7, the financial ratios of AC X differ between the cost and the fair value methods of valuation. When fixed assets are valued at revalued amount and biological assets are valued at fair value less point-of-sale costs, the increase in the values of the profitability ratios is due to the increase in the company's

profits. The return on assets and return on equity decreased, with a particularly significant decrease in the return on equity (-32,81 p.p.), due to the revaluation of assets resulting in a revaluation reserve in the company. It can therefore be concluded that the profitability indicators are affected by accounting differences.

The analysis of the company's solvency situation shows that the fair valuation of assets increased the gross liquidity ratio and net working capital. The increase is due to an increase in current assets as a result of the revaluation of agricultural production at fair value. However, it should be noted that the company has a very low critical liquidity ratio. This situation indicates that the company has a large amount of inventories that will have to be sold.

The asset turnover ratio decreased, due to a 160% increase in the value of the assets as a result of fair valuation.

The gearing ratios of AC X at fair value also decreased. The lower these ratios, the better the company's situation. Creditors will always prefer low debt ratios. If a company has a high level of liabilities and little equity or assets, it will be less attractive to investors because of the investment risk.

The analysis shows that the application of the revalued amount method for fixed assets and the fair value less costs at point of sale method for biological assets will be continuously influenced by the market situation, as well as many other conditions. Such fluctuations in the value of assets affect the presentation of equity and the value of assets in the financial statements and, as a result of these fluctuations, users of the financial statements are able to see a truer and more accurate representation of the company's financial results.

4. CONCLUSIONS

1. Assets may be accounted for in two main ways: based on historical cost or fair value. The literature review found that the authors prefer the fair value-based approach because the use of fair value provides a more reliable and realistic valuation of assets. Proponents of the cost approach argue that fair value-based valuation is unreliable because the real price of an asset can only be determined in one case: at the time of sale/purchase. Fair value proponents argue that fair value based valuation provides a more accurate representation of the value of the asset on the balance sheet at the reporting date, thereby providing users of financial statements with more realistic financial information about the entity.

2. The results of the simulation suggest that the valuation of fixed assets at revalued amount and biological assets at fair value less point-of-sale costs has a significant effect on the financial performance of AC X. The application of fair value based methods results in an increase in the value of total assets, equity and liabilities on the company's balance sheet and an increase in the company's profits, which in turn results in an increase in the profitability of sales. The return on assets and the return on equity decrease, with a particularly significant decrease in the return on equity, which is due to the revaluation of the company's assets resulting in a revaluation reserve. Indebtedness ratios also decrease, making the company more attractive to creditors.

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The Effect of Marine Environment on Durable Concrete

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Abstract

The effect of marine environment in the durable structural concrete is an important problem. This paper presents an analysis of a normal environment concrete of 45 MPa (NC 35/45) and marine durable concrete of 45 MPa (MC 35/45) compressive strength and permeability of durable concrete. Both the types of concrete were produced with river materials with different chemical composition. After 90 days were measured the penetration of chloride and water penetration in specimens of durable concrete that are treatment in two environmental conditions. We prepared the mix design with aggregates from 2 different deposits, from river and crashed resources. The results of the test shoes that even a small increase of W/C ratio can increase the concrete permeability to a great extent. Again, permeability is the most important Characteristics determining the long-term durability of reinforced concrete exposed to seawater as it controls the diffusion of aggressive salt-ions into the concrete. In our case a ratio 0.4 is taken in all mix designs formulated. The results also show that the concrete samples which were designed with river aggregates has lower penetration of chlorides.

Keywords: permeability of durable concrete; magnesium content; concrete chloride content

1. INTRODUCTION

Durable concrete, in reality, is a highly versatile and flexible family of construction materials that has performed extremely well in some of the most demanding and aggressive service and exposure conditions. As a material of construction, it embodies high strength, high performance, heavy and normal weight, fiber-reinforced, polymer concrete, and the list goes on. If we designed and constructed according to the standard, concrete construction life has to often outperformed its design life [14].

Some of the more challenging concrete construction is in marine, off-shore, gravity platforms, etc. In marine structures, durability against chlorides and sulphate-rich waters that influence in the concrete of structures are often the overriding constraints. Accordingly, building structural with durable and high-strength concrete has emerged as a highly suitable material for construction in civil and marine structures. Structural durable concrete (SDC), of course, has well-established advantages in comparison with normal-weight concrete (NC) [7]. The mix proportions, strengths, modulus of elasticity development, water/cement ratio, and chloride and sulphate penetration are presented and discussed.

In this study, we say "cement" refers to Portland cement. The cement is a bind material which when water is mixed with water, it forms a paste that binds the aggregate together, through a process called hydration, causing the hardening of concrete. Tricalcium silicate is responsible for most of the early strength (first 2 days). Dicalcium

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silicate reacts more slowly and so contributes only to strength at later ages [13]. The other major components of Portland cement, tricalcium aluminate and tetra calcium aluminoferrite, also react with water. However, because these reactions do not contribute significantly to strength, they are not taken into consideration. The physical characteristics of aggregate can indirectly affect strength because they affect the workability of the concrete. If the aggregate makes the concrete unworkable, more water is added, and this weakens the concrete by increasing the water-to-cement ratio. It is also important to ensure that for reinforced concrete, the nominal maximum size of aggregate should be such that the concrete can be placed without difficulty. Additives also play an important role in the durability of concrete. Some admixtures add fluidity to concrete while requiring less water to be used [6].

Superplasticizer is an admixture, which affects in workability of the concrete. This makes concrete more workable or fluid without changing the water/cement ratio. [5]. The strength of concrete depends very much on the hydration reaction discussed above. Indeed, the water/cement ratio of concrete is the single most important factor that influences the strength of concrete. Porosity is thus determined by the water-to-cement ratio. A low water-to-cement ratio leads to high strength but low workability. A high water-to-cement ratio leads to low strength but high workability. In this research, all factors that have a significant effect on durable concrete [11] are represented.

2. MATERIALS AND METHODOLOGY

The details of the experimental program have been reported in this study. A brief summary is given below: Two types of concretes are curing half of them in normal environment and the other in marine environment, both of C 35/45 at 90-day compressive strength were designed [4]. They are referred to (NC 35/45) and (MC 35/45), respectively. The raw material characteristics used for producing those types of concrete are represented as follow:

2.1. Cement

Composition of Portland cement, CEM I 42.5 R type cement conforming EN 197-1 was used in this study. The cement class, chemical, physical and mechanical characteristics are tabulated in Table 2.1.1, 2.1.2, 2.1.3.

Table 2.1.1. Chemical Composition of CEM I 42.5 R TITAN cement

No.	Chemical composition	Units	Test results	Standard limit based on EN 197-1 standard
1	SiO_2 (Min.)	%	18.01	-
2	Fe_2O_3 (Min.)	%	2.69	-
3	Al_2O_3 (Min.)	%	4.58	-
4	MgO (Max.)	%	1.80	5.00%
5	CaO (Min.)	%	61.23	10.00%
6	SO_3 (Max.)	%	2.67	3.50%
7	(Cl) (Max.)	%	-	0.10%
8	I.R (Max.)	%	0.3	5.00%

Table 2.1.2. Physical Properties of CEM I 42.5 R TITAN Cement

No.	Physical characteristics	Units	Test results	EN 197-1 Standard limit
1	Specific surface, Blaine	cm^2/g	3842	± 200
2	Specific density	g/cm3	-	± 50
3	Standard consistency	%	28	-
4	Initial setting time	min	2h:30min	60
5	Final setting time	min	-	-
6	Loss on ignition (L.O.I)	%	-	≤5%
7	Expansion	mm	0	≤10 mm

Table 2.1.3. Mechanical Properties of CEM I 42.5 R TITAN Cement

No.	Mechanical characteristics	Units	Test results		
			2 Days	28 Days	EN 197-1Standard limits
1	Compressive strength	MPa	26	48	2Days > 20 MPa 28Days ≥ 42.5 and ≤ 62.5MPa
2	Flexural strength	MPa			

2.2. Aggregates

Coarse aggregates - Gravel obtained from river of Mat in Milot and Erzen River, in Kruja quarry units have been used for this study [10]. Maximum size of aggregate used is 5-25 mm and specific gravity of ranging from 2.6 - 2.7 kg/m3. Coarse aggregates were both from river and mountain zone. Particle size distribution of coarse aggregates is represented in Fig.2.2.1 and 2.2.2.

Fine aggregates - Sand obtained from river of Mat in Milot aggregate river, in Kruja mountain quarry units have been used for this study too. Maximum size of aggregate used is 0-5 mm and specific gravity of ranging from 2.68 - 2.7 kg/m3. Fine aggregates were both from river and mountain zone [9]. Particle size distribution of fine aggregates is represented in Fig.2.2.3 and 2.2.4 and also in Tab.2.2.1.

Table 2.2.1. PSD test results obtained from coarse and fine aggregates used in production of durable concrete, 20mm

Granulated stone	20 mm		Milot River	
Dimension of sieves, (mm)	Weigh per each fraction (gr)	Weigh/total (%)	Passing Total in strainer (%)	Rest total in strainer (%)
< 0.075	12.50	0.22%	100	0
0.075	0.00	0%	99.78	0.22
0.125	0.00	0%	99.78	0.22
0.25	0.00	0%	99.78	0.22
0.5	0.00	0%	99.78	0.22
1.00	4.00	0.07%	99.78	0.22
2.00	6.50	0.11%	99.71	0.29
4.00	32.50	0.56%	99.6	0.4
6.00	212.00	3.67%	99.04	0.96
8.00	1053.00	18.23%	95.37	4.63
10.00	1243.00	21.52%	77.14	22.86
12.50	884.00	15.31%	55.61	44.39
14.00	693.50	12.01%	40.31	59.69
16.00	1487.00	25.75%	28.3	71.7
20.00	147.00	2.55%	2.55	97.45
25.00	0.00			100
31.50	0.00			100
40.00	0.00			100
	5775.00	**100.00%**		

Table 2.2.2. PSD test results obtained from coarse and fine aggregates used in production of durable concrete, 10mm

Granulated stone	10 mm		Kruja Mountain	
Dimension of sieves, (mm)	Weigh per each fraction (gr)	Weigh/total (%)	Passing Total in strainer (%)	Rest total in strainer (%)
< 0.075	3.50	0.06%	100	0
0.075	1.00	0.02%	99.94	0.06
0.125	1.50	0.03%	99.92	0.08
0.25	2.00	0.04%	99.89	0.11
0.5	4.50	0.08%	99.86	0.14
1.00	27.00	0.48%	99.78	0.22
2.00	778.00	13.87%	99.3	0.7
4.00	2234.00	39.82%	85.43	14.57

6.00	1416.50	25.25%	45.61	54.39
8.00	1137.00	20.27%	20.36	79.64
10.00	5.50	0.10%	0.1	99.9
12.50		0.00%		100
14.00		0.00%		100
16.00		0.00%		100
20.00		0.00%		100
25.00		0.00%		100
31.50		0.00%		100
40.00		0.00%		100
	5610.50	**100.00%**		

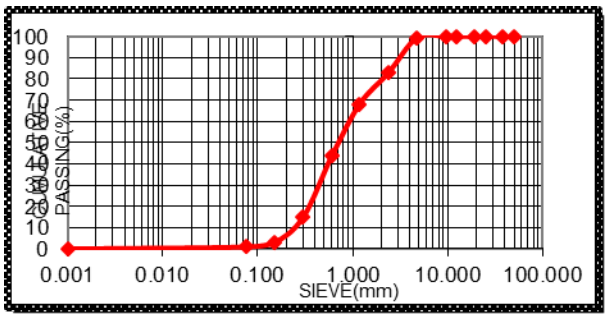

Figure 2.2.1: Milot river gravel PSD graph

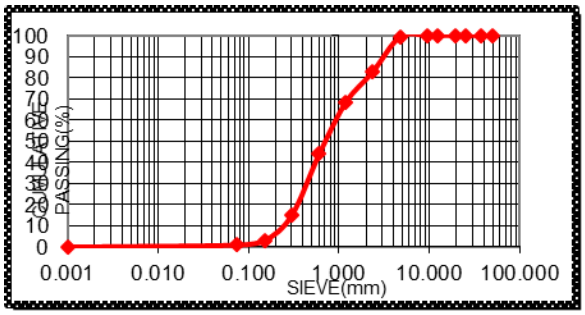

Figure 2.2.2: Kruja mountain gravel PSD graph

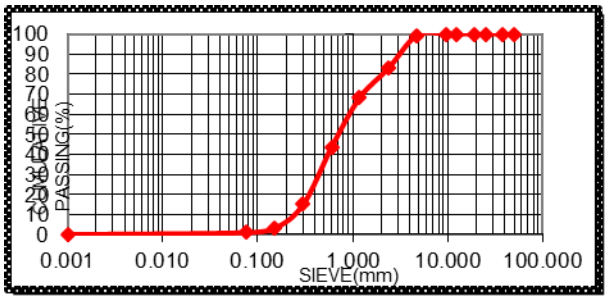

Figure 2.2.3: Milot river sand PSD graph

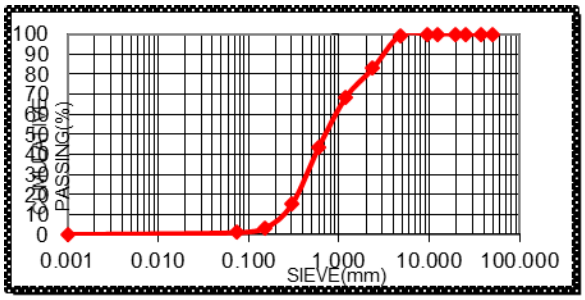

Figure 2.2.4: Kruja mountain r sand PSD graph

The aggregates used in this research were tested for composition by using the wet chemistry test analysis. The results of the tests are summarized in Table 2. Table 2.3.1: Chemical Composition of Kruja aggregates and Milot aggregates measured in [%] [8].

Table 2.3.1. The aggregate chemical composition

Chemical composition of aggregates	Chemical composition in [%]			
	CaO	MgO	SiO_2	Fe_2O_3
Milot (Mat river)	5.36	15.98	48.36	5.89
Kruja (mountain crashed)	43.59	4.23	0.18	0.12

2.3. Water

Potable tap water available in laboratory was used for mixing and curing of concrete is shown in Tab. 2.3.1.

Table 2.3.2. Characteristics of water used in production of durable concrete

No.	Characteristics	Units	Test results	Standard limits acc. EN 1008
1	Water resource	-	Potable	-
2	Color	-	Transparent	-
3	Odor	-	-	-
4	Water density @1900C	kg/l	1.0032	0.9982
5	Total hardness (CaCO3)	mg/l	2.56	-
6	Total dissolved solids @ 1800C	mg/l	3.24	≤4
7	pH value	-	7.23	≥4
8	Chloride content	mg/l	645	≤1000
9	Sulphate content	mg/l	986	≤2000
10	Salts content	mg/l	42	≤100

2.4. Admixture

Type Chryso fluid Premia 180 admixture is used for producing concrete class C 35/45 for this project study. The chemical characteristics of admixture used in concrete are represented in Tab. 2.4.1.

Table 2.4.1. Physical and chemical characteristics of super plasticizing admixture used in durable concrete

Chryso fluid Premia 180 admixture product	
Appearance	Liquid
Color	Brown
Density according to ISO 758	1.26g/cm3 (@ +20˚C)
Dry content according to EN 480-8	23.65%
Principal action	Increased and extended workability and reduction of water content
Classification according to UNI EN 934-2	Set retarding, high-range reducing, super plasticizing
Alkali content according to EN 480-10	<0.1%
pH according to ISO 4316	5.3 (@ +20˚C)

2.5. Durable concrete mix design

The mix quantities used and some characteristics of the durable concretes produced for normal and aggressive environmental ambient are shown in Tab. 2.5.1 and 2.5.2 [2]. In present study durable concrete class C35/45 was produced with mountain and river raw material both. All mix designs are formulated based on specifications of EN 206-1 standard.

Table 2.5.1. Durable concrete mix designs laboratory data for river materials

MIX DESIGN					
	Code	MC, NC			
	Laboratory name:	KIBE1 Laboratory			
	Concrete class:	C 35/45			
	Casting date:	10/10/2013;			
	Exposure class:	XS1; XS2; XS3			
	Standard deviation projection:	7 MPa			
DURABLE CONCRETE INGREDIENTS					
No.	Aggregate rivers materials	Descriptions		Results	
1	Cement	Type		CEM I	
		Class		42.5 R	
2	Water	From		TITAN	
3	Aggregates (Miloti,)	Crashed	Density [kg/m³]	Quantity [kg/m³]	Dosage [%]
	Sand 0/5 mm	River	2.631	915	48.1

	Gravel 5/10mm	River	2.681	294	15.4
	Gravel 10-25 mm	River	2.712	695	36.5
4	Additive	Type		Chryso fluid Premia 180	
		Dosage		1.20%	
		Reduction		30%	

INGREDIENTS QUANTITY

No.	Aggregates	Quantity for 1m3 [kg]	Quantity for 0.027 m3 [kg]	Humidity [%]	Absorption [%]	Corrected quantity [kg]
1	Sand 0/5 mm	915				
2	Gravel 5/10mm	294				
3	Gravel 10/25 mm	695				
5	Cement	380				
7	Water	151				
8	Additive ml/m3	4.56				
9	Total	2440				

FRESH CONCRETE PROPERTIES

No.	Characteristics	Units	Results
1	Concrete temperature	ºC	15.0
2	w/c	ratio	0.40
3	Slump	cm	20
9	Fresh concrete density	kg/m³	2440

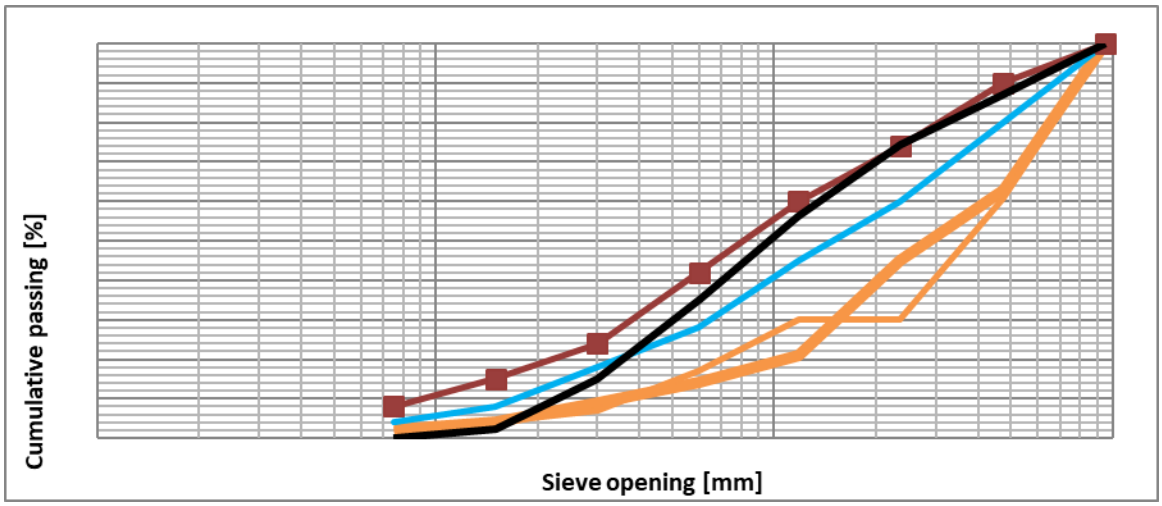

Fig. 2.5.1: Reference curve DIN ISO 1045 Grain maximal diameter = 30 mm

3. RESULTS

The porosity (pore size distribution) of concrete is an important factor determining the durability of the concrete in a marine environment [3]. A layer of impervious magnesium hydroxide is formed on the outer surfaces of the concrete with low water/cement ratios, which prevents the further ingress of magnesium ions. Nevertheless, the reduction the porosity of the concrete and the concomitant reduction in chloride diffusion rates is not the only important factor which can reduce the potential for corrosion of steel reinforcement in marine structures [16]. There is considerable evidence that concretes manufactured with Portland cements with higher levels of C3A are more resistant to corrosion than those with sulphate resisting cements [15].

Reductions in the permeability of concrete can be achieved through the use of higher cement contents (which inherently have lower w/c ratios), high range water reducing admixtures to reduce the w/c ratio further, and supplementary high Mg content aggregates, which reduce porosity through the formation of additional protective coating layer [1].

River raw aggregates materials from 2 different zones were used for production of durable concrete. Specimens of concrete with 150mm * 150mm * 150mm dimensions are treated in normal and aggressive environment [12].

Compressive strength, water depth penetration and chloride content are measured after 90 days curing age. Test results are represented in Tab. 3.1 and Tab.3.2 below:

Table 3.1. Test results obtained from durable concrete produced with Milot materials

No.	Normal water curing condition (River aggregates)			Aggressive curing condition (River aggregates)		
	Compressive strength	Water depth penetration	Chloride content	Compressive strength	Water depth penetration	Chloride content
1	47.56	13.6	0.019	42.73	17.3	0.018
2	48.23	13.5	0.022	46.42	16.2	0.022
3	48.25	13.5	0.022	45.24	18.0	0.015
4	49.00	13.2	0.023	48.60	14.6	0.019
5	49.06	13.2	0.034	48.05	17.0	0.016
6	50.02	13.0	0.021	48.11	14.8	0.015

Table 3.2. Test results obtained from durable concrete produced with Kruja materials

No.	Normal water curing condition (Kruja crashed aggregates)			Aggressive curing condition (Kruja crashed aggregates)		
	Compressive strength	Water depth penetration	Chloride content	Compressive strength	Water depth penetration	Chloride content
1	45.78	18.2	0.018	39.03	23.0	0.038
2	44.82	17.5	0.020	46.73	21.2	0.042
3	45.76	18.1	0.019	43.24	22.0	0.045
4	42.13	18.0	0.021	33.64	24.6	0.045
5	46.50	17.1	0.024	47.00	20.0	0.036
6	45.22	17.9	0.021	38.14	24.8	0.045

The relation between compressive strength (Y) and the chloride content (X), for two environments, in normal and marine environment, for durable concrete made with Milot materials, are shown in Fig. 3.1 and 3.2.

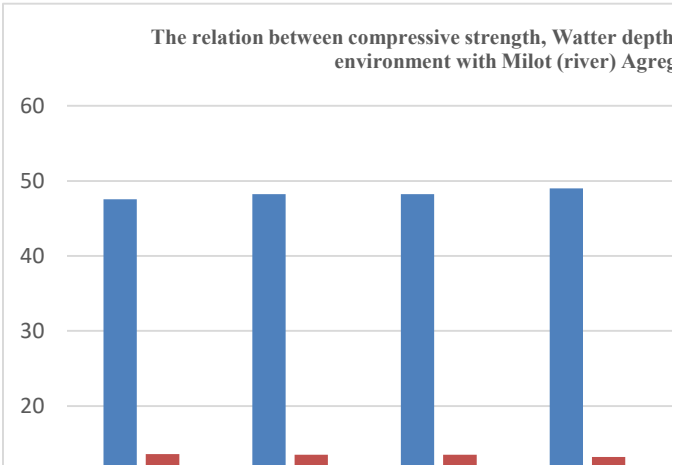

Fig. 3.1: In normal environment

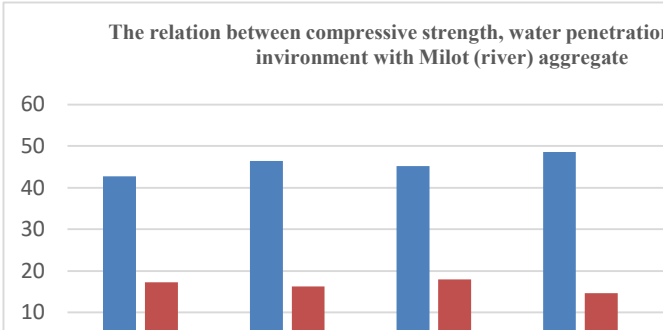

Fig. 3.2: In marine environment

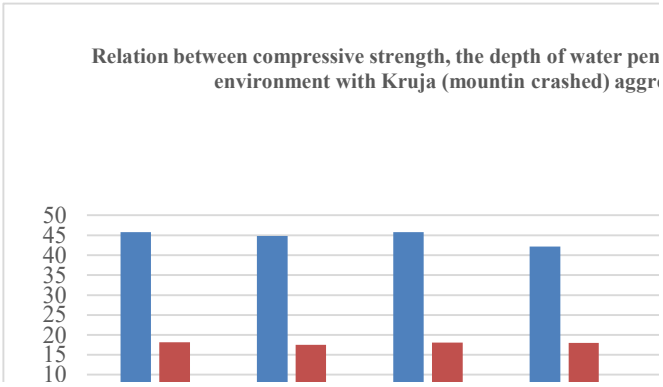

Fig. 3.3: In normal environment

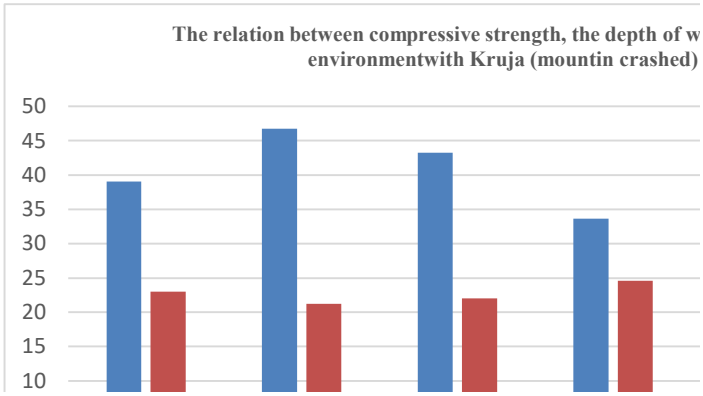

Fig. 3.4: In marine environment

The relation between compressive strength (Y) and the depth of water penetration (X), in normal, for durable concrete made with two different river materials, are shown in Fig. 3.5.

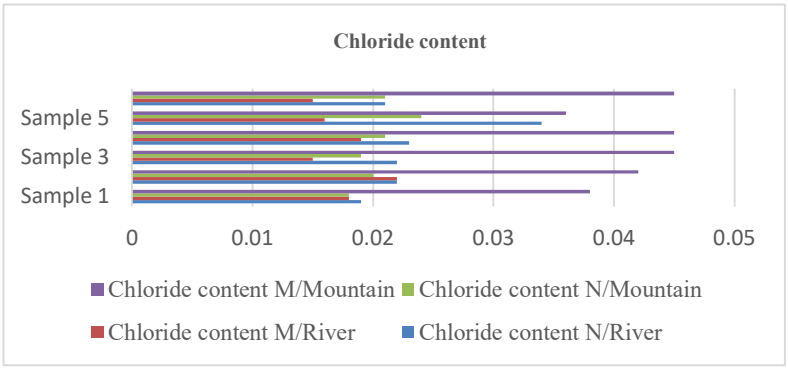

Fig. 3.5: Relation between depth penetration of Milot and Kruja aggregates, in Normal and Marine environment

The relation between compresive strength (Y) and the depth of water penetration (X), in marine environment, for durable concrete made with river materials, are shown in Fig. 3.6.

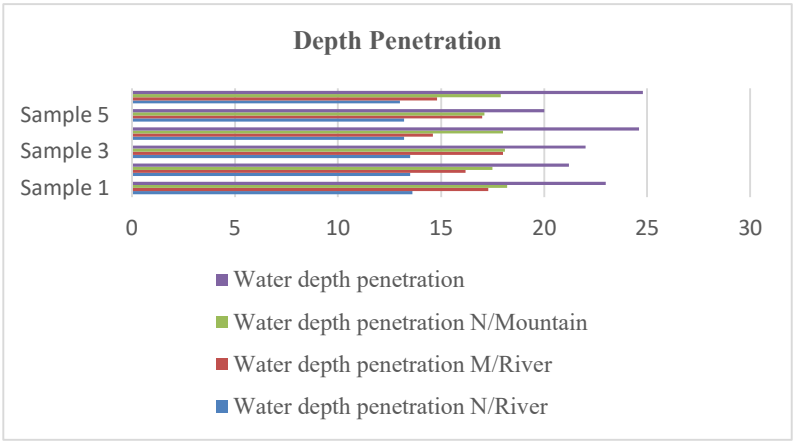

Fig. 3.6: Relation between depth penetration of Milot and Kruja aggregates, in Normal and Marine environment

The relation between Compressive strength (Y) and the depth of water penetration (X), in normale environment, for durable concrete made with Kruja materials, are shown in Fig. 3.7.

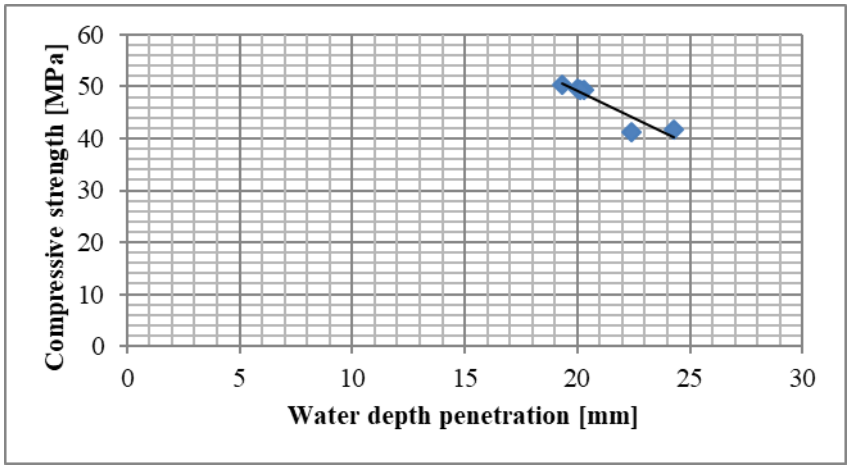

Fig. 3.7: Relation between depth penetration and compressive strength of Kruja materials, in Normal environment

The relation between compressive strength (Y) and the depth of water penetration (X), in marine environment, for durable concrete made with Kruja materials, are shown in Fig. 3.8.

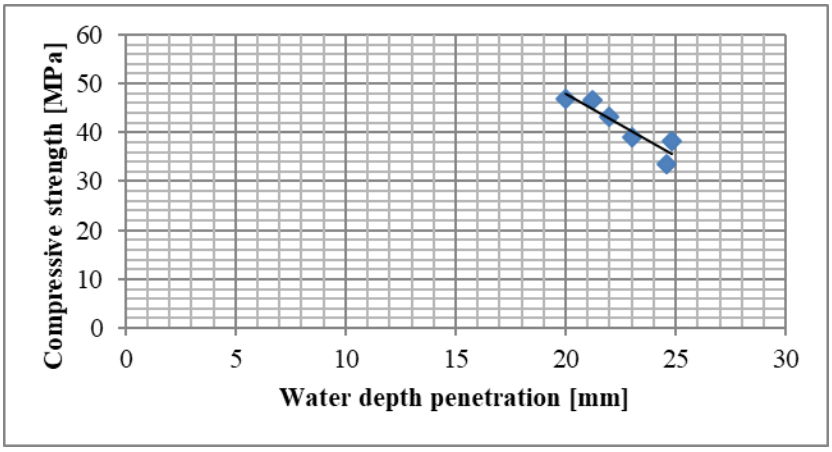

Fig. 3.8: Relation between depth penetration and compressive strength of river materials, in Marine environment

4. CONCLUSIONS

The properties and proportion of constituent materials of concrete have a large influence on the durability of concrete. To ensure adequate durability of marine structure, the river aggregates which are denser, are expecting to be acceptable for producing durable concrete.

It is clear that even a small increase of W/C ratio can increase the concrete permeability to a great extent. Again, permeability is the most important Characteristics determining the long-term durability of reinforced concrete exposed to seawater as it controls the diffusion of aggressive salt-ions into the concrete. In our case a ratio 0.4 is taken in all mix designs formulated.

Comparing test results obtained from durable concrete made with the river materials, which have a higher level of MgO, is obvious that low water depth penetration is indicated in durable concrete produced with these crashed materials and treated in aggressive environment. All data are represented in graph above. The results also show that the concrete samples which were designed with river aggregates has lower penetration of chlorides.

Acknowledgements

Text below continues as normal. I would like to express my gratitude to KIBE1 Laboratory, ALTEA& GEOSTUDIO Laboratory, REZIN ALBANIA company, SAG company for financial supporting of experiments used for this paper.

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Drivers for Electronic Wallet Adoption in Croatia: Technological, Individual and Contextual Determinants

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Abstract

This paper aims at exploring the key determinants of the adoption of electronic wallets (e-wallets) in Croatia, while focusing on the technological, individual and contextual factors. Using e-wallets is a secure and convenient way of making payments as opposed to the conventional methods, however, their adoption in emerging markets such as Croatia has not been well documented. The study employed a quantitative approach and the data collected from 371 Croatian consumers showed that system quality, trust, economic environment and technological infrastructure are the key predictors of e-wallet adoption. The regression analysis showed that while users found e-wallets easy to use, perceived ease of use and social influence were not very effective in influencing the user intentions. On the other hand, the study found that reliability, users trust and favourable economic conditions are the key factors that determine consumption behaviours. The results also show that there is the need to improve the regulatory frameworks and the technological infrastructure in order to enhance user confidence and thus increase the adoption rate. These findings are important for policy makers and service providers in order to improve the development of digital financial inclusion in Croatia.

Keywords: e-wallet adoption, Croatia, financial inclusion

1. INTRODUCTION

Mobile wallets are a form of electronic payment which is increasingly being used particularly among the populations in the developed countries. In this context, Sahut (2008) pointed out that the lack of network externalities has limited the acceptance of e-wallets in the European market. For a payment system to be successful, it must have merchants who accept the platform and users (Zmijewska & Lawrence, 2005; George & Sunny, 2021). This level has been shown to be a good predictor of people's willingness to accept mobile wallets (Seetharaman et al., 2017). Furthermore, the proportion of households that are banked varies widely across Europe. This lack of access to banking facilities is one aspect of a broader phenomenon, namely the different levels of financial access around the world (Demirguç-Kunt et al., 2020).

Technological innovations in cashless payments are justified because they increase security, speed up transactions and increase customer satisfaction (Ahmad et al., 2021). The factors that have been seen to influence the adoption of e-wallets include the usefulness of the service, the level of security, trust and the peer pressure (Gitau & Nzuki 2014; Johnson et al, 2018; George & Sunny 2021; Reiting et al, 2020; Teo et al, 2020; Siew Bee & Yan Ying, 2021; Christian et al, 2024). An e-wallet is defined as a digital wallet that allows consumers to make electronic payments and manage their payment instruments (Kınış & Tanova, 2022). Adoption is defined as the level of acceptance of using a new

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invention or technology. Technological, individual and contextual factors are all factors that affect the adoption process. Examples are system quality and service provision which are technological factors while personal innovativeness and trust willingness are individual determinants (Senali et al., 2022; Kustono et al., 2020).

Kınış and Tanova (2022) in their study attempted to establish how consumers prior knowledge of e-wallet technology and other factors such as perceived usefulness, ease of use and trust influence consumers attitudes towards the technology and their decision to adopt it in North Cyprus. The knowledge that consumers have of the product affects the perceived usefulness, ease of use and trust which in turn affect the attitude and the intention to adopt and use new technologies such as e-wallets. The findings also showed that those who were told that they would get their money back quickly in case they were scammed were likely to use e-wallet than those who were told that they may not get their money back or it may take time. The adoption of e-wallets in Croatia is an area in which one significant gap remains. For instance, Sahut (2008) established that the reasons for the limited adoption of e-wallets in the European market were attributed to the absence of network externalities. In the first place, we know very little about the determinants of the adoption of e-wallets in various cultural and economic environments. This gap is especially relevant because of the expanding use of mobile payment systems in these areas, which require more sophisticated knowledge of regional factors. Also lacking are holistic models that factor in different variables that shape the adoption of e-wallets. Existing studies have made they focus on specific factors, as perceived security or simplicity of use without examining at how these factors are interrelated (Lau, 2022). Therefore, an integrated approach is required to arrive at a more integrated understanding of the factors that shape the adoption of e-wallets and the development of interventions that seek to address several barriers at once. Moreover, there is a lack of research comparing how demographic variables, age and gender, affect and interact with these relationships such that the current evidence is limited in its generalizability (Ahmad et al., 2021). A study on the dynamics of e-wallet adoption in Croatia over time is also necessary. As mentioned above, most of the research that has been done is cross-sectional and therefore, only gives a picture of people's preferences and behaviour at a particular point in time (Cha et al., 2021).

In this way, this research fills small gaps in the research gaps when looking at factors that affect the adoption of e-wallets in emerging economies. It is based on the development of a comprehensive model of the factors. For the purpose of contributing to the understanding of the adoption process it analyses the technological, individual and contextual factors. Moreover, the research will examine the effects of demographic factors on the utilization of e-wallets, which will provide further insight into the perception and usage of e-wallets by various user groups in Croatia. Based on the literature gaps, the study answers the research questions.

1. To identify the determinants affecting the adoption of e-wallet in Croatia.

2. To measure the impact of several determinants on the adoption of e-wallet in Croatia.

2. LITERATURE REVIEW

2.1. Adoption of electronic wallet

Mobile payments (m-payments) are currently more common in Europe than in the United States. Chen & Nath (2008) also points out that there are several reasons for this difference. The United States has a well-established and secure credit and debit card payment system. Technology and consumer behavior are the main drivers of the global adoption of e-wallets. An e-wallet or digital wallet is a kind of electronic device which helps in receiving, keeping and sending money in the digital world. This technology has changed the financial sector by offering a way of sending and receiving money electronically rather than using cash or cards (Ahmad et al., 2021; Ciucan-Rusu et al., 2022). The following factors that influence the use of e-wallets globally are: technological, individual and contextual factors. Developed countries have more e-wallet adoption because of the availability of smartphones and the development of the digital infrastructure. Some countries in the Western world have adopted Apple Pay and Google Pay as forms of integration with the financial systems (Valencia & Layman, 2021). In developing countries e-wallets are vital in the provision of financial services since a large population is financially excluded from formal financial services (Ahmad et al., 2021; Tu, 2019).

E-wallets are crucial to financial inclusion and economic participation in emerging economies. Chen and Nath (2008) and Sahut (2008) have found that geographic factors are associated with the adoption of e-wallets in the United States and Europe respectively. Chen and Nath (2008) claim that the existing secure and efficient payment systems of credit and debit cards have big impact on adoption of mobile payment technologies in the United States. In Europe, according to Sahut (2008) the financial infrastructure is more fragmented and e-wallets can improve the speed and security of payments across different markets which makes mobile payments more relevant and necessary. In addition,

Some authors such as Kınış and Tanova (2022) stated that trust in technology is critical for the adoption of e-wallets. This may be because of satisfaction with existing services and security risks that are frequent in such regions. Another challenge in these regions is access to banking services and the high cost of transactions. E-wallets can solve these problems by offering low cost and easily accessible financial transactions (Siew Bee & Yan Ying, 2021). The use of e-wallets is due to technological advancements, consumer trust and a regulatory framework. Therefore, digital transactions have to be secure and trustworthy for consumers to have confidence in them (Senali et al., 2022). The state of the art in cybersecurity, digital literacy and complex regulatory environments are also a challenge (Ahmad et al., 2021; Kustono et al., 2020). Croatia's AirCash digital wallet is a great example of e-wallet adoption. In reference to the use of local solutions, they can be used to solve certain issues by offering certain benefits to users (Kınış & Tanova 2022). Which means that e-wallet solutions can be developed locally to meet the needs of larger markets (Ahmad et al., 2021). It is safe to say that the rates of e-wallet adoption in the future will depend on the technological and consumer behaviour developments. The use of blockchain and biometric identification would enhance the security and usability of e-wallets (Abbasi et al., 2022; Cha, 2021).

2.2. Determinants of e-wallet adoption

Technological, individual and contextual factors influence the adoption of e-wallet. System quality, security and ease of use are technological factors that enhance user confidence and satisfaction in the system if they are high (Senali et al., 2022). Innovativeness and trust in digital platforms are individual factors that are key in the adoption of e-wallet and are particularly evident among the young and tech literate population (Yang et al., 2021; Siew Bee & Yan Ying, 2021; Lau, 2022). Solutions for digital payment are regulated for regional needs and become popular in markets with underdeveloped traditional banking networks because of contextual factors which include cultural and economic factors (Ahmad et al., 2021). Therefore the factors under consideration work in combination to determine the adoption of e-wallets among various regions and users.

There are three different determinants to adoption of the e-wallet - Technological, Individual and Contextual.

2.2.1. Technological determinants

Technological factors are seen as the primary driver of e-wallet adoption. Perceived ease of use, system quality and security affect the adoption and use of the mobile payment system. Senali et al. (2022) argued that users prefer e-wallets that are secure and easy to use. In emerging economies, Ahmad Ramli and Hamzah (2021) established that the usability of the mobile payment system and perceived security are the determinants of adoption. The use of technology, the level of infrastructure development, consumers confidence and market development are all different in the United States and European countries in implementing the e-wallet. Chen and Nath (2008) argued that an efficient banking system that has introduced credit and debit cards has slowed down the adoption of mobile payment systems in the United States. Sahut (2008) and Fintech News (2019) have pointed out that the digital payment environment is evolving and digital payment instruments are gradually being replaced by more digital options as the market evolves and new generations demand more digital payment options.

Europeans use e-wallets more often than people in other regions because of the high mobile phone penetration and the financial ecosystem in these countries is divided (eMarketer, 2019; Stiltner, 2023). Demirguç-Kunt et al. (2020) observed that there is a high demand for financial technologies because of the need for more accessible and inclusive financial services across the economic sectors. This is because Europeans have strong regulations and fast adoption of technology in trade, thereby making consumers trust and accept mobile payment apps (George & Sunny, 2021). The findings of the study are consistent with the theoretical perspective because the perceived benefits of convenience, security and transaction speed converge with the overall global shift to digital financial services and the relatively higher European enthusiasm to embrace financial innovation.

2.2.1.1. Perceived ease of use and user interface design

Usability is another key technological factor that has an influence on the adoption of e-wallets. This factor captures how easy or difficult person thinks it is to use some system. Numerous studies have been conducted to establish that an easy to use interface enhances the adoption of e-wallets (Kustono et al., 2020). The emphasis on usability reduces the learning curve for new users and enhances the user experience thus leading to higher adoption rates (Demirguç-Kunt et al., 2020).

2.2.1.2. Security features and privacy concerns

Another important technological factor that increases the take up of e-wallets is security features. Ming et al. (2020); Ahmad et al. (2021); Senali et al., (2022) argued that users are concerned with the protection of the financial data and the unauthorized use of the funds. As a result, Shopeepay in Indonesia has been able to keep its customers by implementing strict security measures (Valencia & Layman, 2021). The effectiveness of e-wallets (Kınış & Tanova, 2022) is determined by the level of security and privacy as perceived by consumers. Sahut (2008) stresses that there is a need for very strict security and privacy policies which according to George and Sunny (2021) are crucial in capturing the trust of the consumers and make them adopt mobile payment solutions. Therefore, it is important for e-wallet providers to ensure that their platforms are secure and that they have ways of protecting consumers data. Therefore, it is crucial for e-wallet providers to make sure that the platforms they develop are secure and that they can protect consumers data. Thus, the success of e-wallet adoption in Indonesia can be attributed to several factors: Access, speed, promotion, acceptance from merchants, security and government support. These factors have greatly affected the consumption of e-wallet services by consumers in Indonesia. As for the research questions it is recommended that the government and regulatory bodies should remain supportive to the growth and development of e-wallets especially for the unbanked and underbanked populations. On the other hand, e-wallet providers should focus on improving security features and the customer experience to gain the trust of the public to increase adoption.

2.2.1.3. System Quality and Reliability

The quality and reliability of the e-wallet system are also important for its adoption. System quality includes stability, performance and responsiveness that determine the efficiency and reliability of e-wallets (Abbasi et al., 2022; Ahmad et al., 2021). E-wallet users do not want e-wallets that have frequent downtime or technical problems. Increasing the systems quality increases the user confidence and encourages the use of the e-wallets for more and frequent transactions.

Another technological factor that influences the use of e-wallet is its interface with other financial services and channels. E-wallets are most useful when they are linked to banking, online shopping and other financial products and services (Cha et al., 2021; Ahmad et al., 2021). Such integration facilitates the formation of a single digital financial platform and thus makes e-wallets more valuable for users who are looking for a single solution to their financial needs. The interconnectedness enhances the user experience and makes it more extensive and easier to use, thus increasing the adoption rates.

2.2.2. Individual determinants

Other factors that are also roles in the adoption of e-wallets are trust and innovation. E-wallet users are those who have faith in digital platforms and are willing to try out new forms of technology (Senali et al., 2022; Ciucan-Rusu, 2022). This is particularly the case with Generation Z who have faith in digital financial services and are tech oriented (Lau, 2022). E-wallet adoption varies with personal and contextual factors in the US and Europe. In the US, security, technology innovation and personal experience with digital payment systems are significant. Chen and Nath (2008) state that Americans are skeptical about e-wallets because they are confident and dependent on credit and debit cards. The FDIC (2019, 2021, 2023) survey also shows that financial literacy and the reliability of digital payment methods are the main individual determinants of e-wallet adoption. In their paper, Siew Bee and Yan Ying (2021) stated that the adoption of e-wallet depends on the perception towards technology and trust in the digital financial services. The use of e-wallets is inspired by several individual determinants.

2.2.2.1. Personal innovation and technology readiness

One of the most important roles in the introduction of electronic wallets is played by personal innovativeness of a person. This concept is the readiness of people to accept new technologies. Research reveals that a positive propensity to innovate enhances the e-wallets as experience seekers have low innovation resistance (Senali et al., 2022; Lau, 2022). The willingness to adopt new technologies increases the adoption of e-wallets hence personal willingness to innovate is an important factor in the adoption of e-wallets. Security and familiarity are not only individual determinants in Europe with its diverse economy and many cross border financial transactions. Demirguç-Kunt et al. (2020) and eMarketer (2019) explain that European users adopt e-wallets because of the cross-border transaction convenience and EU regulations of digital payment trust and security.

2.2.2.2. Trust and security perceptions

Trust in digital platforms is one of the most important factors that affect the decision to use e-wallets since users are likely to use a platform that is secure and reliable (Yang et al., 2021; Stiltner, 2023). Trust is developed by providing positive user experiences, having strong security measures in place and being fully transparent in our activities. According to Abdul-Halim et al. (2022), the level of trust that users have in e-wallets affects their decision to adopt and keep on using them. Senali et al. (2022) research also stresses the role of trust in the moderation of the security perception – user adoption relationship. Stiltner (2023) further established that cultural openness to technology and higher levels of technology penetration are strong determinants of e-wallet adoption. This suggests that in Europe, the perception of personal control over the use of new technologies and the general attitude towards innovation are the key predictors of mobile wallet adoption.

2.2.2.3. Perceived usefulness

The following individual determinants are identified to influence the adoption of e-wallets: perceived usefulness and perceived ease of use. Perceived usefulness is the level to which an individual thinks that the application of a certain system will help him or her perform his or her role better or make his or her work easier (Ahmad et al., 2021; Siew Bee & Yan Ying, 2021). This means the ease and quickness of e-wallets in the management of financial transactions. On the other hand, perceived ease of use is the effort required by the system to perform a task. Thus, the literature reveals that customers are likely to adopt an e-wallet that is easy to use and useful in their frequent spending (Kustono et al., 2020). These aspects are enhanced through the development of user-friendly interfaces to enhance the overall user experience.

2.2.2.4. Social influence

The use of electronic wallets is influenced by social factors such as peers, family and social norms and constraints, which make it an important determinant. Especially in collectivist cultures where people's behavior is shaped by the opinions and actions of others (Yang et al., 2021; Ahmad et al., 2021). This social component makes the adoption process easier and creates a community of users who can share their experiences and tips on how to use the product. The study also revealed innovativeness, trust, perceived usefulness, ease of use and social influence as the key determinants of e-wallet adoption. These factors are perception and behaviour related to the users and should therefore be taken into consideration in order to relieve the users concerns and make them use e-wallets. These determinants can be used by e-wallet providers to come up with strategies that enhance the acceptance and satisfaction of the users of the services.

2.2.3. Contextual determinants

Cultural and economic contexts are factors that can influence the adoption of e-wallets. E-wallets are a viable financial option for emerging markets with weak banking infrastructure (Tu, 2019; Ahmad et al., 2021). Family businesses and street vendors in these areas do not use cards because they prefer cash to avoid card transaction fees, thus there is a need for affordable digital payment solutions (Ahmad et al., 2021). The adoption of e-wallet is affected by several contextual models and determinants.

2.2.3.1. Cultural influence

A key factor that determines the rate of adoption of e-wallets and digital payment is cultural influence which includes social norms and peer behaviour that determine the adoption of new technologies (Ahmad et al., 2021). This cultural dimension focuses on social endorsement and the role of community leaders in the adoption of the digital payment system.

2.2.3.2. Economic environment

Another factor that is key in the adoption of e-wallet is the economy. E-wallets are important for the unbanked and the underbanked in the emerging markets because they offer them low-cost and easily obtainable financial services (Ahmad et al., 2021; Tu, 2019). Regional variations in economic policies and consumer protection laws affect e-wallet

adoption and integration in the US and Europe. A strong and well-established financial system with a high penetration of conventional banking channels has checked the very fast adoption of e-wallets in the US (Chen & Nath, 2008). Although robust, the regulatory framework has been slow to react to the fintech revolution, which may slow adoption. The FDIC (2019, 2021, 2023) reports that regulatory bodies are acknowledging fintech developments to enhance financial inclusion through digital financial services.

2.2.3.3. Regulatory framework

Regulatory framework for digital payment solutions across Europe enhances e-wallets economic integration. A country or region's regulations are important for e-wallet adoption. It can boost growth of e-wallets if there are favourable regulations for digital payments and consumer protection (Ahmad et al., 2021). Strict or unclear regulations are difficult to implement for e-wallet providers due to operational issues. The European Central Bank, together with national banks, has issued regulations to protect consumers and to promote financial sector innovation (eMarketer, 2019). The e-wallet services growth in Europe has been on the incremental side due to the EU Payment Services Directive 2 (PSD2) that opened the market to new market players and the development of new innovations (Stiltner, 2023). PSD2 is not only the number of the PayTech start-ups that it has encouraged, but it has also led to a integrated and competitive market for payment services across the European Union.

2.2.3.4. Technological infrastructure

The availability and the quality of the technological infrastructure are the key determinants of the e-wallet systems acceptance. E-wallet systems need a good internet connection, the use of smartphones and the development of the telecommunications networks (Siew Bee & Yan Ying, 2021; Kustono et al., 2020). The implementation of e-wallet systems is better in the regions with better technological development since digital services are more available and reliable in such areas. The region's advanced technological infrastructure facilitates easy and secure digital transactions and pushes the population to adopt e-wallets (Valencia & Layman, 2021). This is because e-wallets are difficult to use in areas with poor technological infrastructure, which could limit its financial inclusion potential.

1. Integrated models

The use of e-wallets is an evolving trend that requires a more holistic approach to understanding its drivers and motivations. While several studies have investigated the role of various factors individually, very few have tried to develop comprehensive models that can capture the interplay among these factors. Valencia and Layman (2021) stress service innovation and delivery in the context of customer satisfaction and loyalty, but technological and individual factors need to be taken into account to create a more complete picture. Abbasi et al. (2022) propose hybrid approaches based on PLS-SEM and fsQCA to study the role of various factors together and understand the complexity of e-wallet adoption.

2. Demographics

Another important area of research is the role of factors such as age, gender and education in moderating e-wallet adoption. But then again, older people and those in rural areas may be reluctant because of low levels of technology adoption and trust (Ahmad et al., 2021; Kustono et al., 2020). Knowing these demographic effects could aid in designing specific adoption plans for various users.

Finally, the study develops the theoretical framework:

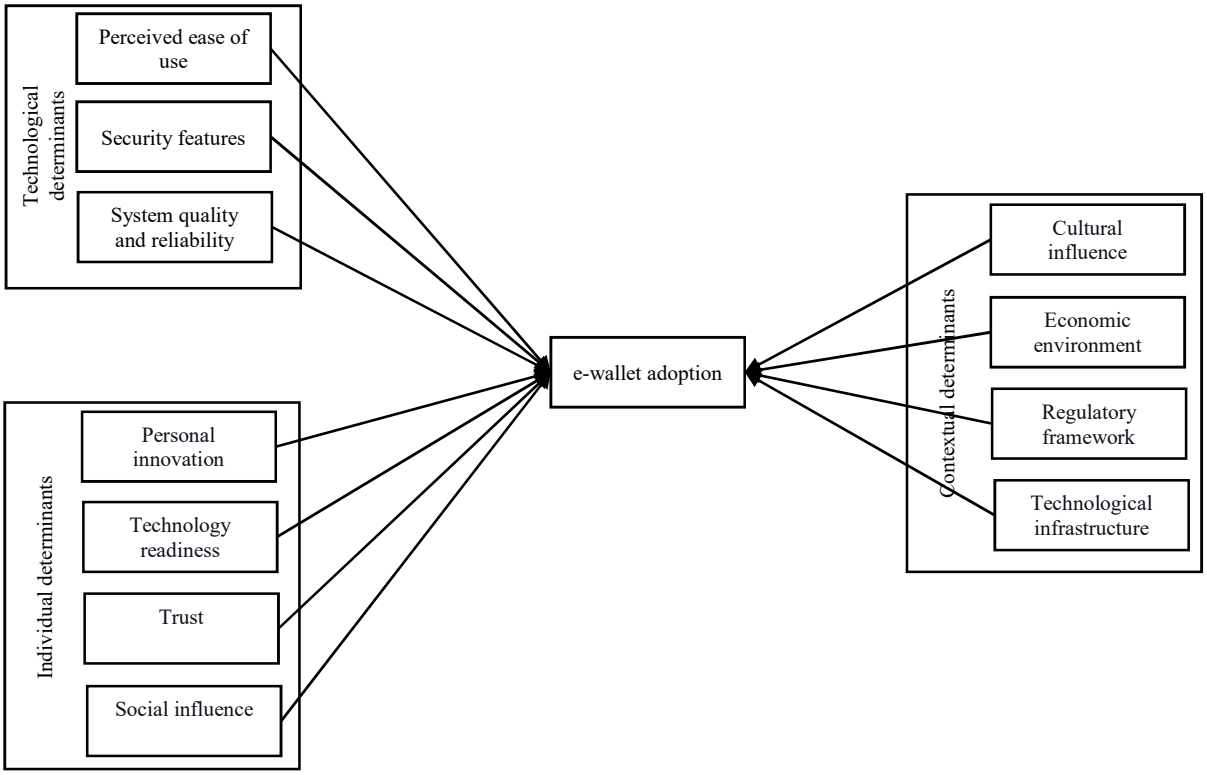

Figure 1. Theoretical framework

3. RESEARCH METHODOLOGY

The study design of the study is made on quantitative method to identify the determinants of e-wallet adoption in Croatia. Quantitative research is a scientific approach to research that enables the identification of patterns and relationships in a given population. The data was collected using an online questionnaire. This method is almost the same as other quantitative researches on technology adoption behaviour (Siew Bee & Yan Ying, 2021). Kınış and Tanova (2022) also carried out a similar study in Northern Cyprus to establish the determinants of e-wallet adoption. The questionnaire used in this study is structured to ensure that data is collected in a systematic manner so as to enhance the credibility and validity of the study results (Hair et al., 2019).

The target audience in Croatia was reached through an online survey administered through social media platforms since these are very popular in Croatia to ensure that the respondents of the study are diverse in all aspects. The questionnaire was developed to include questions that can aid in identifying the factors that influence the adoption of e-wallets. In order to define the population, the demographic section of the questionnaire contained information on the age, gender, education and employment of the respondents. The technological factors included questions on ease of use, security, system quality and reliability. These questions were based on previous studies made on the Technology Acceptance System (TAS) (Davis, 1989; Venkatesh and Davis, 2000). Other individual determinants include personal innovation, technology readiness, trust and social influence which were assessed using validated items from previous research (Rogers, 2003; Lau, 2022). The contextual determinants which are cultural, economic, regulatory and technological environment were also explored based on the literature on digital payment adoption in different environments (Ahmad et al., 2021). Hair et al. (2019) rated each item on a Likert scale, so that the data could be easily analyzed.

For data analysis is used statistics software SPSS. Descriptive statistics were used to present information about the sample population and the variables involved in the study, together with measures of central tendency and variability. Frequency statistics presented the distribution of the responses in the survey. Regression analysis was applied to establish the relationship between the determinants and the dependent variable, that is, the adoption of e-wallets. This is because, for the purpose of the present study this statistical method has been fitted to examine how several variables

affect one dependent variable and to explain the factors that moderate the adoption of e-wallets. The study also employed regression analysis to establish the effects of factors like trust, security and cultural attitudes on the adoption of e-wallets in the Croatian population. Thus, using this statistical approach, the study identified the determinants of e-wallet usage, which can be useful to stakeholders in the development of strategies to overcome obstacles to the adoption of e-wallets.

4. RESULTS

4.1. Demographic analysis

The survey was completed by 371 participants. The gender distribution shows that 34.77% of the participants are male and 65.23% are female, which indicates possible differences in the use or interest in e-wallets by gender. The majority of respondents are 25-34 (33.7%) and 35+ (43.1%) suggesting that it is young to middle-aged adults who are using e-wallets. Digital payments are used by the working population as 37.5% of the respondents are full time employee and 20.2% are part time employee. Majorities of participants have master's degree (66.0%), bachelor's degree (19.4%) and doctorate (12.9%), which suggests that e-wallet usage may grow with higher education attainment. These findings also highlight the need to target young, educated, employed Croatians for e-wallet adoption. To guarantee the inclusion of all segments of the population in digital financial participation, the data suggest measures to eliminate the gender gap and involve older individuals and those with lower levels of education.

Table 1. Demographic statistics (N=371)

Demographics	Categories	N	%
Gender			
	Male	129	34,77
	Female	242	65.23
Age			
	Under 18	17	4.6
	18-24	69	18.6
	25-34	125	33.7
	Older than 35	160	43.1
Educational Level			
	High school	6	1.6
	Bachelor's degree	72	19.4
	Master's degree	245	66.0
	PhD degree	48	12.9
Employment status			
	Student	71	19.1
	Employed full-time	139	37.5
	Employed part-time	75	20.2
	Unemployed/Retired	86	23.2

4.2. Descriptive statistics

The mean values in Table 2 present the characteristics of the response distribution of the population of interest regarding the adoption of the Croatian e-wallet. The high mean score for "Perceived ease of use" (4.0566) reveals that many users of e-wallets find these products easy to use. Therefore, one can state that the ease of use of this technology is an important factor in its adoption. The low standard deviation and variance of the responses also generalize that most of the respondents are in agreement that e-wallets are easy to use. The mean value of the “Security features” (4.0795) also creates a positive picture of the users trust in the security of e-wallets. It means that users are sure that their financial data is safe which is crucial for digital payments. Low variability of responses indicates that respondents are not insecure in their understanding of security. Trust was high (4.1267) and this points to the importance of one having faith in the reliability and security of systems in the adoption of e-wallets.

The mean values of "Cultural influence" (3.9394) and "Economic environment" (3.9933) show that cultural acceptance and economic climate also determine the adoption of e-wallets. The higher standard deviations for these variables reveal a greater spread in opinions and are, therefore, a function of cultural and economic realities in Croatia. The mean value for "Regulatory framework" (3.7642) reveals that respondents are not satisfied with the current regulatory framework of e-wallets. This implies that better regulation is likely to lead to increased confidence and adoption of e-wallets.

Technological ease of use and security, for instance, influence the adoption of e-wallets; however, other factors including cultural acceptance, economic state and regulatory framework also matter. So, if these areas are understood and improved, then the rate of e-wallet adoption in Croatia is likely to rise, leading to more people using digital payment methods.

Table 2. Descriptive statistics

Variables	N	Minimum	Maximum	Mean	Std. Error	Std. Deviation	Variance
Perceived ease of use	371	1.00	5.00	4.0566	0.03481	0.67044	0.449
Security features	371	1.00	5.00	4.0795	0.03513	0.67665	0.458
System quality and reliability	371	1.00	5.00	3.9865	0.03700	0.71269	0.508
Personal innovation	371	1.00	5.00	3.9084	0.03600	0.69337	0.481
Technology readiness	371	1.00	5.00	4.1671	0.03582	0.68996	0.476
Trust	371	1.00	5.00	4.1267	0.03494	0.67292	0.453
Social influence	371	1.00	5.00	4.1509	0.03535	0.68091	0.464
Cultural influence	371	1.00	5.00	3.9394	0.04258	0.82016	0.673
Economic environment	371	1.00	5.00	3.9933	0.04010	0.77238	0.597
Regulatory framework	371	1.00	5.00	3.7642	0.04182	0.80558	0.649
Technological infrastructure	371	1.00	5.00	4.0067	0.03862	0.74386	0.553

4.3. Regression analysis

To find out why people have embraced e-wallets, a regression analysis was conducted for Croatian users (see Table 3). Standard coefficients (Beta) and significance levels (Sig) were used to both the relative importance and the statistical significance of each determinant. System quality and reliability, trust, economic environment and technological infrastructure are revealed as significant predictors of e-wallet adoption (Beta = 0.199, $p < 0.001$; Beta = 0.123, $p = 0.026$; Beta = 0.231, $p < 0.001$; Beta = 0.129, $p = 0.014$). Thus, dependent and effective operational systems, reliable providers of the service, a good economic environment and a well-developed technological foundation positively influence the adoption of electronic wallets.

The analysis of the previous descriptive statistics also shows that users are highly satisfied with the quality of the system, which is why it is not surprising that the reliability of the system has a strong emphasis. This means that e-wallet providers must develop and implement strong security measures and transparent processes to gain and keep the trust of users. Moreover, the economic environment has a strong positive impact, meaning that convenience and cost are very important factors that drive the acceptance of e-wallets.

The analysis also shows that perceived ease of use ($p = 0.963$) and technological readiness ($p = 0.805$) do not have a significant impact on the adoption of e-wallets. Although users say that e-wallets are easy to use and are ready to use such technologies, these factors alone are not enough to push people to adopt them. Instead, they may be considered as common characteristics and not as important variables. Also, social influence, cultural influence and personal innovation have an insignificant effect on the adoption of e-wallets; hence individual tastes or social consequences are not as significant as the functional and infrastructural factors that influence the decision to adopt.

Table 3. Regression analysis

Model		Standardized Coefficients	t	p	95.0% Confidence Interval for Beta		Collinearity Statistics	
		Beta			Lower Bound	Upper Bound	Tolerance	VIF
1	(Constant)		.161	.872	-.398	.469		
	Perceived ease of use -> E-Wallet adoption	.002	.046	.963	-.105	.110	.566	1.766
	Security features -> E-Wallet adoption	.051	.966	.335	-.058	.169	.499	2.002
	System quality and reliability -> E-Wallet adoption	.199	3.980	.000	.104	.308	.554	1.804
	Personal innovation -> E-Wallet adoption	.044	.850	.396	-.062	.156	.515	1.942
	Technology readiness -> E-Wallet adoption	-.013	-.247	.805	-.127	.099	.482	2.074
	Trust -> E-Wallet adoption	.123	2.228	.026	.016	.254	.454	2.203
	Social influence -> E-Wallet adoption	.055	.967	.334	-.062	.183	.421	2.373

Cultural influence -> E-Wallet adoption	.042	.681	.497	-.071	.146	.371	2.693
Economic environment -> E-Wallet adoption	.231	3.663	.000	.102	.339	.349	2.862
Regulatory framework -> E-Wallet adoption	.093	1.864	.063	-.005	.176	.554	1.805
Technological infrastructure -> E-Wallet adoption	.129	2.471	.014	.026	.230	.507	1.971

The presence of multicollinearity, i.e. the situation where an independent variable is a linear combination of the other independent variables, can be a problem. The tolerance and variance inflation factors are a measure of this problem. A severe multicollinearity is indicated by a VIF value of more than 10 or a tolerance value of less than 0.1. But in this study all the VIF values are less than 3 and the tolerance values are all greater than 0.3 which implies that the independent variables are not highly correlated and hence do not distort the regression coefficients. The study is also open to possible biases from the method of data collection which is a random sample. This study can be generalized to all Croatian e-wallet users but it is not a probability sample. For example, the respondents could be more tech-savvy people who are active on social media platforms. To minimize this bias in future studies, researchers could use probability sampling or increase the diversity of the sample to improve the representation of the population of interest. The regression analysis also shows the significance of system quality, trust, economic environment and technological infrastructure for e-wallet adoption. These results are quite useful for e-wallet companies and policy makers as they should concentrate on improving the effectiveness of the system, enhancing customers confidence, improving the economic environment and building a solid technological platform to enhance the adoption. However, since there is no significant multicollinearity, these results are accurate; however, there is a chance of sampling bias and the extensions of these findings are more robust.

5. DISCUSSION

The results of the study indicate that the key factors that affect the acceptance of electronic wallets are system quality, trust, the economic environment and the technological infrastructure. These results are in consonance with a number of previous studies that have assessed these determinants. The result that system quality is the most important (Beta = .199, p <.001) is in line with previous research. In their study on consumer behaviour in Northern Cyprus, Kınış and Tanova (2022) established that consumer knowledge, perceived usefulness, ease of use, trust and the consumers attitude towards using an e-wallet payment system are important in the consumers decision to adopt the system.

Trust in the e-wallet provider is essential to secure payments and protect the user's details to encourage adoption. Abdul-Halim et al. (2022) also proved that trust is one of the key factors that affect the intention to use e-wallets. It is impossible to achieve trust in digital transactions to pay without paying attention to privacy and security risks. To resolve privacy and security risks, trust is required; therefore, it is impossible for digital transactions to function effectively. Economic environment (Beta = .231, p value <.001). Chen and Nath (2008) also proved that e-wallet adoption in the United States is driven by transaction cost and risk.

As in previous studies, the technological infrastructure (Beta = .129, p = .014) is also found to be a determinant of e-wallet adoption. To be effective, e-wallet cannot be used effectively in an environment with weak internet and mobile connectivity (George & Sunny, 2021). Technological infrastructure as reported by Ciucan-Rusu et al. (2022) is a determinant of consumers behaviour in online market platforms, including e-wallet adoption. Technology support makes it easy and fast to transact with the e-wallet, thus enhancing the user experience and adoption. The study established that perceived ease of use (Beta = .002, p = .963) and technology readiness (Beta = -.013, p = .805) had no effect on the adoption of e-wallet. This is in contrast with Tu (2019) who established that ease of use positively influenced the adoption of mobile wallet. Because Croatia has a high rate of smartphone usage and people are accustomed to using digital products, they may not consider the ease of use and technology readiness. Social influence was not mentioned as an important factor in e-wallet adoption by Valencia and Layman (2021) because of the cultural differences between the two countries, where social and cultural factors do not have a significant effect in Croatia. This variation can be attributed to social and cultural forces being relatively unimportant in Croatia than in other countries such as Indonesia.

The VIF values of all the variables are less than 10 and the tolerance values are greater than 0.1, which indicates that there are no severe multicollinearity problems. This ensures that regression coefficients are not biased by correlations between independent variables. There is a potential for bias in the study because it used convenience

sampling. This non-probability sampling may not capture all the e-wallet users in Croatia, especially those who are not very active on social media. The regression analysis reveals that system quality and reliability, trust, the economic environment and the technological infrastructure affect the adoption of e-wallet services among Croatian consumers. These factors have been found in previous research to play a role in digital payment adoption. Understanding these factors could be helpful in increasing the adoption of e-wallet services to expand the market for digital payment products. It is advisable that future studies should employ random sampling to minimize bias and compare the results across different demographic categories.

5.1 Managerial implications

As stated in this study, Croatian e-wallet payment companies should focus more on system quality and reliability as these are the key factors that affect e-wallet adoption. Thus, it is clear that users are more likely to appreciate a seamless process. Croatian e-wallet providers should focus on building a strong technological architecture and strict quality control to avoid mistakes and outages. Solving technical problems can improve users trust and increase the likelihood of using the application more often. However, since trust is a key factor, the companies should also use encryption, authentication and biometric identification to secure user's data. This can be supported by clear privacy policy and security certificates that can increase users trust towards the platform. The benefits of the digital wallet in terms of cost and the collaboration with the local merchants to provide e-wallet deals can increase the convenience and desirability of the payment method, thus increasing the adoption. Furthermore, through appropriate partnerships and educational initiatives, it is possible to eliminate the technological and educational barriers to the use of e-wallets. For instance, users are likely to be concerned with the costs of the transactions and therefore, e-wallet services that offer lower costs or even free transactions, may be preferred. The ability to make use of e-wallet for both online and offline merchants can increase the convenience and make it a more desirable payment method. This can help in increasing adoption through the collaboration with local businesses to offer e-wallet exclusive deals. Last but not least, Croatian e-wallet providers should focus on technology. E-wallet usage is most effective with high internet and mobile network coverage. It is therefore possible that companies could team up with telecoms to enhance signal reception, particularly in previously uncharted territories. Online literacy campaigns can also assist e-wallet users to navigate through the wallet with ease leaving them with no excuse of not using the wallet. In this case, companies can remove these infrastructural and educational barriers to ensure that the user base and hence the e-wallet adoption.

5.2 Limitations and future directions

This study's reliance on convenience sampling may not fully capture the perspectives of all Croatian e-wallet users, leading to a limited representation. The current sample, comprising tech-savvy social media users, warrants further consideration of less technologically-inclined individuals and those with restricted internet access. Future investigations should employ probability-based sampling techniques, such as random or stratified sampling, to obtain a more representative sample. This approach could uncover e-wallet adoption rates across diverse demographic subgroups, including the elderly and rural populations. Additionally, the cross-sectional design of this study provides a snapshot at a single time point, lacking the ability to track time-related shifts in user behavior and perception. Longitudinal studies would be beneficial to investigate e-wallet adoption and user perspectives at different time points, potentially revealing the effects of adoption interventions and factors that facilitate or inhibit use over an extended period. While this study examined numerous determinants, there may be other influential factors, such as financial literacy, marketing efforts and the impact of peer influence, that merit further exploration. To gain a more comprehensive understanding of e-wallet adoption, future research should employ a combination of quantitative and qualitative methods, including techniques such as interviews and focus groups. This multifaceted approach could expand the findings and provide valuable insights for e-wallet providers when developing their strategies.

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Appendix A - Survey questionnaire

SECTION 1: DEMOGRAPHIC INFORMATION

1) What is your age?
   a) Under 18
   b) 18-24
   c) 25-34
   d) Older than 35
2) Always What is your gender?
   a) Male
   b) Female
3) What is your education level?
   a) High School
   b) Bachelor's degree
   c) Master's degree
   d) PhD degree
4) What is your employment status?
   a) Student
   b) Employed full-time
   c) Employed part-time
   d) Unemployed/Retired

SECTION 2: TECHNOLOGICAL DETERMINANTS OF ADOPTION OF E-WALLET

		SD	D	N	A	SA
	Perceived Ease of Use					
1.	Using an e-wallet is easy for me.					
2.	I find the interface of e-wallets user-friendly.					
	Security Features					
3.	I feel that my financial information is secure when using an e-wallet.					
4.	The security measures of e-wallets (e.g., encryption, two-factor authentication) are satisfactory.					
	System Quality and Reliability					
5.	The e-wallet I use performs reliably without frequent technical issues					
6.	I am satisfied with the quality of service provided by my e-wallet.					

SD - Strongly Disagree, D – Disagree, N – Neutral, A – Agree, SA – Strongly Agree

SECTION 3: INDIVIDUAL DETERMINANTS

		SD	D	N	A	SA
	Personal Innovation					
7.	I am always interested in trying out new technologies.					
8.	I consider myself innovative when it comes to using new digital services.					
	Technology Readiness					
9.	I feel prepared to use new technologies such as e-wallets.					
10.	I find it easy to learn how to use new digital tools.					
	Trust					
11.	I trust the e-wallet services I use.					
12.	I believe that e-wallet providers have my best interests in mind.					
	Social Influence					
13.	My friends and family influence my decision to use e-wallets					
14.	I use e-wallets because people around me use them.					

SD - Strongly Disagree, D – Disagree, N – Neutral, A – Agree, SA – Strongly Agree

SECTION 4: CONTEXTUAL DETERMINANTS

		SD	D	N	A	SA
	Cultural Influence					
15.	Using e-wallets is common in my social circles.					
16.	My cultural background supports the use of digital payment methods.					
	Economic Environment					
17.	E-wallets are more convenient than traditional banking in my economic environment.					
18.	The economic conditions in my region favor the use of e-wallets.					
	Regulatory Framework					
19.	I am aware of the regulations surrounding the use of e-wallets in my country.					
20.	The regulatory environment in my country supports the use of e-wallets.					
	Technological Infrastructure					
21.	The technological infrastructure in my region supports the use of e-wallets.					
22.	I have access to reliable internet and mobile services to use e-wallets effectively.					

SD - Strongly Disagree, D – Disagree, N – Neutral, A – Agree, SA – Strongly Agree

SECTION 5: E-WALLET ADOPTION

23. How often do you use an e-wallet for transactions?
    a) Never
    b) Rarely
    c) Sometimes
    d) Often
    e) Always
24. What do you primarily use your e-wallet for?
    a) Online shopping
    b) In store purchases
    c) Money transfers
    d) Bill payments
    e) Other
25. How satisfied are you with your current e-wallet experience?
    a) Very Dissatisfied
    b) Dissatisfied
    c) Neutral
    d) Satisfied
    e) Veri Satisfied

Thank you for your participation!

Sustainable Practices in Airport Catering: A Case Study of Václav Havel Airport Prague

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Abstract

The research analyzes the profitability of food and beverage retail sales in the duty-free zone of Václav Havel Airport in Prague and the effects of the 2020 pandemic on rental rates. It examines statistics from 2019, when the airport achieved a record passenger count, and contrasts it with 2023, when food and beverage operators' profits are nearly equivalent to pre-pandemic levels. A projection of the new rental framework for 2024 is established based on 2019 data and anticipated passenger figures. The research delineates three rent calculation models that variably impact tenant profitability. The findings indicate a potential disparity in the contractual connection between landlords and tenants, advocating for a reassessment of lease agreements to establish more equitable terms. The results offer significant insights for airport management, tenants, and other tourism stakeholders.

Keywords: rental agreements, rent formulas, sustainable entrepreneurship, catering, non-aeronautical fees, business efficacy

1. INTRODUCTION

What factors are significant in rent negotiations? Discrepancies in viewpoints between landlords and tenants in the retail sector are extensive (Hermansson & Lundgren, 2023). From the perspective of a commercial tenant, it consistently represents a substantial expense. This study addresses the research vacuum by analysing the financial expenditures associated with leasing commercial space for food and beverage retail at Prague International Airport, and their subsequent effect on monthly financial liquidity and realised monthly F&B revenues. Airports are increasingly regarded as commercial institutions capable of fostering a competitive market framework. According to Airports Council International (ACI World), airports represent a highly competitive market. Airports exhibit significant variation in competitive positioning and may contend across several factors or markets, including destination markets, air base location, downstream operations, and the non-aeronautical sector (Wan & Zou, 2024). Airport retail operations have profited from initiatives to diversify revenue sources outside commercial activities (Chen et al., 2020). Airport retailing has experienced substantial transformation during the past ten years. Currently, numerous airports provide an extensive range of products and an improved shopping experience (Creed et al., 2021). Airport retail is often categorised into five primary segments: food and beverage (F&B), speciality shops, magazines and gifts, duty-free and general services (Herring et al., 2002). Airports serve as more than mere transportation infrastructure; they are seen as multifunctional environments for social interactions and personal experiences that

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transcend geographical boundaries and secular divisions. Airports worldwide, akin to shopping malls, exhibit a 'globalised' retail framework, featuring same brands and products, which aligns with the uniform commercial attributes prevalent in malls abroad (Huang et al., 2018). In recent years, competition among foodservice enterprises has intensified, compelling managers to pursue elevated operational standards and profitability while exploring innovative sales strategies (Sun et al., 2018). Economic recessions or crises frequently result in financial challenges for corporations. To endure tumultuous situations, firms must sustain liquidity (Block et al., 2022). The revised regulations for rent calculation will significantly affect the stated values of corporate assets and liabilities. These alterations will also affect traditional profitability metrics that utilise assets as the foundation for performance assessment. We analyse the ramifications of the new leasing regulations, which would substantially affect EBIT/Assets, an indicator of the operational profitability of assets (Fafatas & Fischer, 2016). A more extensive investigation of a broader cohort of restaurant enterprises offers more evidence regarding the substantial impact of the new commercial retail lease regulations on this ratio. Our findings highlight the significance of comprehending the ramifications of the new commercial lease space regulations on traditional financial analysis methods, especially for sectors that depend substantially on long-term retail sales, such as restaurants and stores. Recent studies focussing on airport operators, rather than private companies, have employed basic drivers such as expenditure per flight and the ratio of shoppers to assess the influence on retail sales (Choi & Park, 2022). This study use econometric analysis to ascertain the nominal commercial rent relative to the percentage cost to revenue ratio of the tenant at Prague International Airport. This study does not directly examine the relationship between rent expense and EBIT; it rather analyses the percentage of expense relative to the realised income of the F&B retail tenant. This study concurrently analyses the effects of passenger and flight attributes on shop and restaurant profits by utilising customer food and beverage transaction data and the actual passenger count from Václav Havel Prague Airport within the duty-free zone. Recent research have concentrated on specific elements influencing tourism. Specifically, consumer purchasing behaviour affects tourism demand (Kajzar & Mura, 2023). Data from 137 global airports indicate that an increase in NAR has a statistically significant adverse impact on airport charges (Shin & Roh, 2021). Airport managements have concentrated on enhanced cost monitoring while diversifying revenue streams, thereby broadening their retail portfolios. This results in a reorganisation of the airport industry with frameworks designed to enhance resilience against future systemic shocks, including societal economic crises. Specifically, novel airport approaches have arisen (Colak et al., 2023): 1) cost efficiency and reduction, 2) diversification of revenue sources and enhancement of commercial operations. Return on investment (ROI) has been widely recognised as a fundamental instrument for making capital investment decisions and for selecting among competing operating budget items. Top management often employs ROI as a critical criterion, and frequently the primary criterion, in making firm financing decisions from a cost-benefit analysis standpoint. ROI is nearly a globally recognised decision-making instrument (Smith, 2024). Rents represent returns that exceed the standard return on investment (Ryan-Collins et al., 2017). Competition in the product market enhances the value of substantial business incentives (rents), hence elevating the maximum level of risk an entrepreneur is prepared to undertake (de Bettignies et al., 2015). It is essential to recognise that in the case of long-term leases, property markets adjust only incrementally; these markets may be deemed latent and will evolve alone if the underlying variables remain constant. Additional research is required to ascertain if landlords and tenants would exhibit divergent expectations during a downturn in the business cycle, namely that landlords would adopt a retrospective perspective while tenants would adopt a prospective one. In certain instances, there is enhanced collaboration between landlords and tenants; one illustration is the percentage contract, wherein the landlord and tenant distribute the risks by incorporating a proportion of turnover into the rent. Examples encompass collaborative initiatives by both sides to create additional spaces, assess customer traffic, or entice tenants to the region. Simultaneously, there has been heightened conflict between landlords and tenants, particularly during the pandemic when customer turnover occurred (Hermansson & Lundgren, 2023). This study aims to elucidate the divergent economic interests and methodologies of landlords and retail tenants regarding rent estimates, a crucial element in negotiating future commercial space rates. The objective is to establish a mutually agreeable equilibrium of rental rates. For one party, this represents a distinct advantage; for the opposing party, it constitutes a detrimental impact with elevated expenses. The paper focusses on the primary distinctions among the various parties rather than examining all aspects that influence this process. Landlords prioritise characteristics and calculating methods that lead to elevated rents, whilst tenants emphasise elements that result in reduced rates. The structural transformations post-pandemic has resulted in diminished demand for retail space and heightened vacancy rates, hence exerting pressure on the rental value of commercial properties. Consequently, research questions (RQs) are formulated to obtain profound analytical insight:

RQ1: How do the specific critical attributes of a concession agreement influence the equilibrium of tenant relationships? („Take it or leave it “)

RQ2: What is the sustainable rate of rental growth that tenants may endure to guarantee the long-term profitability of their businesses? („Time for a rent freeze “)

RQ3: What is the correlation and magnitude of the association between the amount of passengers processed at the airport and the retail sales of food and beverage sector commercial tenants?

In the future, we anticipate that commercial food and beverage renters would prioritise market consumer behaviour over consumer demographics when negotiating rental agreements. Landlords of commercial rental properties will hold dissenting opinions.

This article makes three contributions. The paper elucidates the existing legislative framework governing rent negotiations, including both retrospective and prospective expectations within the consolidation phase of the post-pandemic economic cycle. Secondly, it improves comprehension of the divergent economic motivations influencing landlords' and tenants' views on the sustainability of future business, which are interrelated in the context of rent determination. Third, it offers insight into the equilibrium of the rental arrangements between both parties. This exploratory study establishes a foundation for subsequent quantitative and qualitative research.

The article is structured as follows: In the introduction, scientific enquiries are presented for enhanced analytical understanding. The second portion introduces the issues related to commercial airport operations. A literature review addressing airports from the standpoint of commercial activity and retail is then provided. The data section delineates and substantiates the hypotheses to be examined while detailing the data collection process, limits, and variables employed in the regressions, including several control variables for the entities and their leased spaces. The paper subsequently delineates the employed approach, followed by the presentation of outcomes. Ultimately, conclusions and recommendations for further research are presented.

1.1. Introduction to airport operations

Prague Václav Havel Airport (LKPR), with a capacity of 10 to 25 million passengers, is internationally designated as an International Basic Hub Airport and Destination (O&Ds).

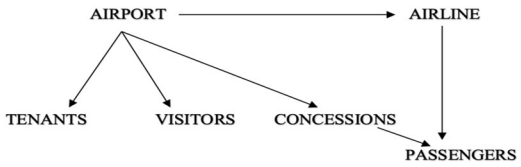
An aerodrome is a designated and appropriately developed space, comprising a collection of structures and amenities, permanently designated for the take-off and landing of aircraft, as well as for their associated movements. From the current viewpoint, it is no more merely an operational domain and a collection of structures. It is also a site where travelers can access various airport-related amenities that provide a range of supplementary services, thus constituting the so-called airport business facilities. From the airport's standpoint, these are termed commercial activities, typically offered by external businesses within airports.

To maximize the airport's financial potential, it is imperative to provide services to the widest possible range of prospective clients, specifically addressing all passenger demographics. Passenger food operators are a substantial source of revenue for the airport owner-operator. Most current research on air traffic operations at international airports has only superficially examined the economics and profitability (ROI) of food and beverage retail operations. This research study conducts a comprehensive examination of the commercial leasing of food and beverage spaces, following an initial assessment of its contribution to the airport's commercial income. The investigation will address the previously overlooked subject of the financial profitability (ROI) of tenants' operations within the realm of the non-aviation industry, namely services offered to enhance passenger travel experience. The study analyzes verified data from food and beverage operators leasing commercial space, in conjunction with airport statistics, particularly the actual number of passengers processed in 2019 (the peak passenger volume at Prague Václav Havel Airport) and in 2023, during which the F&B operator achieved nearly comparable economic results to those of 2019.

1.2. Theoretical basis

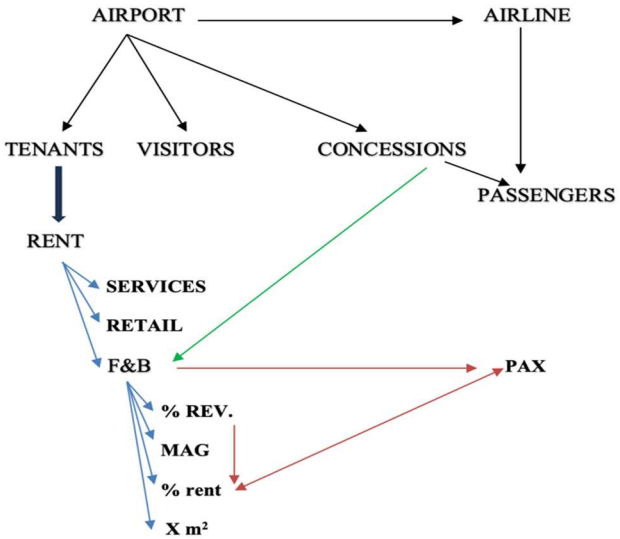
The capital necessary for the development and operation of the airport is derived from two sources: aviation fees and commercial income. The significant association between tourism and retail has persuaded airport administrators to expand their perspective of airports from mere passenger transport facilities to leisure destinations (Freathy & O'Connell, 1999). The increasing significance of non-aeronautical earnings for airport management can be ascribed to several factors. Neglected airports, even two decades prior, when there were more than 200 in Europe alone. Airport proprietors must ensure that activities secure their financial viability and long-term profitability. Consequently, they must explore alternative methods of revenue generation (Francis et al., 2004). The pursuit of revenue maximization has progressively transitioned its major emphasis from conventional core airline services to non-aeronautical or commercial avenues (Morrison, 2009).

Figure 1. Airport relationship: commercial model (Source: Francis et al., 2004)



The transition of airport development from the public sector to commercialized and, in certain instances, privatized initiatives has afforded airports enhanced autonomy, knowledge, and incentive to capitalize on novel business prospects. Simultaneously, escalating pressure from airlines regarding airfares has compelled various airports to regulate their primary revenue sources. This is mostly due to the increasing competitiveness of the aviation sector and the subsequent fall in its revenues. Meticulous oversight of all expenditure categories, especially airport fees, is essential for the low-cost carrier (LCC) sector. The pressure on aviation revenues has intensified due to heightened government economic control, primarily through airport privatizations. In addition to these long-term patterns, key events have influenced commercial airport revenue production, accompanied by challenges in leasing commercial space. The integration of mainstream retail with consumer trends, including the rise of online shopping and the influence of political and economic shifts, particularly inside the EU, is driven by operational advancements at airports, especially in security measures (Graham, 2009). The ownership framework at airports facilitates intriguing commercial asset concepts. Ownership structures abroad exhibit greater diversification. At Hamburg Airport in Germany, a distinct correlation exists between the airport's retail and aviation strategies; nevertheless, in other instances, the spectrum of non-aviation activity at airports has broadened to encompass enterprises with minimal or, in certain situations, no affiliation to aviation (Morrison, 2009). The government autonomously handled several airport policy concerns regarding state ownership without external participation. The concerns encompassed evaluating the degree of cost recovery, analyzing significant investment proposals, and resolving conflicts with environmental goals. In a privately regulated context, the resolution of these issues is contingent upon the firm's aims, the regulatory framework, and competitive dynamics. Governments continue to play a crucial role in addressing issues, particularly those concerning environmental factors, such as the construction of a new runway in a sensitive region. Governments continue to seek to influence decisions and enhance cooperation among national regulators to promote substantial investments. Since privatization, the private owners have operated within the regulatory framework, establishing airport pricing, operational efficiency, and investment in airports (Winston & Rus, 2008). The administration of commercial ancillary operations has emerged as a critical factor in enhancing the contemporary airport sector. Currently, airports have significantly augmented their reliance on non-aeronautical revenues, which constitute, on average, fifty percent of total revenues, with considerable variability across areas and airports (Fasone et al., 2016).

Figure 2. Airport relationship: commercial model (Source: Francis et al., 2004, Enhanced: Author - airport Prague 2024)



2. METHODOLOGY

Post-pandemic market developments from 2023 onwards as the business cycle strengthens led us to the following hypotheses (H):

H1: The existing leasing agreements between the parties are equitable.

H2: The escalating rental value is viable for the tenant's future enterprise.

H3: Higher passenger volume in an airport positively correlates with increased retail sales of food and beverages.

A method was selected to monitor the temporal evolution of data by collecting secondary data from the financial statements of the F&B tenant and the obligatory published statistics of Václav Havel Airport Prague, which are disseminated monthly to commercial space tenants and concurrently published by the International Air Transport Association (IATA).

Linear regression analysis, which examines the dependence of variables (Bekes & Kezdi, 2021), was employed to assess the data collected when the datasets of both variables were combined (REV. + Models 1-3).

The foundation comprises data from monthly reports of the commercial space lessor, encompassing details on passenger volume; an additional source is the food and beverage revenue (REV) data from the monitored commercial space lessee. Employing a regression function with a minimal number of coefficients is sufficiently adaptable to possess the necessary properties (asymptotes) for managing the gathered data (Hendl, 2015). The tenant's food and beverage revenue volume data has been expressed as a percentage ratio of rent expense to the tenant's total monthly financial expenditures to safeguard the tenant's proprietary information. Section 5.1 use the correlation approach to assess the strength of the association between two variables (Egermayer & Novák, 1964).

The chosen data sample exhibits a high response rate; however, it must be regarded primarily as an exploratory sample intended for initial research into the profitability of airport commercial tenants and as a foundation for rent negotiations throughout various phases of the business cycle. The results must be evaluated with caution, as not all connections may be causative. Our examination of the sample indicates a satisfactory distribution regarding comparable tenant space dimensions and location.

The data solely represent the business cycle phase at the time of the survey, specifically the increasing trend subsequent to the significant recession caused by the pandemic. This study enhances our comprehension of the disparities in financial profitability between the two parties involved.

Rental Model 1 (2019) (1)

Figure 3. Calculation of rent 2019

$$MAG\ (x1) + FIX\%\ REV.\ (x2)$$

Growing x1 < x2, f(x1) < f(x2)
Constant x1, x2 f(x1) = f(x2)

Regression analysis, in which the constant is MAG + a fixed percentage (%) of F& revenue.
Regulations:
MAG = Minimum Annual Guarantee Fee
FIX % REV. = Establish a fixed percentage of sales (F&B revenue)

Rental Model 2 (2023) (2)

Figure 4. Calculation of rent 2023

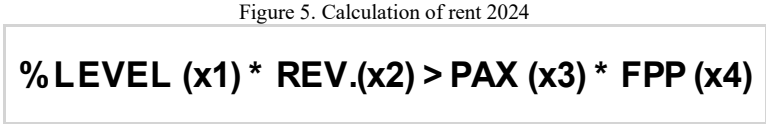
$$\%\ (x1) * REV.\ (x2) \geq MAG2\ (x3)$$

Variable rent, contingent upon the passenger count, with the final figure calculated by multiplying the percentage (x1) by the revenue (x2).

Regulations:
% (x1) = Contractual percentage fee scale based on the number of passengers (PAX) per month
REV.(x2) = F&B Revenue
MAG2(x3) = Minimum Annual Guarantee Fee per square meter

Rental Model 3 (2024) (3)

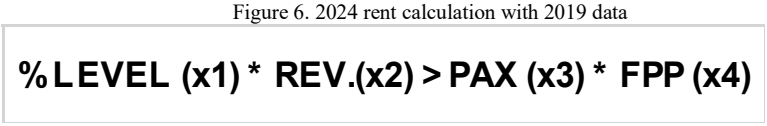
Figure 5. Calculation of rent 2024



The most thorough computation of commercial space rental costs.
Three levels with a predetermined percentage replacement of MAG (Minimum Average Guarantee) PAX (x3) and FPP (x4) to get MAG.
Regulations:
% LEVEL (x1) = Contractual % fee and aviation period scale based on the number of passengers per month
REV.(x2) = F&B Revenue
PAX (x3) = Passenger number
FPP (x4) = assumed [NAR] per passenger (Net Annualized Return) FIX PER PAX (FPP)

Rental model 3* (Comparison of rent with data 2019*) (4)

Figure 6. 2024 rent calculation with 2019 data



Hypothetical modelling utilising anticipated data regarding the passenger volume managed by the lessor and the food and beverage transactions of the lessee in 2019, when Rental Model 1 [2019] was applicable, alongside the airport's forecast for passenger volume in 2024.

Correlation – number of passengers & FB transaction (5)
The association between the number of passengers processed by the airport and the possible rise in F&B retail sales was analysed in regard to the hypothesis H3.

Figure 7. Year 2019 Airport Prague (Source: Airport Prague & tenant F&B, 2019) (5.1.)

Position	2019- SUM	JAN 19	FEB 19	MÄRZ 19	APR 19	MAI 19	JUN 19	JUL 19	AUG 19	SEPT 19	OKT 19	NOV 19	DEZ 19
Passangers 1	**7 949 376**	448 259	432 497	542 821	575 627	629 740	754 898	941 155	965 331	816 245	707 052	544 858	590 893
Passangers 2	**9 780 779**	526 055	541 449	684 001	811 614	854 727	989 794	1 027 353	1 026 609	1 026 359	873 102	699 736	719 980
Transaction 1	**138 033**	8 098	8 209	9 897	10 304	11 705	14 715	15 988	14 726	13 077	11 396	8 757	11 161
Transaction 2	**261 222**	15 976	15 229	18 999	21 619	22 584	23 977	24 891	24 439	26 640	25 316	20 448	21 104

Figure 8. Year 2023 Airport Prague (Source: Airport Prague & tenant F&B, 2023) (5.2.)

Position	2023- SUM	JAN 23	FEB 23	MÄRZ 23	APR 23	MAI 23	JUN 23	JUL 23	AUG 23	SEPT 23	OKT 23	NOV 23	DEZ 23
Passangers 1	**5 416 654**	263 997	291 392	357 540	386 138	411 891	*535 388*	*660 054*	*663 556*	*559 439*	*474 707*	*386 752*	*425 800*
Passangers 2	**8 369 454**	394 957	403 332	529 683	665 245	711 802	*857 453*	*920 855*	*908 468*	*905 486*	*796 562*	*613 202*	*662 409*
Transaction 1	**112 714**	6 142	6 706	8 536	8 608	9 210	11 351	12 699	11 672	10 555	10 354	8 588	8 293
Transaction 2	**218 827**	10 882	11 408	15 557	20 184	21 568	23 224	21 305	20 552	21 979	20 476	15 846	15 846

3. RESULTS

Rental Model 1 (1)

Figure 9. Rental Model 1 (Source: Airport Prague & tenant F&B, 2019)

Position	2019- SUM	JAN 19	FEB 19	MÄRZ 19	APR 19	MAI 19	JUN 19	JUL 19	AUG 19	SEPT 19	OKT 19	NOV 19	DEZ 19
Passangers 1	**7 949 376**	448 259	432 497	542 821	575 627	629 740	754 898	941 155	965 331	816 245	707 052	544 858	590 893
Passangers 2	**9 780 779**	526 055	541 449	684 001	811 614	854 727	989 794	1 027 353	1 026 609	1 026 359	873 102	699 736	719 980
Rent % T 1	**11,78%**	15,00%	14,68%	12,47%	11,53%	11,00%	11,00%	11,01%	11,00%	11,00%	11,00%	13,92%	11,00%
Rent % T 2	**12,00%**	12,00%	12,00%	12,00%	12,00%	12,00%	12,00%	12,00%	12,00%	12,00%	12,00%	12,00%	12,00%

The uniform percentage rate on retail turnover annually is influenced by the minimum guaranteed rent (MAG) during the winter months (January to April and November to December). The observed food and beverage tenant cost criterion is merely a percentage of turnover throughout the summer air cycle (May–October). The computation involves the larger amount (% rate) multiplied by the minimum rental rate (MAG).

Rental Model 2 (2)

Figure 10. Rental Model 2 (Source: Airport Prague & tenant F&B, 2023)

Position	2023- SUM	JAN 23	FEB 23	MÄRZ 23	APR 23	MAI 23	JUN 23	JUL 23	AUG 23	SEPT 23	OKT 23	NOV 23	DEZ 23
Passangers 1	**5 416 654**	263 997	291 392	357 540	386 138	411 891	535 388	660 054	663 556	559 439	474 707	386 752	425 800
Passangers 2	**8 369 454**	394 957	403 332	529 683	665 245	711 802	857 453	920 855	908 468	905 486	796 562	613 202	662 409
Rent % T 1	**15,08%**	8,14%	8,35%	8,68%	10,58%	12,49%	19,71%	24,32%	24,16%	20,70%	19,23%	10,46%	14,16%
Rent % T 2	**19,31%**	9,38%	9,41%	12,80%	18,85%	20,62%	24,78%	25,87%	25,90%	25,87%	22,90%	16,64%	18,74%

Parameter quantifying the number of passengers during the winter and summer seasons. % Adjust according to passenger quantity parameters. Profitability of both parties during the summer flight season (May – October).

Rental Model 3 (3)

Figure 11. Rental Model 3 (Source: Airport Prague & tenant F&B)

Position	2024- SUM	JAN 24- WFT	FEB 24- WFT	MÄRZ 24- WFT	APR 24- SFT1	MAI 24- SFT1	JUN 24- SFT1	JUL 24- SFT2	AUG 24- SFT2	SEPT 24- SFT1	OKT 24- SFT1	NOV 24- WTF	DEZ 24- WTF
Passangers 1	**6 036 041**	331 650	331 639	417 699	471 346	503 873	602 265	667 026	677 065	626 438	537 445	423 893	445 702
Passangers 2	**8 831 051**	485 224	485 205	611 115	689 603	737 193	881 146	975 894	990 582	916 513	786 313	620 178	652 085
Rent % T 1	**19,28%**	10,00%	10,00%	13,90%	18,50%	27,20%	*23,80%*	*25,30%*	*26,00%*	*24,60%*	*20,90%*	*15,60%*	*15,60%*
Min FPP % T1	**6,51%**	*4,90%*	*4,60%*	*4,55%*	*6,82%*	*6,96%*	*6,54%*	*8,57%*	*9,33%*	*6,14%*	*5,27%*	*6,26%*	*6,18%*
Rent % T 2	**20,31%**	10,00%	10,00%	17,10%	20,10%	21,80%	*25,60%*	*26,70%*	*26,70%*	*26,20%*	*23,20%*	*17,10%*	*19,20%*
Min FPP % T2	**14,80%**	*4,90%*	*4,60%*	*4,55%*	*6,82%*	*6,96%*	*6,54%*	*8,57%*	*9,33%*	*6,14%*	*5,27%*	*6,26%*	*6,18%*

Factors influencing the final profitability of both parties. Airline operations regarding retail revenue and rental distribution across three seasons. Modified percentage variation of Model 2 rents for each month. Minimum (FPP) Parameter.
Temporal marker:
WFT = Winter flight table – low season
SFT1 = Summer flight table – middle season
SFT2 = Summer flight table – high season

Rental model 3* (Comparison of rent with data 2019*) (4)

Figure 12. Rental Model 3*(Source: Airport Prague & tenant F&B)

Position	2024- SUM	JAN 24- WFT	FEB 24- WFT	MÄRZ 24- WFT	APR 24- SFT1	MAI 24- SFT1	JUN 24- SFT1	JUL 24- SFT2	AUG 24- SFT2	SEPT 24- SFT1	OKT 24- SFT1	NOV 24- WTF	DEZ 24- WTF
Passangers 1	**5 416 654**	263 997	291 392	357 540	386 138	411 891	535 388	660 054	663 556	559 439	474 707	386 752	425 800
Passangers 2	**8 369 454**	394 957	403 332	529 683	665 245	711 802	857 453	920 855	908 468	905 486	796 562	613 202	662 409
Rent % T 1	**16,78%**	13,00%	13,00%	13,00%	17,00%	17,00%	17,00%	22,00%	22,00%	17,00%	17,00%	13,00%	13,00%
Min FPP % T1	**8,27%**	*6,16%*	*5,81%*	*6,20%*	*8,07%*	*7,87%*	*7,46%*	*10,84%*	*11,83%*	*9,51%*	*8,99%*	*6,94%*	*5,61%*
Rent % T 2	**17,20%**	13,00%	13,00%	13,00%	18,00%	18,00%	18,00%	23,00%	23,00%	18,00%	18,00%	13,00%	13,00%
Min FPP % T2	**16,58%**	*10,58%*	*11,59%*	*11,89%*	*16,67%*	*16,89%*	*18,04%*	*24,21%*	*25,38%*	*18,38%*	*16,17%*	*11,17%*	*10,91%*

Conduct three simulations of prospective projected developments for 2024. 2023 passenger numbers (77.75% of 2019). F&B tenant turnover in 2023 (92% of 2019).
Temporal marker:
WFT = Winter flight table – low season
SFT1 = Summer flight table – middle season
SFT2 = summer flight table – high season

Correlation – number of passengers & FB transaction (5)

Year 2019 (5.1.)

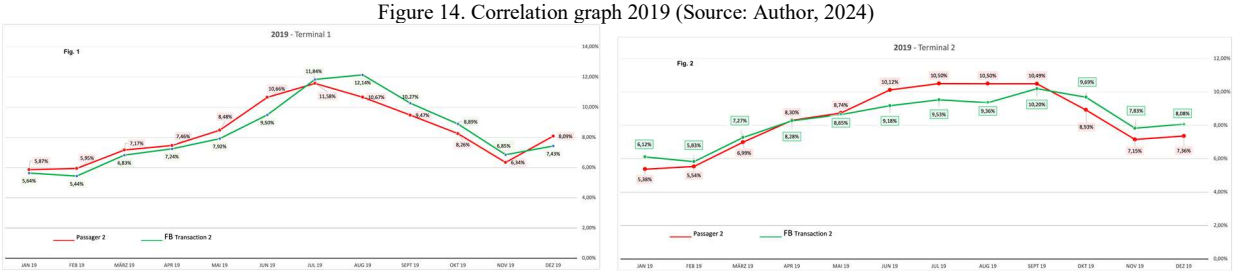
Monthly passenger enplanements (PAX) and F&B transactions (customer accounts) are expressed as a percentage (%) of total annual volume (year-to-date YTD).

PAX1 (passenger)/ TRANS 1 (F&B transaction) = Data Terminal 1 (Non-Schengen Area)
PAX2 (passenger)/ TRANS 2 (F&B transaction) = Data Terminal 2 (Schengen Area)

Figure 13. Correlation data 2019 (Source: Airport Prague & tenant F&B, 2019)

2019	JAN 19	FEB 19	MÄRZ 19	APR 19	MAI 19	JUN 19	JUL 19	AUG 19	SEPT 19	OKT 19	NOV 19	DEZ 19
PAX 1	*5,639%*	*5,441%*	*6,828%*	*7,241%*	*7,922%*	*9,496%*	*11,839%*	*12,143%*	*10,268%*	*8,894%*	*6,854%*	*7,433%*
TRANS 1	*5,867%*	*5,947%*	*7,170%*	*7,465%*	*8,480%*	*10,660%*	*11,583%*	*10,668%*	*9,474%*	*8,256%*	*6,344%*	*8,086%*
PAX 2	*5,378%*	*5,536%*	*6,993%*	*8,298%*	*8,739%*	*10,120%*	*10,504%*	*10,496%*	*10,494%*	*8,927%*	*7,154%*	*7,361%*
TRANS 2	*6,116%*	*5,830%*	*7,273%*	*8,276%*	*8,646%*	*9,179%*	*9,529%*	*9,356%*	*10,198%*	*9,691%*	*7,828%*	*8,079%*

Figure 14. Correlation graph 2019 (Source: Author, 2024)



The trend line (number of passengers x F&B transactions) indicates a rise in F&B transactions at Terminal 1 (Fig. 1), particularly during the winter flying season, with heightened PAX1 passenger travel beyond Europe and an influx of domestic passengers during winter holidays. This temporal pattern is similarly applicable to Terminal 2 (Fig. 2), concerning travel destinations within Europe. The summer months, concerning the summer flight schedule (SFT Summer flight table), do not exhibit this variance; the association between the two variables is weaker.

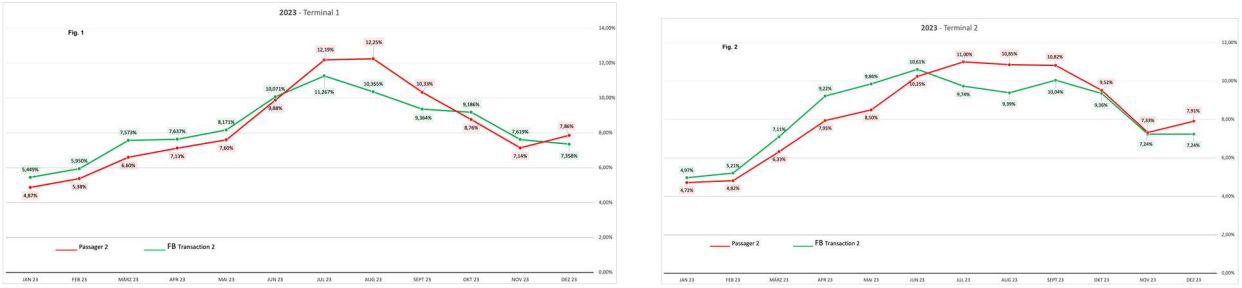
Year 2023 (5.2.)

Figure 15. Correlation data 2023 (Source: Airport Prague & tenant F&B, 2023)

2023	JAN 23	FEB 23	MÄRZ 23	APR 23	MAI 23	JUN 23	JUL 23	AUG 23	SEPT 23	OKT 23	NOV 23	DEZ 23
PAX 1	*4,874%*	*5,380%*	*6,601%*	*7,129%*	*7,604%*	*9,884%*	*12,186%*	*12,250%*	*10,328%*	*8,764%*	*7,140%*	*7,861%*
TRANS 1	*5,449%*	*5,950%*	*7,573%*	*7,637%*	*8,171%*	*10,071%*	*11,267%*	*10,355%*	*9,364%*	*9,186%*	*7,619%*	*7,358%*
PAX2	*4,719%*	*4,819%*	*6,329%*	*7,948%*	*8,505%*	*10,245%*	*11,003%*	*10,855%*	*10,819%*	*9,517%*	*7,327%*	*7,915%*
TRANS 2	*4,973%*	*5,213%*	*7,109%*	*9,224%*	*9,856%*	*10,613%*	*9,736%*	*9,392%*	*10,044%*	*9,357%*	*7,241%*	*7,241%*

Monthly data are shown as a percentage of the annual total (YTM).

Figure 16. Correlation graph 2023 (Source: Author, 2024)



The linear trend lines (number of passengers vs F&B transactions) for Terminals 1 and 2 exhibit aberrations during the winter flight season (January to April) and subsequently from September to December.

4. DISCUSSION

This study employs a sample of landlords and retail F&B tenants to analyse the economic disparities between these entities. The disparities are a significant element regarding the stances of the two parties in the rental negotiation process. The study additionally examines the tenant's eventual profitability. This study's significance lies in its potential applicability in future contexts, derived from the data collected by both parties. Economic profitability seems to be equitable in certain rental models analysed, despite variations in the ultimate outcomes of the distinct rental

formulas. Certain models increase investment uncertainty for tenants. Landlord-tenant rental models operate based on a priori probabilities ("Bayes, Thomas," 2020). The passenger count and its relationship to the revenue generated by the F&B tenant might be classified as an independent event (Besbes & Zeevi, 2012). The descriptive method, a type of qualitative research, was the potential interpretation of the gathered managerial data.

RQ1: How do the specific critical attributes of a concession agreement influence the equilibrium of tenant relationships? („Take it or leave it “)

The contractual implications of leases and their equilibrium yielded a response to RQ1. The analysis considered the 8-year contractual cycle of both parties, including a 3-year extension, which primarily accounts for the financial triumphs and failures of the commercial space tenant's investment. Comprehending the lease relationship through a concession agreement offered a significant foundation for accurately interpreting the tenant's investment intentions in this market. Simultaneously, it disclosed prospective financial problems regarding the renter. The lessor's selected 'Concession Agreement' format is incompatible with the nature of the leased subject (Fleta-Asín et al., 2024). Simultaneously, within the framework of this contractual connection, the lessor's unilateral exclusion of statutory dispositive provisions seems to restrict the contractual parity of the parties, which is standard in their business interactions. A (fictitious) contractual disparity disadvantages the tenant and simultaneously places him in a weaker negotiating position.

RQ2: What is the sustainable rate of rental growth that tenants may endure to guarantee the long-term profitability of their businesses? („Time for a rent freeze “)

Exploratory study enabled the incorporation of trustworthy data from both research participants into the model's calculation formulae 1-3, while also providing insights into RQ2 regarding the viability of future tenant businesses.

The analysis of passenger numbers reveals substantial discrepancies at the airport in 2023 relative to 2019. Upon analysis, it is evident that domestic air traffic has significantly rebounded, however remains 77.75% below the levels recorded in 2019. In 2019, Václav Havel Airport Prague had reached its maximum capacity for both terminals. The alteration in the rent computation has considerably impacted the tenant's profitability, which is a crucial financial factor influencing gross operating profit (GOP).

RQ3: What is the correlation and magnitude of the association between the amount of passengers processed at the airport and the retail sales of food and beverage sector commercial tenants?

The analysis of Model 3* did not reveal a correlation between the number of passengers processed and the tenant's retail revenue. The data analysis does not demonstrate a definitive correlation or impact between the two variables. Model 3 results from the 2023 data exhibit minimal correlation. The analysis simultaneously indicated potential future disparities in the standing of the two actors. The volume of passengers at various periods may conflict with the capacity of the F&B tenant and the diverse patterns of travel behaviour and customer preferences for F&B demand, resulting in unpredictable retail turnover. In the future, it is possible that other competitors may exhibit diminished interest in investing in commercial airport space within this particular, restricted market.

5. CONCLUSION

This study aimed to evaluate the relationship between retail rents and the revenues generated by food and beverage tenants, thereby assessing the profitability of operating in a geographically confined market. A concurrent sub-objective was to theoretically assess the anticipated rise in retail food and beverage sales in the Airside sector of Prague Václav Havel Airport, contingent upon the rising passenger volume. The pandemic period of prior years’ provided an opportunity for all stakeholders in the airport business to acquire knowledge. Travel patterns and consumer behaviour have undergone substantial changes since 2019. All stakeholders must enhance their preparedness for increasingly frequent and profound disruptions (global pandemics, climate change, geopolitical conflicts, cybersecurity) while safeguarding employee employment.

Upon examining the elements in the computation of the rental models (Model 2) individually, it became evident that landlords were experiencing a lack of understanding on the structure of the resultant rent. The eventual financial return is unknown and unexpected. In the rent calculation model that incorporates all factors (Model 3), there exists significant uncertainty on the tenant's profit. Projecting future tenant income and the plausible progression of business growth disadvantages the tenant's management. The forthcoming research will concentrate on analysing tenants capable of effectively accommodating rent hikes while sustaining their business profitability. Future research should

encompass the new methods, trends, and business plans employed by lessors to enhance the revenue of F&B tenants, taking into account passenger volume and specific temporal occurrences as frequent aircraft delays and cancellations.

The survey was conducted during a period when the economic cycle was once again in decline following a pandemic and recession, perhaps indicating that the two parties were in opposition. Simultaneously, Court determined that both parties must reach a mutual agreement during the renegotiation of the contractual rent calculation terms.

The airport is state-owned and managed by a government-operated corporation. Leases of commercial space serve as both a by-product and a substantial source of income (Messer, 2022). The demand for increasing anticipated revenues is exceedingly great in this company partnership.

This study has certain limitations, notably the examination of F&B transactions, which may influence the overall results. Nonetheless, the most suitable non-existent tenant parameter seems to be the actual F&B consumption per client. The study also neglects to include the purchasing habits of travelers. Subsequent research should integrate these limits and determinants to enhance the comprehension of the association between shopping behavior and airport F&B operations.

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Barriers to Digitalization in a Preschool Institution

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Abstract

This thesis explores the barriers to implementing digital applications in a small group setting from the perspective of early childhood care and education organizations. The author discusses the benefits and challenges of digitalization in early childhood education institutions and maps the current opportunities and limits in transforming some traditional practices into digital form, with an emphasis on defining the barriers from the perspective of educators. The study defines the barriers to the implementation of digital applications from the perspective of direct participants in the educational process, from the perspective of school management and educators. A mixed method research design was used for the study, which draws conclusions using quantitative and qualitative methods based on the principle of sequential design implemented in two steps, a questionnaire survey among respondents and direct observation of the phenomenon under study. The study concludes that although digitalization in early childhood education offers significant potential for improving learning and development, it also presents challenges that need to be addressed through careful implementation, teacher training and ongoing research. Barriers to digitalization in pre-school are mainly inadequate equipment (resources) on the part of schools, insufficient teacher qualifications, and perceived attitudes of teachers and parents towards the use of digital technologies in early learning.

Keywords: pres-school, ICT, digitalization

1. INTRODUCTION

Preschool age is a very important developmental stage in a person's life, which affects the whole future life. It is the age of play, of close attachment to a caring person, it is the time when a person's involvement in society is emerging, when innate potential is developing, it is the age when basic life needs need to be met (Matějček & Langmeier, 2011). Digital technologies are becoming part of school policy in most European countries (Zounek et al., 2020), learning in the age of digitalization carries the potential to promote changes in education, leading to thinking about so-called modern pedagogy, the context of educational research is changing as a result of digitalization (Sivachenko et al., 2022). Digital competence is becoming a key cross-cutting competence in the Czech Republic (Neumajer, 2014) and most European countries (MŠMT, 2020), it would be interesting to compare the state of digitalization of Czech schools with other countries (Potužníková et al., 2014). Caregivers often use technology as babysitters (Lafton, 2015), parents gain time for their responsibilities through digital play (Magdalena et al., 2023), increasing numbers of children can use a mobile phone before they can talk(Sundus, 2018) , the average length of

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screen use can be up to two hours per day (Stewart et al., 2019). Digitalization is a growing trend (Atış Akyol et al., 2023), which aims to incorporate digital technologies (Tan & Mo). The process brings with it both opportunities and challenges as it seeks to improve educational outcomes while addressing concerns about potential negative impacts on young children (Paulus & Gerstner, 2023). A large-scale study in European schools has shown that the level of digitalization is improving, but many barriers remain (Commission et al., 2013), not only on the material side, but also on the operational and human side. Based on the above, this study will mainly address these research questions.

RQ1: What technical, financial, organizational or educational barriers do schools experience in the area of introducing new technologies and digitalizing learning?

2. LITERARY RESEARCH

The current rapid rise in the capabilities of digital technologies is affecting many areas of our lives, digitalization is not only present especially in industry, commerce, services, but is also gaining a prominent place in the field of education (Richert et al., 2016). The current digital world makes demands for a positive attitude towards the adoption of information technology (Šabić et al., 2022) and its aspects are also entering the education sector (Kundu et al., 2022). Digital technology in education has the potential to develop the effectiveness of the learning process (Alia & Irwansyah, 2018), however, in preschool it is good to keep in mind the potential threats of exposure to digital technologies (Nurdiantami & Agil, 2020). Digitalization in early childhood education and evaluation offers not only the benefits of new possibilities and approaches to the educational process, benefits for students (Chen & Ding, 2024), but it is also important to be aware of the challenges associated with digitalization (Shykyrynska et al., 2024), which have a major impact on the effectiveness and way of educating preschoolers and the role of educators(Ciarko & Paluch-Dybe, 2021). Educational methods themselves have also seen rapid developments, such as open courses, personalized learning and gamification (Kursch, 2018) and the focus of society on creating optimal educational environments (Ciarko & Paluch-Dybe, 2021) or diversifying them (Otterborn et al., 2024). Digital technologies can improve learning outcomes, make learning more effective especially in mathematical (Preradovic et al., 2016) as well as the development of computational thinking (Su et al., 2024), literacy (Rakhimova et al., 2024) and social skills (Yadav & Vyas, 2021), emotional intelligence (Iksanova, 2022) , the development of creativity (Kavak et al., 2024), and the quality of education of educators themselves (Yang, 2024), thus depending on the digital skills of educators. Preschool children are in quite intensive contact with digital technologies from early childhood(Palaiologou, 2016), i.e. they possess a certain level of computer literacy (Su, 2024), i.e. it is in the hands of families and especially young educators to work with this fact (Zevenbergen, 2007), for example through the teaching method of digital games (Behnamnia et al., 2023) , where children's increasingly frequent contact with digital devices can be taken into account (Pervolaraki et al., 2016).

The integration of digital technologies in preschool and early childhood education therefore presents both opportunities and challenges, as mentioned above. The strongest debate is generated by those who consider computers to be detrimental to health and learning, and those who believe that computers can be a key asset for children's social and intellectual development. An example of the conservative approach in the U.S. is the view of the Alliance for Childhood (Cordes & Miller, 2000), which calls for an immediate moratorium on the further introduction of computers in early childhood, except in the special cases of students with disabilities. The Alliance recommends focusing on so-called "essential elements of a healthy childhood" such as play, book reading, and "hands-on experiences with nature and the physical world," and this view may persist among many educators and parents, In the UK there is even talk of the 'death of childhood' with the introduction of digital technologies into pre-school (Buckingham, 2013), concerns about disrupting children's natural development (Healy, 2000), hence the need to use critical thinking to introduce new technologies (Yelland, 1999). This unresolved debate is evident in the views of both parents and practitioners, as demonstrated for example in A study by the Annenberg Public Policy Centre (Turow & Nir, 2000), which found that parents generally support the Internet as a valuable educational resource, but are concerned about children being exposed to pornography, violent content, etc., and there was even a noticeable resistance among educators to introducing ICT into the classroom (Turbill, 2001), which can be a significant barrier to the introduction of these innovations. While digital tools can enhance the learning experience(Zakharova et al., 2021) and provide personalized learning (Kolesnikova & Orlova, 2022), several barriers hinder their effective implementation. These include lack of funding (Ihmeideh, 2009) , time and technological skills of educators (Shimasaki, 2015) , and concerns about possible negative impacts on children's health and development (Lazareva & Zvezda, 2021). The digital divide and equity issues are also problematic (Stephen & Plowman, 2003). To overcome these barriers, teachers' digital competencies need to be improved (Andryukhina et al., 2020) and the adoption of digital technologies needs to be critically reflected

upon (Jernes et al., 2010). Despite these challenges, digitalization offers potential benefits for continuous learning and optimization of the educational process in preschool settings (Kolesnikova & Orlova, 2022)

Thus, much research shows that incorporating ICT in preschool education increases children's motivation(Rahiem, 2021) . These benefits can be achieved if educators have positive attitudes towards and are able to use ICT technologies. Incorporating ICT tools into the preschool environment can be accompanied by a number of challenges(Blackwell et al., 2014) , these barriers include unfavourable attitudes of educators, lack of training in education (Bingimlas, 2009). According to existing literature, attitudes towards ICT are influenced by educator level factors such as age (Lawrence & Tar, 2018) , years of teaching experience (Schomakers et al., 2018), professional knowledge (Ayub et al., 2015) . Educators need ICT training (Baturay et al., 2017), while educators' experience with digital technologies is one of the factors influencing their attitudes (Lawrence & Tar, 2018)

3. DATA AND METHODS

Based on the literature search, the main barriers to the implementation of digital technologies in kindergartens appear to be parameters in the following areas - technical barriers, barriers on the part of teachers, low digital competence, lack of training, lack of methodological materials, and inconsistency with traditional pedagogical methods. Last but not least, personal barriers, fear, mistrust, attitudes, low motivation and organizational and systemic barriers. At the same time, the relatively short time to define the risks for the children themselves and the associated cultural and social barriers in terms of the ambiguity of the impact of digitalization.

Based on this research question RQ1: What technical, financial, organizational or educational barriers do schools perceive to the adoption of new technologies and digitalization of learning? The following hypotheses were established:

H1: If teachers have the opportunity to use a sufficiently equipped classroom for teaching with digital technologies, they include these teaching methods more often.

H2: If teachers are supported with training opportunities in digital competences, they feel more confident in teaching children and use digital teaching methods more often.

Thus, the research aims to describe the main obstacles that hinder the implementation or integration of digital technologies in the environment of pre-school education institutions, kindergartens, children's groups mainly from the perspective of school management and teachers, from the perspective of the school organization. The aim of the research is to identify the main barriers (from the perspective of direct participants in the pedagogical process) that affect the implementation of digital technologies in the teaching and daily practice of preschool institutions, with the sub-goal of providing suggestions for overcoming these barriers. It seems optimal to design the research as a mixed-method study according to Tashakkori & Creswell (2007), who defined mixed-method research as "research in which the researcher collects and analyzes data, integrates findings, and draws conclusions using both qualitative and quantitative methods". Mixed methods research can facilitate a deeper understanding of research questions (Akyar et al., 2024). The research procedure is designed based on the principle of sequential design, implemented in two steps. The first step is data collection through a questionnaire and then data collection through observation of the phenomenon under study, which is done in order to clarify the situation more accurately. The questionnaire survey was conducted in 2025 among nannies and preschool teachers, employees of a non-profit organization providing preschool education in the country. The questionnaire on preschool teachers' attitudes towards ICT consists of three parts. The first collects demographic data, the second collects data on ICT use and the third collects data on teachers' attitudes towards ICT (general attitudes, attitudes towards use in education and use according to Scherer et al. (2018) Participants rate 10 items on a five-point Likert scale. The scale is shaped by three sub-scales namely OPT (General attitude towards technology, general interest, enjoyment, usefulness), PVP (Attitude towards use in education) and SA (Ease of use measures the perception of how easy it is to use ICT). By calculating the Cronbach's alpha, the values for OPT, PVP and SA are determined. A Python program was used for the calculation. The observation itself was conducted on a selected sample of children's groups of the organization Kindergarten Andelska, the classes are marked with the code A, B, C, D, E, F, G. Data from the qualitative part of the study, similar to the study (Çelik et al., 2023) was analyzed by SPSS software, data was collected through field notes and analyzed through coding and qualitative thematic content analysis (Orhani et al., 2022). Correlation analysis was performed with IBM SPSS Statistics 29. The second step of data collection is to collect data through observation and the CoRe method (Loughran et al., 2004) , which was developed for science educators but is applicable to studies in the use of digital technology in the classroom and TPACK (Walan, 2020). In TPACK, the elements of T that we focus on are defined as follows:

Technology proficiency (TK) refers to teachers' knowledge of technology devices (hardware) and their use, as well as software suites. It refers to the practical use of digital tools.

Technology Content Knowledge (TCK) refers to teachers' knowledge of the relationship between technology (in this case, all kinds of digital tools) and course content. That is, how different digital tools can best embody and support understanding of particular concepts or processes.

Technological and pedagogical knowledge (TPK) refers to teachers' knowledge of how teaching and learning changes when using specific technologies. Barriers arise with different digital tools and their relationship to teaching practice.

Technology and Pedagogical Content Knowledge (TPACK) includes teachers' knowledge of the interaction between technology (digital tools), pedagogy and subject matter, and the strategic application of technology in the learning situation. This knowledge is dynamic and adaptable to the needs of different learners (in our case, children).

4. RESULTS

Children may have better motor skills, better cognitive skills and competitive skills, while conversely, children may face serious problems such as speech delays, attention deficits, learning problems, even mental disorders that can impact their characters. Therefore, serious attention is needed from the environment where children grow and develop such as parents, caregivers, early childhood educators and the community holistically to minimize the negative effects of the internet on their character and moral edifice. The conclusions of this paper are in line with those of a large study in European countries. Teachers still believe that the biggest barrier to ICT use is lack of equipment, ICT is used for lesson preparation rather than actual teaching, and teacher training in ICT is rarely compulsory. If schools combine policies on the integration of ICT into teaching and learning, this area is more widely used by pupils and teachers, but most schools do not yet have such an overarching policy and this area awaits more radical change(Commission et al., 2013) Virtually all primary and secondary schools in the Czech Republic are already equipped with computers, with 24 computers per 100 pupils in 2023. Over 46% of schools operate a school information system and 75% of schools provide their own internet connection. Almost 100% of Czech students have a smartphone and use it to connect to the internet. Therefore, investment in technical equipment, the organization of regular training courses on digital literacy for teachers and, last but not least, the introduction of support programmes at national or regional level seems to be suggestions for improvement. Based on this brief initial research exploration, the possibilities for further research open up; in particular, it would be useful to investigate the impact of digitalization on learning outcomes in pre-school institutions, or the effectiveness of training.

5. DISCUSSION OF RESULTS

Similarly to the study(Çelik et al., 2023), barriers within the sub-themes of physical conditions, teacher-parent collaboration, administrative barriers, policies and teachers' beliefs and opinions, and teachers' competencies appear to be barriers in the Czech context. Teachers encountered the following problems in incorporating digital tools in their teaching such as classroom facilities, lack of variety of digital tools in the school, parents' biases, lack of knowledge and negative attitudes towards the use of digital tools. As mentioned above, the digitalization of early childhood education presents both opportunities and challenges. While digital tools can enhance learning(Marklund, 2022), adapt to change and prepare children for the future (Çelik et al., 2023), their implementation faces several obstacles. These include insufficient facilities and connections, lack of teacher competence and lack of administrative support(Area-Moreira et al., 2020). Teachers' beliefs and pedagogical philosophies also play a crucial role, with many not fully exploiting the potential of ICT (Magen-Nagar & Firstater, 2019). The integration of digital technologies in kindergartens varies, reflecting different views on democracy and digital competence (Enochsson & Ribaeus, 2021). Digital tools can enhance social learning and inclusion in science education (Otterborn et al., 2024), but concerns remain about their impact on children's well-being and social development (Fleer, 2017) . The COVID-19 pandemic has highlighted the opportunities and limitations of digital mathematics education in kindergartens (Lavidas et al., 2022) In the era of 21st century education, it is essential for teachers to have a better understanding of subject content and pedagogical principles aligned with educational technology. This will ensure that the use of technology in the classroom is relevant to current educational needs. This approach reflects the TPACK model, which emphasizes the importance of the interaction between content knowledge, pedagogy, and technology in classroom practice. Implementation of the TPACK model has been shown to improve the teaching and learning process (Nisa et al., 2023)

and that 21st century teachers need to understand and master the teaching skills of this century, including the effective integration of technology (Shafie et al., 2019).

6. CONCLUSION

The results of this study confirm that digitalization in pre-school education has significant potential, but its implementation faces a number of barriers. Key barriers are the technical limitations of schools, low digital competences of teachers and persistent scepticism among some professionals. The analysis shows that effective integration of digital technologies into the educational process requires not only adequate technological infrastructure, but above all systematic training of teaching staff and well-thought-out implementation strategies. The study also pointed out that digitization can have a positive impact on the development of children's cognitive abilities if it is used adequately to their age needs. Although digitalization offers new opportunities to personalise learning and to assess pupils' progress more effectively, the extent to which technology should be integrated into early education remains a question. This issue requires further research focusing on the long-term implications of the use of digital technologies in early childhood settings. Recommendations based on this study include investing in technical equipment in schools, developing comprehensive methodological materials for teachers and introducing across-the-board training programmes aimed at developing teachers' digital competences. Research on measuring the effectiveness of digital tools in pre-primary education also needs to be strengthened in order to accurately identify their benefits and potential risks. Only in this way can it be ensured that digitalization will not only represent an administrative or technical challenge, but a real qualitative contribution to the educational process of the youngest generation.

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Overview Study: Digitalization of Norwegian Education

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Abstract

Digitalization creates space for new ways of learning, new assessment practices and the use of more resources in and outside of school. This means that the potential for more adapted and inclusive education is increasing. Digitalization also brings new demands on schools, for example in terms of increasing the digital competence of teachers, infrastructure and protecting the privacy of pupils, students and teachers. In our contribution, we focused on the digitalization of Norwegian education because the Norwegian public sector is one of the most digitalized in the world, for example, public agencies are already using artificial intelligence-based solutions to provide user-oriented services and to streamline operations, work processes and reduce risks. For this reason, the Norwegian education sector emphasizes the need to develop expertise in areas such as artificial intelligence and machine learning. Norway has recently taken bold steps towards the future of education. The updated national digitalization strategy, "Strategi for digital kompetanse og infrastruktur i barnehage og skole", published in 2023, represents a significant turning point on the path to digitalizing education in Norway. At the core of this strategy is the effort to support inclusive, safe and seamless digital services that value individual creativity from kindergarten onwards. The aim of the paper is to contribute to the understanding of the Norwegian digitalization of the education sector. The first part of the paper provides an introduction to the issue. The second part focuses on the terminology of digitalization and digital transformation. The last part presents an overview of key documents related to the Norwegian digitalization of education. The overview study presents significant documents in the field of digitalization of education in Norway from 2020 to the present. Digitalization can be seen as a process that is currently changing schools and education systems, and better access to technology in schools creates new opportunities for teaching and learning.

Keywords: digitalization, digital transformation, digitalization strategy, education policy, Norway.

1. INTRODUCTION

In Norwegian education, the first beginnings of digital technologies can be seen as early as the 1980s, and since then the digital transformation in Norway has gone through several phases. In the last five years, the Norwegian Ministry of Education and Research, together with the local government sector, has built a so-called digital foundation for schools to increase the availability of digital devices, teaching materials, infrastructure, and clearer requirements for information security and privacy have been formulated [1]. Here, the Norwegian higher education sector should be highlighted, in which the Norwegian Ministry of Education and Research has established an Agency group (AG) that contributes to a common direction for the development of innovative digital user journeys in the education sector.

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The AG explores new opportunities and supports cooperation in the development of digital services. Digitalization supports key sector goals, including [2]:

- Better quality education offer.
- Skills development and lifelong learning to be accessible to all people throughout Norway.
- Vocational training and education that provide more people with relevant qualifications.
- A stronger shared environment for training and education that supports inclusion, motivation and mastery.

The strategy document, called "Digitaliseringstrategi for grunnopplæringen 2017–2021", emphasizes that pupils' digital skills are a prerequisite for life skills and for success in education, work and participation in society. The strategy emphasizes that information and communication technologies (ICT) must be well used in the organization and delivery of teaching in order to improve pupils' learning outcomes. The strategy addresses various aspects of digitalization and places particular emphasis on digital infrastructure, digital pedagogies, digital skills and privacy and information security. The strategy responds to the consequences of the coronavirus pandemic, which has deepened the conditions for the introduction of digital teaching, whether at school or for independent study in the environment of the pupil's or home. However, the pandemic has highlighted the need for detailed information about the digital infrastructure of schools and how digital technologies affect teachers' practices and pupils' learning. Schools were put to the test when they closed on 12 March 2020 and the lockdown accelerated the use of digital technologies. Compared to other countries, Norway was relatively well equipped for digital home learning. Digitalization has been shown to be vulnerable in the area of school technological solutions that are not stable or good enough. It has also been shown that the competences of teachers, pupils and students vary. In the area of school digitalization, it is the school founders who are responsible for purchasing and introducing digital devices into schools. Since 2007, secondary school pupils have been receiving personal digital devices from regional authorities, and the digitalization of primary schools in municipalities has been taking place at different rates, without national control. There is no precise data on the number of digital devices in primary and elementary schools, but it has been shown that more and more primary school pupils are receiving their own digital devices at school [3].

In our review text, we present the titles of the documents in their original Norwegian language. The English translation of the document titles is given in Table 2. For our review study, we base our review study on publications that are publicly available and are presented on the Norwegian government website (i.e. Regjeringen) or the websites of the Ministry of Education and Research (i.e. Kunnskapsdepartementet) and the Directorate for Education and Training (i.e. Utdanningsdirektoratet). The review study focused on publications in which the key area is the digitalization of Norway and the digitalization of education. The issue of digitalization of Norway is relatively broad, and for this reason we narrowed our focus to the period of publications published from 2020 to the present.

2. DEFINITION OF DIGITALIZATION AND DIGITAL TRANSFORMATION

Digitalization is the next step in the digital evolution. Digitalization refers to the use of digital technologies and digitized data to influence how users and society engage and communicate, and to create new digital revenue streams. It can be argued that it is about using digitalization to improve processes, increase productivity and foster innovation. An often overlooked aspect of digitalization is its potential contribution to environmental sustainability. Digitalization can lead to more sustainable practices by optimizing processes and reducing resource consumption. For example, digital tools can increase efficiency in manufacturing or reduce paper consumption in offices, contributing to broader environmental goals [4].

Digital leadership [5] characterizes digitalization as:

- Strategic integration of digital technologies to transform processes and operations.
- Increasing efficiency, innovation, and key technologies include data analytics, cloud computing, and artificial intelligence (AI).
- The benefit of reducing costs associated with paper processes, manual labor, and physical infrastructure, leading to significant cost savings over time, provides access to real-time data and insights.
- Making information accessible and enabling organizations to more effectively obtain and share information.
- Help preserve valuable documents, records, and media by converting them into digital formats that can be archived.

Gartner [6] comes up with a brief definition of digitalization, i.e. Digitalization is the use of digital technologies to change the business model and provide new opportunities for revenue and value creation. Gradillas and Thomas [7], based on a systematic review of the field of digitalization, define digitalization as the transformation of the socio-

economic environment through the processes of adoption, application and use of digital artifacts. This definition defines digitalization as a process that includes both social and economic aspects, specifically with regard to the adoption and application of digital artifacts, which leads to socio-economic changes through new business opportunities, the transformation of industries and the emergence of new socio-economic realities. Digitalization is currently changing schools and education systems. Better access to technology in schools creates new opportunities for teaching and learning. It should be noted that teachers play an important role in the transition to a digital school, i.e. teachers should develop the ability to be digitally prepared and digitally competent, as well as develop the ability to comprehensively integrate technology into teaching [8].

Digital transformation can be defined as the process by which technology is integrated into institutions and businesses to support fundamental changes in society, such as increasing efficiency, implementing AI or cloud computing. In any case, digital transformation requires a new way of thinking. Digital transformation is not just a matter of purchasing new technology. Ideally, digital transformation creates an organization that is more efficient, adaptable and responsive to change [9]. Nowadays, digital technology solutions have become essential to improve the overall experience of pupils and students, as well as teachers and other education and training professionals. Integrating digital technologies to enhance personalized learning has become a standard way to support stakeholders in education in an increasingly digital world. Digital transformation of education allows for enhancing the experience of pupils and students, for example:

- Enabling a seamless environment for enrollment into the school year.
- Implementing an interactive learning experience.
- Improving learning outcomes and flexibility, i.e. learning from any device and at any time.
- Improving the way pupils' and students' performance is managed.
- Enabling an easy process of managing a school institute.

It is important to note that educational leaders must foster a culture of innovation and change, i.e. prepare educators, pupils and students for the transition to a digital learning environment. This process primarily includes:

- Investing in teacher professional development.
- Ensuring that teachers are equipped with the skills and knowledge to effectively use digital tools in their teaching.
- Equitable access to technology, recognizing that pupils and students come from diverse backgrounds with varying levels of access to digital resources [10].

The digital transformation of education is a fundamental factor in everyday activities related to education. It is the process of creating new or updating existing processes using digital technologies. Digital transformation is related to the constant need for educational institutions to change and develop strategic plans in such a way as to keep pace with the rapidly changing world and the speed of progress in digital technologies. AI is expected to fundamentally change the future of education [11]. In the digital transformation, we can see the key role of teachers, who are key to the thoughtful digitalization of classrooms, not only by using technology to make teaching more effective, but also in their expertise in teaching pupils and students, which is needed to acquire the skills necessary for future working life. The digital transformation is set to significantly reshape the professional roles of teachers, especially in terms of their responsibilities, and this shift requires a rethinking of how teachers approach curriculum delivery, pupils and students engagement, and the integration of digital tools to support learning. The evolving educational and digital learning environment challenges teachers to adapt, and this challenge to teachers requires their continuous professional development. For these reasons, teachers are required to navigate these changes effectively [12].

In the following section, we attach Table 1 modified according to Digital leadership [13], which focuses on comparing the concepts of digitalization and digital transformation.

Table 1. Differences between digitalization and digital transformation

	Digitalization	**Digital transformation**
Definition	Strategic integration of digital technologies for process transformation.	Managing cultural change, supporting innovation and enabling new educational models.
Focus	Optimization and innovation of educational	Comprehensive transformation of organizational culture,

	processes using digital technologies.	operations and strategies through digital technologies.
Range	A broad scope that includes process transformation, innovation and improving the experience of participants involved in education.	Extensive scope that covers all aspects of an educational institution and its ecosystem.
Impact	Increasing efficiency, innovation and engagement of both teachers and other participants in the educational process.	Supporting cultural transformation, supporting innovation and creating space for new educational models.

3. OVERVIEW OF NATIONAL DOCUMENTS IN THE CONTEXT OF NORWEGIAN DIGITALIZATION OF EDUCATION

In April 2023, the Norwegian government published the document "Strategi for digital kompetanse og infrastruktur i barnehage og skole" (SDKIBS) [14], which is a significant government document contributing to a more transparent support for municipalities and regional authorities in the face of new technologies, digital tools in education and increasing pressure on the privacy of children and young people. The aim of this government strategy document is to fulfill points such as:

- Digital competences of pupils: According to SDKIBS, it is necessary to develop digital competences in pupils in line with the curriculum, starting from pre-school education. Furthermore, SDKIBS is of the opinion that when society is thoroughly digitalised, everyone becomes a digital citizen and must have a basic level of digital competences in order to be able to actively participate in education, society and working life and not be excluded from society. For this reason, all children and young people must have the competences to be able to critically approach digital development and contribute to its shaping. The role of kindergartens and schools in developing children and pupils' digital skills, their digital judgement and their understanding of what citizenship in a digital society should look like is crucial. Kindergartens and other schools should be arenas that support the correct use of digital solutions and media that teach children and young people to navigate and master the digital environment. SDKIBS appeals to kindergartens to use digital solutions and media responsibly, as they place great demands on employees. According to the framework plan for kindergartens, employees or teachers must exercise 1. digital judgment when searching for information, 2. have a conscious attitude to copyright, legitimately criticize sources and 3. protect children's privacy. The scope and structure of digital work in kindergarten must be adapted to the age, interests and needs of children and must follow the recommendations of health authorities. Digital technologies and media can be passive for children and their uncritical use can lead to commercial influence on children. The Norwegian Directorate of Health recommends that young children spend as little passive time in front of a screen as possible, and screen time is not recommended for children under 1 year of age. The recommendation is based on the precautionary principle with regard to eye health and physical inactivity. Kindergartens must have a good dialogue with parents about the kindergarten's digital practice and how digital solutions and media are used in pedagogical work. Digital solutions used in parental collaboration must be secure, adapted to the purpose of communication and must take into account the types of information that is shared. SDKIBS for primary and secondary schools recommends that pupils encounter a society and working life where technology is constantly changing, for example with a greater element of AI. According to SDKIBS, pupils must be aware of the possibilities and limitations of technology and, last but not least, they should be familiar with the ethical issues that may be associated with the use of technology. This requires school founders and school principals to be aware of the consequences of technology in education, among which SDKIBS includes the necessary measures with regard

to privacy and the inclusion of pupils with various disabilities. School founders, leaders and teachers must evaluate and use technology responsibly and in a way that contributes to supporting pupil learning. As for digital practices, competences, infrastructure, learning environment and digital solutions, these are areas that are integrated into comprehensive plans and measures by school providers. Digital practices in schools are knowledge-based, inclusive and fulfil the right to privacy of both staff and pupils. School providers must combat digital exclusion by ensuring that all pupils develop sufficient digital competences to function in society and working life. Furthermore, Norwegian schools should have a good dialogue with parents about the school's goals and the framework for the use of digital technologies. The scope and structure of digital work in school must be adapted to the age, interests and needs of all pupils and must follow the recommendations of health authorities, for example: The Norwegian Directorate of Health recommends that pupils aged 6–17 limit screen time in their free time, but limiting screen time should not affect pedagogical work with digital solutions during lessons. It is not the school's responsibility to regulate pupils' screen use during free time, but the school must have good pedagogical reasons for using screens during lessons and a good dialogue with parents about the teaching methods the school is implementing.

- Digital competences of kindergarten and other school staff: Staff of all schools, especially teachers, should have professional digital competences to fulfil the objectives of the framework plans and curricula in the school.
- Inclusive, safe and good digital environment: All pupils and school staff should experience an inclusive, safe and good digital environment in schools.
- Digital foundation and sustainability: The digital foundation and access to digital solutions should be sustainable, of high quality and contribute to the equitable provision of schools and education across the country.
- Digital services: Digital services and information management in the school sector focus on children, pupils, staff and parents, and coherent services should be developed for them.

The Norwegian digital transformation of education is guided by the government document "Fremtidens digitale Norge: Nasjonal digitaliseringsstrategi 2024-2030" [15], which was published in 2024 by the Ministry of Digitalisation and Public Administration (Digitaliserings-og forvaltningsdepartementet). The government strategy sets the direction for Digital Norway until 2030 and the national vision for Norway to become the most digitalised country in the world. With this initiative, the Norwegian government aims to ensure that technological subjects are a priority in all educational institutions by 2030 [16].

In 2024, the Norwegian Directorate for Education and Training published the so-called framework for teachers' professional digital competence, i.e. "Rammeverk for lærerens profesjonsfaglige digitale kompetanse" [17]. The framework for teachers' professional digital competence is a guiding document consisting of seven competence areas. The purpose of the framework is to prepare teachers for the future in a digital environment. In recent years, schools and teacher education programmes in this area have been strengthened by national and local initiatives focused on teachers' professional digital competence, i.e. more than half of school founders have prioritized digitalization through a grant scheme for local competence development and in this way facilitated the development of competences in schools in cooperation with universities. Teachers' professional digital competence therefore has a dual purpose: One is professional development and the other is the performance of the profession itself. It is also worth mentioning the new curricula that have been implemented since 2020. These curricula are intended to facilitate the development of digital skills of pupils across subjects and disciplines, as well as deep learning in digital environments. Through in-service training, teachers can develop their own professional digital competences and specialized competences in the field of programming. The framework covers the following areas: 1. Subjects and basic skills; 2. School in society; 3. Ethics; 4. Pedagogy and subject-specific didactics; 5. Management of learning processes; 6. Interaction and communication; 7. Change and development. This Framework provides a common reference and conceptual framework for anyone working with the development of teacher competences, and can be used in policy development and research, increasing competences in initial and in-service teacher education.

3.1. Overview of research reports in the context of Norwegian digitalization of education

In 2020, the research center called Research, Innovation and Competence Development at the School of Education, University of Oslo, published a research report from the project called "Gode eksempler på praksis" (GEPP) [18]. In this project, researchers observed teaching in 20 classrooms in 5 different municipalities. In all classes, all pupils had their own digital device for at least one year. An important part of the GEPP project was the observation of teachers

and pupils in classrooms where digital practice had already been implemented. The research project started at the end of January and lasted until the end of May 2019. During the research investigation, more than 50 teaching hours were observed in 20 different classrooms, in which at least 20 different teachers participated. All teachers and more than 100 pupils were interviewed in the research. According to the results of the GEPP, the following points can be drawn:

- The textbook was still present in some lessons, but it was often used in interaction with digital tools and teaching resources in the form of resources that pupils found themselves or that were provided by the teacher.
- Pupils could choose their own resources and digital tools to solve the task.
- Interview data showed that teachers were creating hybrid teaching materials and learning resources.
- Teachers then selected materials from textbooks and other sources and adapted them for pupils. Using applications such as OneNote and Google Classroom, teachers gradually built a so-called resource bank for pupils.
- The pupils appreciated that the teaching content was understandable to them.

A research project called "Digitalisering i grunnopplæring; kunnskap, trender og framtidig kunnskapsbehov" (GrundDig) was conducted between November 2021 and November 2022. The project was commissioned by the Norwegian Directorate for Education and Training and the research partners were the Knowledge Centre for Education at the University of Stavanger, the University of Oslo and Volda University College. The aim of GrundDig was to gain an overview of experiences with digitalization in primary and secondary education and to contribute to a more uniform use of terminology. The results indicate that teachers have a positive attitude towards digitalization and that one in three teachers believe that they have good digital competences. The report also highlights large knowledge gaps regarding the digitalization of schools. A national survey showed that eight out of ten teachers believe that when they can use digital resources and tools, their teaching becomes more varied, relevant and tailored to each individual pupil [19].

We can consider the surveys of the Norwegian Directorate for Education and Vocational Training, the so-called Questions to Schools in Norway, which have been carried out since 2009 to the present, as significant. The survey is sent twice a year to school founders and school directors. The results of these surveys serve as a knowledge base for the work of the Norwegian Ministry of Education and Research and also for the Directorate for Education and Vocational Training. The topics of the individual surveys vary from year to year depending on needs. Examples of topics addressed include, for example, issues of schools and the educational environment; training content; management and organization; offers and services; competencies; differentiated teaching; regulations and supervision; vocational training; exams, tests and evaluation [20]. The latest survey, published in January 2025 and called "Spørsmål til Skole-Norge. Analyser og resultater fra utdanningsdirektoratets spørreundersøkelse til skoler og skoleeiere høsten 2024", focused on AI and the use of screens in schools. The main findings include:

- Teachers have reduced the use of homework, increased the use of oral assessments, and are evaluating pupils' learning processes more than the final product.
- Nine out of ten elementary schools report having content filters on school digital devices that restrict and block unwanted services and harmful online content.
- The use of AI in teaching is most widespread in subjects such as Norwegian, English, and social studies, especially in secondary schools.
- School leaders in upper secondary education and training more often report that AI tools are influencing teacher assessment practices, particularly to ensure that pupil performance reflects the competences they have actually acquired.
- The use of digital devices and screens in education increases with age and grade. In the second stage of primary school, only screens are used in most lessons and written work is mostly done digitally. Reading longer texts on paper is significantly reduced in the second stage of primary school [21].

In June 2024, the Organisation for Economic Co-operation and Development (OECD) Directorate for Science, Technology and Innovation, under the auspices of the OECD Digital Policy Committee, published a report on Norway's digital future [22]. The document highlights the Nordic region as a digital pioneer, but the text also highlights a worrying trend in Norway, namely the growing educational inequality, i.e.: First, the widening gap between the results of the most advantaged and disadvantaged students in terms of socio-economic status between 2012 and 2022 in Norway. Second, Norway faces challenges in encouraging students to study ICT and science, technology, engineering and mathematics (STEM), which is critical for success in a technology-rich workplace. The document highlights the 2021 figures showing a very low number of students in Norway graduating in ICT and STEM fields, behind all countries (except Brazil). This lag has existed despite the government placing special emphasis on ICT-

related degree programmes since 2015. The document also points to Eurostat 2023 figures indicating a noticeable gender gap (only 2% of women graduated in ICT in 2021) and OECD figures from 2024, with only 21% of women having ICT skills. Norway lags behind the OECD average in terms of the availability of workers with AI skills, a critical reality in an increasingly digital economy and society.

It is necessary to mention the document "Meld. St. 14 (2022-2023): Utsyn over kompetansebehovet i Norge", which was prepared for the period 2022-2023 [23]. This document deals with the government's policy for meeting future skills needs and appeals to education, which is to be essential for creating a good life for individuals and for creating a good society for us all. For individuals, education is to become important in the area of their development of a quality life. At the same time, the document emphasizes the government's expectation that universities will prioritize resources for health sciences, IT and areas that are important for the so-called green shift within their portfolio. Furthermore, the document draws attention to the fact that Norway has a relatively low share of highly educated people in STEM compared to the OECD average, while graduates and teachers in health and social care make up a relatively large share of highly educated people in Norway and other Scandinavian countries. Here we would follow up on the national strategic plan published in 2021. This is a national strategy for increasing digital participation and competence in the population. The document, entitled "Digital hele livet", fights against digital exclusion and seeks to provide security for all citizens who want to obtain the digital complementation needed to be able to use the digital tools and services on which we depend today. This national strategy believes that every person should have the opportunity to participate in society, democratic processes and social community using digital tools [24].

Like the "Digital hele livet" document, the Norwegian government's long-term plan for research and higher education also calls for digitalization. The document, called "Meld. St. 5 (2022–2023) Langtidsplan for forskning og høyre utdanning 2023–2032", states that Norway will be a low-emission society by 2050 and the government's goal is to reduce Norwegian emissions by 55% by 2030. These are very ambitious goals, and the business community and the public sector play an important role in the ecological transition. Investment in digitalization supports and enables the transition, and in addition to national knowledge initiatives, Norway is participating in significant investments in the ecological and digital transformation through the Horizon Europe program, the European Research Area, the Erasmus+ program and the European Education Area [25].

4. CONCLUSION

It is clear that the COVID-19 pandemic has accelerated the process not only of the digitalization of education, but above all of the digital transformation of most societies. This global situation has led to a faster introduction of digital technologies into education. In today's education environment, digitalization has become essential for education to remain sustainable and for pupils and students to succeed in a world that is constantly evolving and becoming more and more advanced. Digitalization of education allows schools to adapt to rapidly changing school conditions (including the conditions of pupils' and students' employability in the labor market) and optimize their processes for greater efficiency and productivity. It could be argued that digitalization of education is the process of facilitating and streamlining not only teaching procedures, but also educational processes. Especially in today's technology-driven world, it is crucial to adopt the so-called digital culture so that future generations of pupils and students can succeed in the modern technological world. Given that digital technologies are constantly developing rapidly, there is no doubt that education is undergoing a digital transformation. Based on the overview study, we have sorted the aforementioned documents by year of publication for better orientation of the digitalization of Norwegian education (see Table 2). We started the overview study with the publication of the national strategy called "Nasjonal strategi for kunstig intelligens", which was published by the Ministry of Digitalization and Public Administration in 2020 and clearly formulates a number of assumptions that will allow Norway to succeed with AI, because Norway has a digitally competent population and businesses, a well-developed infrastructure and well-developed digital government and public institutions that have come a long way in digitalization and have the expertise to experiment with new technologies. The Norwegian government thus believes that AI in Norway must be based on ethical principles and respect for human rights, and that research, development and use of AI will contribute to digital security, protection of the integrity and privacy of the individual [26]. According to Table 2, we can clearly see the development of national documents in the field of digitalization and the continuity of the report on this issue. It should also be noted that the Norwegian public sector is one of the most digitalised in the world, and there is still potential for improvement. Several public agencies are already using AI-based solutions to provide more accurate and user-oriented services, increase the social value of their own activities, streamline operations and work processes, and reduce risks. In the future, AI is likely to be used even more in Norway, and thus the need for expertise in areas such as AI and machine learning. Since it is challenging to keep up with these developments, especially for many smaller businesses, there is a need for both specialised and more flexible education in this area [27]. The overview study presents the Norwegian

digitalization of education as a well-thought-out and comprehensive strategy that creates space not only for the development of digitalization of education from kindergartens to universities, but also for national research in this area, from which the effectiveness and gaps of digitalization in education can be deduced. It is necessary to reflect on the fact that the Norwegian digitalization of education includes long-term planning and an effort to balance digital innovations with human values, but based on the aforementioned documents and research reports, we lack a clear and unified analysis of the costs and benefits of digitalization of education.

Table 2. Overview of documents focused on the Norwegian digitalization of education

Year of release	Publication type	Original title of the publication	Title of the publication in English
1/2025	Report	Spørsmål til Skole-Norge. Analyser og resultater fra Utdanningsdirektoratets spørreundersøkelse til skoler og skoleeiere høsten 2024	Questions to School-Norway. Analyses and results from the Norwegian Directorate for Education and Training's survey of schools and school owners in the spring of 2024
11/2024	Framework	Rammeverk for lærerens profesjonsfaglige digitale kompetanse	The Framework for the Teacher's Professional Digital Competence
9/2024	Strategy	Fremtidens digitale Norge: Nasjonal digitaliseringsstrategi 2024–2030	The digital Norway of the future: National digitalization strategy 2024–2030
6/2024	Report	Shaping Norway's Digital Future	
4/2023	Strategy	Strategi for digital kompetanse og infrastruktur i barnehage og skole	Strategy for digital competence and infrastructure in kindergartens and schools
3/2023	Report	Meld. St. 14 (2022–2023): Utsyn over kompetansebehovet i Norge	Notifications. St. 14 (2022–2023): Overview of the need for expertise in Norway
12/2022	Report	GrundDig: Strategi for digital kompetanse og infrastruktur i barnehage og skole	GrundDig: Digitalisation in primary and secondary education: knowledge, trends and future research needs
9/2022	Long-term plan	Meld. St. 5 (2022–2023): Langtidsplan for forskning og høyere utdanning 2023–2032	Meld. St. 5 (2022–2023): Long-term plan
9/2021	Strategy	Digital hele livet	

			for research and higher education 2023–2032
8/2021	Strategy	Digitaliseringstrategi for grunnopplæringen 2017–2021	Digital Throughout Life
			Digitalization strategy for primary and secondary education and training 2017–2021
5/2020	Report	Gode eksempler på praksis	Good examples of practice
1/2020	Strategic plan	Nasjonal strategi for kunstig intelligens	The National Strategy for Artificial Intelligence

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E-Learning in Rwandan Higher Learning Institutions: Educators' Perceptions and Challenges

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Abstract

The rapid advancement of digital technologies has transformed higher education, offering new opportunities for flexible and inclusive learning. In Rwanda, government initiatives such as Vision 2020 and Vision 2050 have encouraged the adoption of e-learning in higher learning institutions. However, the successful implementation of digital education remains a challenge due to infrastructural deficits, limited technical support, inadequate training, and cultural resistance to shifting from traditional teaching methods. This study explores educators' perceptions of e-learning in Rwandan higher learning institutions, identifying both the benefits and barriers associated with its adoption. Using a qualitative research design, semi-structured interviews were conducted with 15 faculty members from diverse academic disciplines in Rwandan universities. Thematic analysis of the data revealed five key themes: enhanced access to resources and pedagogical flexibility, infrastructural and technical challenges, limited training and institutional support, cultural resistance to digital education, and prospects for collaboration and future digital integration. Findings indicate that while educators recognize the potential of e-learning to enhance teaching and learning, inadequate ICT infrastructure, insufficient digital literacy programs, and weak institutional policies significantly hinder its effective implementation. To address these challenges, this study recommends targeted investments in digital infrastructure, comprehensive faculty training programs, institutional incentives to encourage technology adoption, and stronger policy alignment between national education strategies and university-level implementation. Future research should explore longitudinal studies on e-learning adoption, conduct comparative regional analyses, and investigate student perspectives on digital education. Strengthening Rwanda's e-learning ecosystem will require a collaborative effort among educators, policymakers, and technology stakeholders to create a sustainable and inclusive digital learning environment.

Keywords: E-learning, higher learning institutions, faculty perceptions, digital transformation, Rwanda

1. INTRODUCTION

The rapid advancement of information and communication technology (ICT) has significantly transformed the education landscape, particularly in higher learning institutions worldwide (Haleem et al., 2022). Adopting digital learning tools has reshaped traditional pedagogical methods, enabling greater flexibility, accessibility, and engagement in teaching and learning processes (Adeshina, 2024; Ahamad et al., 2024). With the increasing demand for more inclusive and efficient educational models, many institutions are integrating e-learning platforms to complement or, in some cases, replace conventional classroom-based instruction (Khan & Khan, 2024). This shift is

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particularly relevant in developing nations where digital transformation is seen as a crucial strategy for expanding educational opportunities and addressing systemic challenges in the sector (Habib, 2023).

As reported by MICT (2024), Rwanda has emerged as one of the leading countries in Africa embracing ICT-driven education reforms. As part of its national development agenda, the government has consistently emphasized the role of digital technology in fostering a knowledge-based economy (Mugiraneza, 2021). Policies such as Vision 2020 and the more recent Vision 2050 underscore the government's commitment to leveraging technology to improve educational access, quality, and efficiency (NCST, 2020). Within this framework, higher learning institutions have been encouraged to integrate e-learning into their academic programs, utilizing digital platforms to enhance content delivery, promote interactive learning, and support research initiatives (Abera et al., 2023).

Despite these policy efforts, the implementation of e-learning in Rwanda's higher learning institutions has encountered significant obstacles (Bizimana, 2018). Recent research indicates that while faculty members recognize the potential benefits of digital education such as expanded access to learning materials, increased flexibility in teaching, and opportunities for pedagogical innovation they also face multiple challenges (Mushimiyimana et al., 2025). Key barriers include inadequate ICT infrastructure, unreliable internet connectivity, insufficient technical support, limited digital literacy among educators, and cultural resistance to transitioning from traditional face-to-face instruction to digital learning environments (North et al., 2014). These challenges highlight a critical gap between policy aspirations and the actual experiences of educators responsible for implementing e-learning initiatives.

The role of educators in this transition is pivotal, as their perceptions, competencies, and willingness to integrate digital tools significantly influence the success of e-learning adoption (Wohlfart & Wagner, 2024). However, existing research on digital transformation in education has largely focused on institutional policies and student experiences, with limited emphasis on the perspectives of educators themselves (Means et al., 2010). Understanding how faculty members in Rwandan higher learning institutions perceive e-learning, the benefits they identify, and the obstacles they encounter is essential for designing more effective strategies to support digital education initiatives.

This study contributes to the growing body of knowledge on digital learning in higher education, offering insights that can inform policymakers, institutional leaders, and educators in designing strategies for more effective e-learning integration. The findings will help bridge the gap between policy directives and practical implementation, ensuring that digital transformation efforts in Rwandan higher learning institutions align with both national development objectives and the needs of educators and students alike.

This study aims to explore educators' perceptions of e-learning within Rwandan higher learning institutions, examining both the advantages they associate with digital learning and the challenges they face in its implementation. Specifically, it seeks to answer the following research questions:

1. What advantages do educators perceive in using e-learning platforms in higher learning institutions?
2. What barriers hinder the effective adoption of e-learning in academic environments?
3. How do institutional policies, infrastructural constraints, and cultural factors influence the sustainability of digital education initiatives?

2. LITERATURE REVIEW

According to Wolniak and Stecuła (2024), E-learning has become an essential component of modern education, providing flexible and innovative ways of teaching and learning in higher learning institutions. Singh et al. (2023) have found that the growing reliance on digital tools has significantly reshaped traditional instructional methods, enabling educators and students to engage with educational content beyond physical classrooms. This shift has facilitated access to education for diverse populations, including non-traditional students and those in remote areas (Ahamad et al., 2024). However, it also presents challenges such as ensuring equitable access to technology, maintaining academic integrity, and providing effective training for educators (Maqbool et al., 2024). Institutions worldwide are actively developing strategies to address these issues, aiming to harness the full potential of e-learning while mitigating associated challenges (Bashir & Lapshun, 2025).

In many developing countries, including Rwanda, e-learning is viewed as a strategy to expand access to education and enhance the quality of learning experiences (Matete et al., 2023). As reported by NCST (2020), the Rwandan government has integrated digital learning into its national development agenda, as outlined in Vision 2020, and expanded to Vision 2050, emphasizing the role of technology in transforming education and fostering a knowledge-based economy. While policy efforts have been made to integrate e-learning into higher learning

institutions, numerous challenges remain (Mushimiyimana et al., 2025). Educators often face obstacles such as limited digital literacy, inadequate institutional support, unreliable technological infrastructure, and resistance to adopting new teaching methodologies (Mushimiyimana et al., 2025). A study by Twesige and Gasheja (2021) analyzed the challenges and opportunities of moving to online learning in Rwandan higher learning institutions during the COVID-19 pandemic and revealed that while online learning provided a necessary alternative during periods of physical distancing, it also exposed significant obstacles. These included limited internet access, insufficient digital devices, and a lack of preparedness among both students and faculty for a swift transition to online platforms. The study emphasized the need for comprehensive strategies to address these issues to ensure the resilience and effectiveness of e-learning initiatives in the face of future disruptions.

The Higher Education Council (HEC) of Rwanda has recognized that, despite existing challenges, e-learning offers significant opportunities to enhance the quality of education within the country's higher learning institutions. The integration of digital tools facilitates personalized learning experiences, enabling students to progress at their own pace and access a broader range of resources than traditional classrooms might offer. Furthermore, e-learning platforms support the development of digital literacy skills among students, better preparing them for a technology-driven global economy. To fully realize these benefits, HEC emphasizes the importance of investing in robust technological infrastructure, providing ongoing training for educators, and developing policies that promote inclusive access to digital learning resources (HEC, 2024).

According to Aparicio et al. (2016), understanding the factors that influence the adoption and effectiveness of e-learning requires a theoretical lens that captures both technological and pedagogical dimensions. This study applies four theoretical frameworks to examine e-learning adoption in Rwandan higher learning institutions: the Technology Acceptance Model (TAM), the Diffusion of Innovations (DOI) Theory, the Constructivist Learning Theory, and the Community of Inquiry (CoI) Model. These theories offer insights into the factors that shape educators' attitudes toward digital learning, the processes involved in technology diffusion, and the pedagogical implications of e-learning environments.

2.1. Theoretical framework

2.1.1. Technology Acceptance Model (TAM) and E-Learning Adoption

The Technology Acceptance Model (TAM) developed by Davis (1989) is widely used to analyze how individuals adopt and use technology. According to TAM, the likelihood of adopting a new technology depends on two key factors: perceived usefulness (PU) and perceived ease of use (PEOU). According to Venkatesh (2000), perceived usefulness refers to the extent to which an individual believes that using a specific technology will enhance their performance, while perceived ease of use relates to the degree to which the technology is considered user-friendly and free from effortful challenges. In the context of higher learning institutions in Rwanda, TAM provides valuable insights into the reasons why educators either embrace or resist e-learning.

For many educators, e-learning is perceived as a tool that enhances instructional delivery, allows flexible teaching, and provides students with access to a vast range of learning materials (Abera et al., 2023). However, some faculty members are reluctant to adopt e-learning due to a lack of training, inadequate technical support, and concerns about the complexity of digital platforms. Research has shown that institutions that provide proper training, ongoing support, and simplified digital tools can significantly improve educators' perceived ease of use, thus increasing their willingness to integrate e-learning into their teaching practices (North et al., 2014). In Rwanda, enhancing faculty digital literacy through continuous professional development programs, peer mentorship, and institutional incentives could encourage more educators to engage with e-learning platforms effectively.

2.1.2. Diffusion of Innovations (DOI) Theory and E-Learning Implementation

Rogers' Diffusion of Innovations (DOI) Theory (2003) explains how new technologies spread within a community or organization (Rogers, 2003). The theory categorizes individuals into five groups based on their readiness to adopt an innovation: innovators, early adopters, early majority, late majority, and laggards. These categories are relevant to understanding how educators in Rwandan higher learning institutions engage with e-learning.

Innovators and early adopters are typically faculty members who are enthusiastic about technology and eager to explore new digital tools (Anderson et al., 2017; Stumbrienė et al., 2024). They play a crucial role in promoting e-

learning by demonstrating its benefits to their colleagues. The early majority tends to adopt technology only after observing its success among peers, while the late majority adopts it when it becomes a standard institutional practice (Anderson et al., 2017). Laggards, on the other hand, are often resistant to technological changes and prefer traditional teaching methods.

In Rwanda, many educators fall into the late majority and laggard categories, primarily due to infrastructural limitations, inadequate training, and uncertainty regarding the effectiveness of e-learning (NCST, 2020). To accelerate the adoption of digital education, institutions should implement peer-led mentorship programs, provide incentives for technology integration, and establish clear policies that encourage digital teaching methodologies (Musikavanhu & Scheepers, 2024). By addressing these challenges, universities can create an environment where digital learning is seen as an essential and sustainable component of higher education.

2.1.3. Constructivist Learning Theory and Pedagogical Implications of E-Learning

The Constructivist Learning Theory, pioneered by Piaget (1971) and Vygotsky (1978), emphasizes that learning occurs most effectively when individuals actively engage with knowledge, collaborate with peers, and apply critical thinking. Unlike traditional lecture-based methods, constructivist approaches encourage students to take an active role in their learning by exploring concepts, solving problems, and engaging in discussions (McBlain & Gray, 1996).

E-learning platforms align well with constructivist principles by providing interactive tools such as discussion forums, virtual simulations, multimedia resources, and real-time collaborative assignments. These tools enable students to explore concepts independently and engage in deeper learning experiences. In Rwandan higher learning institutions, the integration of digital tools can enhance student-centered learning, improve accessibility to academic resources, and foster collaborative knowledge-building (Mushimiyimana et al., 2025).

Despite these benefits, many educators still rely on teacher-centered approaches that limit student interaction and engagement in digital learning environments. Research suggests that training faculty members in interactive teaching strategies, promoting digital collaboration, and redesigning e-learning courses to encourage student participation can improve the effectiveness of online learning in Rwanda (Means et al., 2010).

2.1.4. Community of Inquiry (CoI) Model: Enhancing Engagement in Online Learning

The Community of Inquiry (CoI) Model provides a structured approach to understanding how effective online learning environments are developed (Fiock, 2020). The model is built on three core elements: cognitive presence, social presence, and teaching presence.

According to Rasikawati et al. (2024), cognitive presence refers to the ability of students to construct and confirm meaning through sustained engagement in learning activities. Social presence highlights the importance of communication and interaction in building an engaging online community. Teaching presence involves the role of instructors in designing, facilitating, and guiding meaningful learning experiences.

Applying the CoI Model in Rwandan higher learning institutions can enhance the effectiveness of e-learning by fostering more interactive and engaging online courses. Educators can incorporate discussion-based learning, encourage peer collaboration, and provide timely feedback to maintain active engagement (Means et al., 2010). However, for this model to succeed, institutions must invest in digital infrastructure, provide adequate training, and support instructors in transitioning from traditional teaching to online facilitation (Abera et al., 2023).

In conclusion, the integration of e-learning in Rwandan higher learning institutions presents a unique opportunity to enhance education, but it also comes with significant challenges. The Technology Acceptance Model (TAM) explains how perceived usefulness and ease of use influence educators' willingness to adopt digital tools, while the Diffusion of Innovations (DOI) Theory provides insights into how new technologies spread across institutions. Constructivist Learning Theory emphasizes the importance of active, student-centered learning approaches, whereas the Community of Inquiry (CoI) Model highlights the need for engaging and interactive online learning environments. For e-learning to be effectively implemented in Rwanda, institutions must focus on faculty training, technological infrastructure, and policies that support digital transformation. By leveraging these theoretical perspectives, universities and policymakers can develop strategies that promote sustainable and inclusive e-learning, ensuring that both educators and students benefit from digital education advancements.

Conceptual framework

Figure 1 below, Conceptual Framework for E-Learning Adoption in Rwandan Higher Education provides a comprehensive model for understanding the key factors that influence the successful implementation of digital learning in Rwandan universities. It identifies five interconnected components: technological factors (ICT infrastructure and technical support), individual factors (educator attitudes and student readiness), institutional factors (policy support and training), socio-cultural factors (cultural attitudes and language relevance), and pedagogical factors (teaching strategies and assessment methods). These components interact dynamically, with technological infrastructure enabling individual readiness and shaping pedagogical approaches, while institutional leadership and policies drive the development of resources and training. Socio-cultural factors, such as societal norms and language, further influence both individual attitudes and institutional decisions. The framework emphasizes that successful e-learning adoption requires a holistic approach, addressing technological, institutional, and cultural challenges while ensuring that teaching and assessment methods are adapted to the digital environment. By integrating these elements, the framework offers a structured pathway for Rwandan higher education institutions to create sustainable and effective e-learning ecosystems.

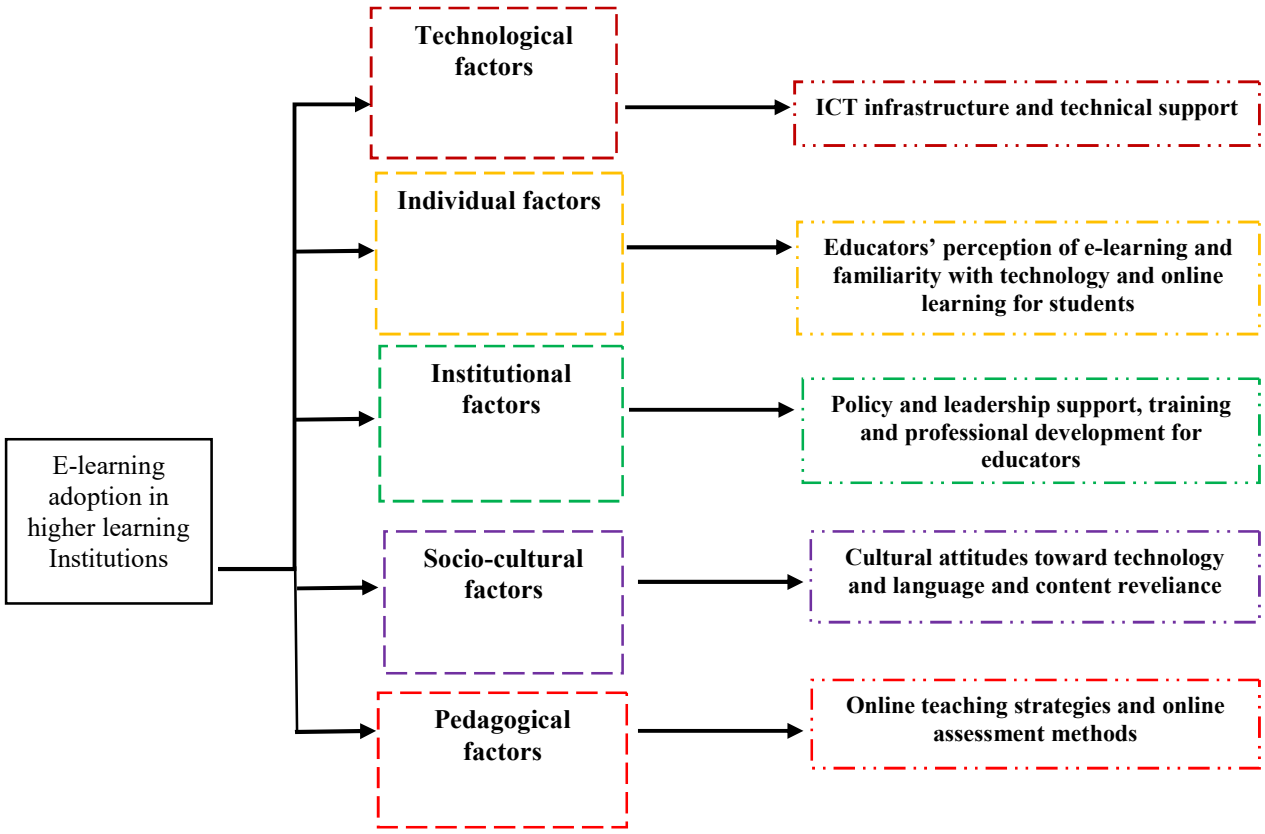

Fig. 1. *Conceptual framework*

3. METHODOLOGY

This study employed a qualitative research design to explore educators' perceptions regarding e-learning adoption in Rwandan higher learning institutions. A purposive sampling strategy was used to select 15 participants from diverse academic disciplines, ensuring that each participant had direct experience with e-learning initiatives. Although qualitative research typically involves smaller sample sizes, the selection of 15 participants was carefully justified. In qualitative inquiry, the sample size is determined by the concept of data saturation defined as the point at which no new themes or insights emerge from additional data collection (Naeem et al., 2023). In this study, the

iterative process of interviewing and analyzing responses revealed that 15 participants provided sufficient depth and breadth to capture the phenomenon under investigation. This number was deemed appropriate given the homogeneity of the sample in terms of their roles and experiences with e-learning, ensuring both the relevance and richness of the data.

Data representativeness was ensured through a deliberate purposive sampling process that targeted educators from various academic backgrounds and levels of technological proficiency. This strategy allowed for the inclusion of multiple perspectives, thereby enhancing the transferability of the findings to similar educational contexts. By carefully selecting participants who were directly involved with digital teaching initiatives, the study captured a wide range of experiences and challenges, ultimately reinforcing the validity of the findings.

After the interviews were transcribed, participants were allowed to review and verify the accuracy of the data. This process, known as member checking, ensured that the participants' viewpoints were accurately captured and interpreted. By inviting feedback on the preliminary analysis, any misunderstandings or inaccuracies were corrected, thus enhancing the credibility of the findings.

To mitigate potential biases and confirm the consistency of the data, triangulation was employed. Data triangulation involved comparing the interview data with existing literature, institutional documents, and policy frameworks related to e-learning in Rwanda (Braun & Clarke, 2006). This multi-source approach provided a comprehensive understanding of the phenomenon and helped validate the emerging themes from different perspectives.

The coding and analysis process involved multiple researchers to ensure consistency in theme identification and interpretation. Independent coding by at least two researchers was followed by discussions to reconcile any differences. This collaborative approach helped achieve inter-rater reliability, ensuring that the findings were not solely dependent on a single researcher's interpretation but rather reflected a consensus view based on systematic analysis. By justifying the sample size through the concept of saturation, ensuring data representativeness via purposive sampling, and employing multiple strategies for trustworthiness, the study adheres to rigorous qualitative research standards. These methodological choices enhance the robustness of the findings, thereby providing a solid foundation for understanding the factors influencing e-learning adoption in Rwandan higher learning institutions. Respondents' characteristics are represented in the table 1 below

Table 1. Respondents' characteristics

Participant code	Discipline	Years of experience	Role
P1	Humanities	12	Lecturer
P2	Sciences	8	Senior lecturer
P3	Engineering	10	Lecturer
P4	Social sciences	7	Lecturer
P5	Law	15	Senior lecturer
P6	Business studies	9	Lecturer
P7	Medicine	11	Lecturer
P8	Computer science	5	Lecturer
P9	Education	13	Lecturer
P10	Engineering	6	Lecturer
P11	Humanities	14	Senior lecturer
P12	Social sciences	8	Lecturer
P13	Sciences	10	Lecturer
P14	Business studies	7	Lecturer
P15	Law	12	Lecturer

4. FINDINGS

The qualitative analysis of interview data from 15 educators revealed five major themes concerning the adoption and implementation of e-learning in Rwandan higher learning institutions. These themes are the benefits of E-Learning; Infrastructural and Technical challenges; Training and Institutional support; Cultural resistance and Attitudinal Barriers; and Future prospects and Collaborative approaches are supported by rich participant narratives and are further discussed below with direct quotes and comparative insights.

Theme 1: Benefits of E-learning

Educators frequently underscored the transformative benefits of e-learning, particularly highlighting enhanced access to information and increased flexibility in instructional delivery. For example, Participant P1 from Humanities remarked:

"Since adopting e-learning, our students can access scholarly databases and digital libraries that were once out of our reach. This access has enriched our curriculum in ways that traditional methods never could."

Similarly, Participant P3 from Engineering explained:

"Recording lectures has provided an invaluable resource. Students can revisit complex topics as many times as needed, which not only improves understanding but also reduces classroom anxiety."

These perspectives are consistent with studies from other sub-Saharan regions, where e-learning has been recognized for democratizing access to education and fostering innovative teaching practices (Abera et al., 2023). The flexibility reported here echoes findings from similar low-resource contexts where digital platforms serve as critical tools in overcoming geographical and resource limitations.

Theme 2: Infrastructure and Technical challenges

A significant number of respondents pointed to infrastructural challenges as a major barrier to effective e-learning. Participant P4 from Social Sciences noted:

"Our internet connectivity is so unstable that even a short live session can be disrupted several times. This unpredictability makes it difficult for both instructors and students to maintain engagement."

Participant P7 from Medicine also shared:

"Outdated hardware and software are daily frustrations. We struggle with slow computers and legacy systems that can't support modern e-learning platforms, which ultimately undermines the learning experience."

These challenges are similar to those reported in other low-resource educational environments, where limited investments in technology hinder the full potential of digital education (North et al., 2014). The recurring emphasis on connectivity and outdated technology underscores the urgent need for infrastructural improvements.

Theme 3: Training and Institutional support

Many educators expressed that while e-learning technologies are available, the necessary training and institutional support are lacking. Participant P5, a Senior Lecturer in Law, stated:

"We are expected to integrate e-learning tools into our teaching, but the training provided is minimal. More comprehensive workshops and continuous support are needed to make full use of these tools."

Participant P9 from Education added:

"There is a clear gap between the institutional mandate for digital transformation and the support that is provided. Without proper technical assistance and clear guidelines, our efforts remain fragmented."

These comments align with research from other sub-Saharan institutions, where insufficient training and support are commonly cited as barriers to successful e-learning implementation (Musikavanhu & Scheepers, 2024). The need for robust professional development and clearer policy directives is evident and has been identified as a priority area in similar contexts.

Theme 4: Cultural resistance and Attitudinal barriers

Cultural factors emerged as a notable barrier, with many participants expressing a strong preference for traditional face-to-face teaching methods. Participant P11 from Humanities observed:

"There is a longstanding belief in the superiority of traditional classroom teaching. Many of my colleagues remain skeptical about online learning, viewing it as an inferior substitute."

Participant P14 from Business Studies commented:

"Even when the necessary technology is available, many instructors are hesitant to change their teaching style. The resistance to digital transformation is deeply rooted in our educational culture."

These sentiments are in line with findings from other low-resource regions, where cultural resistance and an attachment to traditional methods frequently slow the adoption of innovative educational practices (Means et al., 2010). Overcoming this barrier will require targeted change management strategies and efforts to shift long-standing mindsets.

Theme 5: Future prospects and Collaborative approaches

Despite the challenges, there was an overall sense of optimism among respondents regarding the future of e-learning. Participant P8 from Computer Science expressed:

"I am confident that with better institutional support and improved infrastructure, we can overcome current challenges. Collaborative initiatives and mentorship programs will be key to driving this change."

Participant P12 from Social Sciences noted:

"If we create communities of practice where educators can share experiences and strategies, I believe we can bridge the gap between traditional and digital teaching. There is a lot of untapped potential here."

This optimism is supported by research from other sub-Saharan contexts, where collaborative approaches and the formation of mentorship networks have been shown to significantly enhance digital education initiatives (Abera et al., 2023). The willingness to engage in collaborative practices indicates that educators see a promising path forward if the right supports are put in place.

4.1. Comparative Analysis with other contexts

The themes emerging from this study closely mirror those found in other sub-Saharan and low-resource higher learning institutions. For instance, the enhanced access and flexibility provided by e-learning are widely acknowledged benefits across Africa (Abera et al., 2023). Similarly, infrastructural deficiencies and inadequate training are recurrent issues noted in various studies, confirming that these challenges are not unique to Rwanda (Musikavanhu & Scheepers, 2024; North et al., 2014). The cultural resistance encountered in this study aligns with broader regional findings, where traditional teaching methods continue to dominate (Means et al., 2010). Finally, the expressed optimism and interest in collaborative strategies offer a common thread in recent research, suggesting that mentorship and community-building initiatives are promising strategies for overcoming digital education barriers.

In summary, the analysis of educator perceptions reveals that while e-learning in Rwandan higher learning institutions offers significant benefits such as increased resource access and enhanced flexibility it is simultaneously hindered by infrastructural shortcomings, insufficient training, and cultural resistance. The findings, bolstered by direct participant quotes and comparative analysis with studies from similar contexts, underscore the complex interplay between these factors. Addressing these challenges through improved infrastructure, robust professional development, and strategies to shift cultural attitudes will be essential for realizing the full potential of e-learning in resource-constrained environments.

Table 2. Themes and subthemes

Theme	Subthemes
1. Benefits of E-learning	1.1. Enhanced access to resources
	1.2. Flexibility in teaching and learning
	1.3. Opportunities for innovation
2. Infrastructural and Technical challenges	2.1. Unreliable internet connectivity
	2.2. Outdated hardware/software
	2.3. Limited technical support
3. Training and Institutional Support	3.1. Lack of comprehensive training
	3.2. Insufficient technical assistance
	3.3. Weak policy implementation
4. Cultural resistance and Attitudinal barriers	4.1. Preference for traditional teaching methods
	4.2. Resistance to change
5. Future prospects and Collaborative approaches	5.1. Optimism for digital integration
	5.2. Interest in mentorship and collaboration

5. DISCUSSION

The findings of this study reveal a multifaceted picture of e-learning adoption in Rwandan higher learning institutions. While educators recognize significant benefits such as enhanced access to resources and increased instructional flexibility they also face considerable challenges related to infrastructural deficits, insufficient training,

and entrenched cultural resistance. These findings have substantial implications for policymakers and institutional leaders in Rwanda.

5.1. Policy Implications for the Rwandan Government and Higher Learning Institutions

The evidence underscores the urgent need for comprehensive policy measures aimed at strengthening the digital ecosystem in higher learning. Based on the Technology Acceptance Model (TAM), which emphasizes perceived usefulness and ease of use, policies should focus on upgrading digital infrastructure and ensuring that e-learning platforms are intuitive and user-friendly. This entails significant investment in reliable internet connectivity, modern hardware, and robust technical support services. Policymakers should allocate dedicated funds for these improvements, especially in public universities and institutions in remote regions.

Furthermore, the Diffusion of Innovations (DOI) Theory suggests that early adopters play a critical role in encouraging broader acceptance among educators. Hence, government policies could incentivize innovation by establishing recognition programs or financial incentives for faculty members who successfully integrate e-learning into their teaching practices. By fostering a culture of innovation, the government can accelerate the diffusion of digital technologies across institutions.

Higher learning institutions must also develop internal policies that support ongoing professional development. Drawing on the insights from Constructivist Learning Theory, which advocates for student-centered and interactive pedagogies, universities should design and implement regular training programs. These programs would not only improve educators' digital literacy but also equip them with skills to create engaging, constructivist-oriented online learning environments. Additionally, clear guidelines and strategic plans that align institutional objectives with national e-learning policies are essential for bridging the gap between policy and practice.

5.2. Influence of Gender, Socioeconomic Status, and Institutional Hierarchy

The study further reveals that e-learning adoption is not experienced uniformly by all educators, as factors such as gender, socioeconomic status, and institutional hierarchy play influential roles. Women, for example, may face unique challenges in accessing and mastering digital tools due to existing gender disparities in technological education and confidence. The Technology Acceptance Model (TAM) indicates that perceived ease of use is critical; if female educators encounter additional obstacles or biases in accessing digital training, their willingness to adopt e-learning could be adversely affected. Thus, gender-sensitive policies are needed policies that provide targeted training and support for female faculty and address any systemic barriers they may face.

Socioeconomic status is another critical factor influencing e-learning adoption. Educators working in institutions located in lower-income or under-resourced regions are more likely to encounter infrastructural challenges, such as unreliable internet connectivity and outdated equipment. This disparity can lead to a digital divide that affects not only educators but also the student populations they serve. Policy interventions must therefore prioritize equitable resource distribution, ensuring that all institutions, regardless of their geographic or economic context, receive the necessary support to implement e-learning effectively.

Institutional hierarchy also influences the dynamics of digital transformation. Senior faculty and administrators often positioned in decision-making roles tend to be more conservative and may exhibit resistance to rapid changes in teaching methodologies. According to the Diffusion of Innovations (DOI) Theory, the late majority or laggards can delay the overall adoption process if they do not see clear benefits or receive sufficient support. Addressing this requires deliberate change management strategies within institutions. Creating formal structures for mentorship and peer-to-peer learning, as suggested by the Community of Inquiry (CoI) Model, can help bridge the gap between early adopters and those resistant to change. Encouraging collaboration across hierarchical levels may facilitate a more cohesive and accelerated transition to digital learning.

5.3. Integration of Theoretical Frameworks in Addressing Challenges

The theories and models discussed provide a robust framework for understanding and addressing the complexities of e-learning adoption in Rwanda. TAM emphasizes that improving the perceived ease of use and usefulness of e-learning platforms is paramount governments and institutions must invest in user-friendly technologies and comprehensive training programs. Meanwhile, DOI Theory highlights the importance of

leveraging early adopters and fostering a culture of innovation to overcome resistance. Constructivist Learning Theory and the CoI Model stress that digital pedagogy must be interactive and learner-centered, which can only be achieved through proper support and training.

Collectively, these theoretical perspectives inform a holistic policy approach. By addressing technological, pedagogical, and cultural dimensions simultaneously, policymakers and institutional leaders can create an environment in which e-learning not only survives but thrives. Ensuring equitable access and addressing specific challenges related to gender, socioeconomic status, and institutional hierarchy will be critical for bridging the digital divide and realizing the full potential of e-learning in Rwanda.

6. CONCLUSION

The integration of e-learning in Rwandan higher learning institutions presents both opportunities and challenges. While educators acknowledge the benefits of digital learning, including increased accessibility to resources, greater instructional flexibility, and opportunities for pedagogical innovation, significant barriers persist. Infrastructural limitations, unreliable internet connectivity, insufficient technical support, and cultural resistance to digital transformation continue to hinder the effective adoption of e-learning. Addressing these challenges requires a multifaceted approach that combines targeted policy actions, institutional reforms, and ongoing support for educators. To ensure sustainable e-learning implementation, investment in ICT infrastructure must be prioritized. Higher education institutions, in collaboration with the government, should allocate targeted funding to improve internet connectivity, provide updated digital tools, and establish modern e-learning platforms. Special attention should be given to institutions in rural areas to minimize the digital divide and ensure equitable access to online education. Additionally, comprehensive digital literacy programs should be implemented to equip educators with the necessary skills to integrate technology effectively into their teaching. Continuous training workshops, peer mentorship programs, and structured capacity-building initiatives will help educators navigate digital tools with confidence, enhancing both teaching quality and student engagement. Institutional incentives also play a crucial role in encouraging faculty engagement with e-learning. Universities should introduce recognition programs, grants, and career advancement opportunities for educators who actively embrace digital teaching methods. Providing workload adjustments for faculty members who develop high-quality digital content and engage in online course facilitation can further motivate the adoption of e-learning. Moreover, clear policy frameworks and collaborative efforts between policymakers, academic institutions, and private-sector technology providers are essential to ensuring that national digital education strategies align with institutional realities. Establishing a continuous dialogue between stakeholders will help address emerging challenges and create adaptive policies that support e-learning sustainability. Beyond policy interventions, the development of localized digital learning materials should be emphasized to ensure that e-learning remains relevant and accessible to a diverse student population. Course content should reflect the linguistic, cultural, and educational context of Rwanda, enabling students to engage more effectively with digital learning resources. Encouraging universities to invest in open educational resources and digital repositories can enhance the availability of locally produced academic materials, further strengthening e-learning adoption. While this study provides valuable insights into educators' perceptions of e-learning in Rwanda, further research is necessary to deepen the understanding of digital education dynamics. Longitudinal studies tracking the progression of e-learning adoption over time will provide crucial insights into its sustainability and impact. Comparative research between Rwanda and other African countries with similar socioeconomic contexts can help identify best practices and lessons that can be adapted to Rwanda's higher education system. Additionally, future studies should explore students' perspectives on e-learning, particularly regarding accessibility, engagement, and learning outcomes in digital environments. Investigating the effectiveness of different e-learning models, such as blended learning versus fully online courses, can also provide evidence-based recommendations for improving digital pedagogies. By implementing these strategic policy actions and expanding research efforts, Rwanda's higher education system can build a more resilient and inclusive digital learning ecosystem. The successful integration of e-learning will not only enhance teaching and learning experiences but also contribute to the country's broader goal of becoming a knowledge-driven economy. Ensuring that educators receive the necessary support, infrastructure, and training will be critical in transforming Rwanda's higher education sector into one that fully embraces the potential of digital learning.

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Appendix A. An example appendix

Interview Guide: Educators' Perceptions of E-Learning in Rwandan Higher Learning Institutions

Section 1: Background Information

1. Can you tell me about your academic discipline and your teaching experience?
2. How long have you been using e-learning tools in your teaching?

Section 2: Perceptions of E-Learning

3. What do you see as the main advantages of using e-learning in your teaching?
4. How has e-learning influenced your teaching methods and student engagement?
5. Do you believe e-learning improves learning outcomes? Why or why not?

Section 3: Challenges in E-Learning Adoption

6. What challenges have you encountered while integrating e-learning in your teaching?
7. How does the availability of ICT infrastructure (internet connectivity, hardware, software) affect your ability to use e-learning?
8. What kind of technical support or training have you received for using e-learning platforms?
9. How do institutional policies and leadership impact e-learning adoption at your university?
10. Have you faced any cultural resistance (from students, colleagues, or administrators) to the adoption of e-learning?

Section 4: Institutional Support and Training

11. What kind of training or support would help you use e-learning more effectively?
12. How do you perceive the university's commitment to digital learning transformation?

Section 5: Future Prospects and Recommendations

13. What strategies do you think can improve the implementation of e-learning in Rwandan higher learning institutions?
14. What role should the government and policymakers play in enhancing e-learning adoption?
15. In your opinion, what are the best ways to encourage educators to embrace e-learning?

Field Deployment and Analysis of Fiber Optic Sensing for Thermal Recovery in a Heavy Oil Reservoir

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Abstract

This paper will focus on the thermal recovery methods, such as cyclic steam stimulation, which are widely used to enhance heavy oil production by reducing viscosity and improving fluid mobility. However, optimizing steam injection efficiency remains a challenge due to the complex thermal and pressure dynamics within the reservoir. This study presents the field deployment and analysis of Distributed Temperature Sensing (DTS) and Distributed Pressure Sensing (DPS) using fiber optic technology in a horizontal heavy oil well undergoing thermal recovery. Over a one-month period, real-time DTS and DPS data were collected to evaluate temperature distribution, steam front movement, and pressure variations along the wellbore. The analysis provides key insights into thermal propagation efficiency, steam breakthrough detection, and pressure anomalies that impact overall well performance. The results highlight the advantages of fiber optic monitoring in optimizing thermal recovery by offering continuous, high-resolution data, enabling improved reservoir management decisions. Additionally, challenges related to sensor deployment, data interpretation, and operational limitations are discussed. This study contributes to the growing field of intelligent well monitoring, demonstrating how real-time fiber optic sensing can enhance heavy oil production efficiency and provide valuable input for future well optimization strategies.

Keywords: Fiber Optic Sensing, Distributed Temperature Sensing, Distributed Pressure Sensing, Thermal Recovery Optimization, Heavy Oil Production

1. INTRODUCTION

Heavy oil reservoirs present significant production challenges due to the high viscosity of crude oil, which limits its mobility within the reservoir. To enhance recovery, thermal methods such as Cyclic Steam Stimulation (CSS) or Steam-Assisted Gravity Drainage (SAGD) are commonly used to reduce viscosity and improve flow rates.

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However, optimizing the efficiency of steam injection remains a complex task, requiring continuous monitoring of temperature distribution and pressure variations within the wellbore.

Traditional well monitoring methods, such as downhole pressure gauges and temperature logs, provide only periodic data, limiting real-time analysis of reservoir behavior. In contrast, fiber optic sensing technologies, including Distributed Temperature Sensing (DTS) and Distributed Pressure Sensing (DPS), offer high-resolution, continuous data along the entire length of the wellbore. These technologies enable real-time monitoring of temperature propagation, steam front movement, and pressure variations, helping operators make data-driven decisions to improve thermal efficiency and prevent operational issues such as steam breakthrough or uneven heating.

This study presents a field deployment and analysis of DTS and DPS in a horizontal heavy oil well undergoing thermal recovery. Over a one-month period, fiber optic sensors recorded temperature and pressure data to assess the well's thermal behavior and steam injection efficiency. The study aims to:

- Evaluate the temperature and pressure trends during the thermal cycle.
- Identify steam movement patterns and potential inefficiencies.
- Demonstrate the advantages of fiber optic sensing for optimizing heavy oil production.

The findings contribute to a better understanding of real-time reservoir monitoring and highlight the potential of fiber optic technology to enhance thermal recovery strategies in heavy oil fields.

2. LITERATURE REVIEW

The application of fiber optic sensing in petroleum engineering has gained significant attention due to its ability to provide high-resolution, real-time wellbore monitoring. Technologies such as Distributed Temperature Sensing (DTS) and Distributed Pressure Sensing (DPS) offer continuous measurement along the length of the well, enabling enhanced reservoir surveillance and production optimization.

2.1. Thermal Recovery and the Need for Advanced Monitoring

Heavy oil production relies on thermal enhanced oil recovery (EOR) methods, including Cyclic Steam Stimulation (CSS) and Steam-Assisted Gravity Drainage (SAGD). These processes involve injecting high-temperature steam into the reservoir to reduce oil viscosity and improve mobility. However, optimizing steam distribution remains a challenge due to reservoir heterogeneity and unpredictable heat transfer mechanisms (Butler, 1997). Traditional monitoring tools, such as downhole sensors and well logging techniques, provide only periodic snapshots of well conditions, limiting the ability to detect real-time steam front movement, thermal inefficiencies, and pressure variations (Li et al., 2015).

2.2. Fiber Optic Sensing Technologies (DTS & DPS) in Oilfield Applications

The introduction of fiber optic sensing technology has significantly improved downhole monitoring capabilities. DTS systems utilize optical fibers to measure temperature variations along the wellbore with high spatial and temporal resolution, providing insights into steam chamber growth, heat distribution, and potential steam breakthrough zones (Brown et al., 2012). Similarly, DPS technology enables real-time pressure monitoring, which is crucial for detecting fluid movement, steam injection efficiency, and reservoir response (Gao & Wang, 2018). These technologies have been successfully deployed in various thermal recovery projects, demonstrating their effectiveness in optimizing steam injection and enhancing overall production performance (Singh et al., 2020).

2.3. Key Challenges and Opportunities

Despite their advantages, DTS and DPS implementations face challenges such as data interpretation complexity, sensor reliability, and deployment costs (Zhang et al., 2019). Recent advancements in machine learning and data analytics have improved the ability to process and extract actionable insights from large-scale fiber optic datasets, enabling better decision-making for thermal EOR operations (Martinez et al., 2021). The integration of fiber optic

data with reservoir models and production optimization workflows presents a significant opportunity for further improving heavy oil recovery efficiency.

This study builds upon existing research by applying DTS and DPS technology in a real-world field setting, focusing on analyzing temperature and pressure behavior over a one-month period in a horizontal heavy oil well. The findings contribute to the ongoing efforts to improve thermal recovery efficiency through advanced monitoring techniques.

3. FIBER OPTIC TECHNOLOGY FOR WELL MONITORING

3.1. Principles of Distributed Fiber Optic Sensing

Fiber optic sensing technologies, such as Distributed Temperature Sensing (DTS) and Distributed Pressure Sensing (DPS), provide real-time data along the entire length of the wellbore. Unlike traditional sensors, which measure only specific points, fiber optic cables allow for continuous, high-resolution measurements of temperature and pressure.

- DTS (Distributed Temperature Sensing): Measures temperature variations along the wellbore using light scattering in optical fibers.

- DPS (Distributed Pressure Sensing): Detects pressure fluctuations by analyzing changes in the refractive index caused by strain in the fiber.

These technologies are particularly useful in thermal recovery operations, where tracking steam distribution and pressure changes is essential for optimizing oil production.

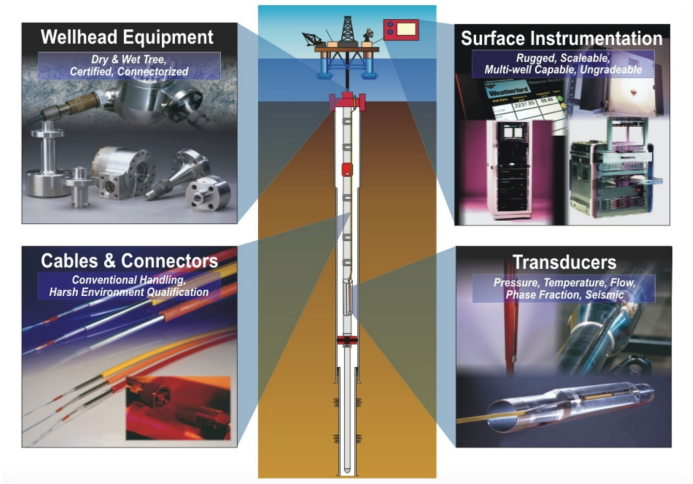

Fig. 1. Overview of Fiber Optic Well Monitoring Technology

3.2. Fiber Optic System and Functionality

A fiber optic system functions by transmitting a light signal from a surface transmitter through the fiber optic cable, which serves as a vehicle to carry light. The process follows these key steps:

1. Light Transmission: A pulse of light is sent from the transmitter into the fiber optic cable.

2. Propagation through the Fiber: The light pulse travels through the optical medium, where interactions occur.

3. Backscattering: Light pulses generate reflections with a very low attenuation index, known as backscattered light.

4. Reception and Comparison: The backscattered light waves return to the receiver at the surface, where they are compared to the originally transmitted pulse.

5. Data Interpretation: Based on the differences in the returning light, the system decodes information and translates it into temperature, pressure, acoustic, or strain data.

6. Storage & Analysis: The processed data is stored in a database for real-time analysis and historical review.

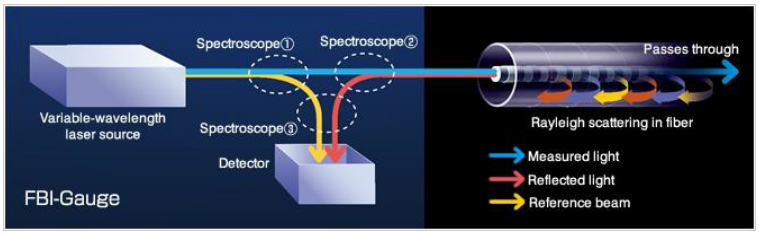

Fig. 2. Schematic representation of a fiber optic monitoring system

3.3. Installation Process

The installation of fiber optic sensors involves placing the optical fiber along the wellbore, either inside the production tubing, cemented behind the casing, or attached to the well casing. The main installation techniques include:

- Helically wrapped fiber on production tubing: Provides enhanced strain sensitivity.
- Direct attachment to casing: Ensures direct contact with formation temperatures.
- Loose fiber in conduit: Protects against harsh well conditions.

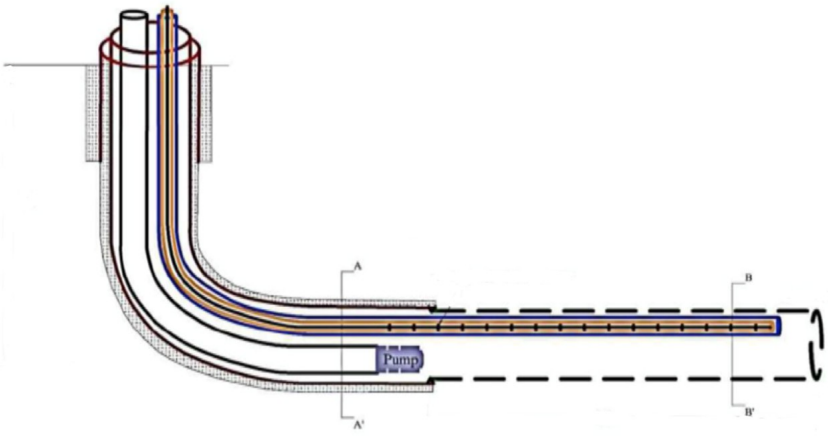

Fig. 3. Well trajectory diagram illustrating fiber optic cable placement in a horizontal well

A fiber optic monitoring system consists of the following key components:

Table 1. Components of FO System

Component	Function
Optical Fiber	Serves as the sensing element along the wellbore
Interrogator Unit	Sends laser pulses and interprets backscattered signals
Data Acquisition System	Collects and stores temperature/pressure data
Processing Software	Analyzes and visualizes well performance
Splice Box	Protects fiber optic connections and enables repairs
RMS (Rack-Mounted System)	Houses interrogators and interfaces with surface equipment

3.4. Data Collection and Processing

DTS systems operate based on Raman backscattering, where a laser pulse is sent through the fiber, and temperature is determined by analyzing the scattered light. The system captures:

- Temperature readings along the well at regular intervals.
- Continuous monitoring at intervals from seconds to minutes.
- Thermal gradients indicating steam movement and fluid behavior

DPS systems rely on Brillouin scattering, where pressure variations alter the optical fiber's strain properties. This provides:

- Pressure readings with high accuracy (~0.1 psi resolution).
- Ability to detect pressure anomalies such as steam breakthrough.

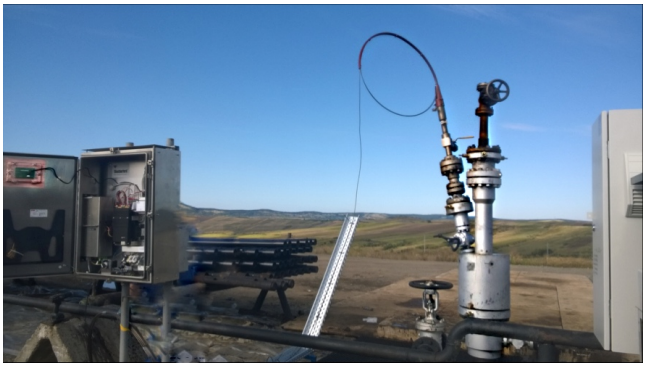

Fig. 4. Wellhead equipment showing fiber optic monitoring integration

4. FIELD DATA ANALYSIS: TEMPERATURE AND PRESSURE BEHAVIOUR

4.1. Overview of Data Collection

This chapter presents the analysis of temperature and pressure variations recorded over a period of one month using fiber optic sensing technology. The dataset covers the period from 31 August to 16 November, capturing real-time fluctuations at different depths in the well.

Key observations include:

- Temperature and pressure measurements at various depths.
- Detection of an electrical break that occurred from 30 October to 5 November, affecting data continuity.

- Comparative analysis of pressure and temperature trends to assess well performance.
- Analysis of temperature and pressure variations during steam injection cycles.

4.2. Temperature behavior over time

Temperature readings were collected across different well depths. A line graph representation of the data illustrates how temperature evolved throughout the monitoring period.

Key insights from the temperature data:

- Uniform Temperature During Injection: During steam injection, temperature readings remained largely uniform along the slotted liner, indicating a stable thermal distribution within this section.
- Persistent Heat Retention at the Toe: The well toe consistently remained warmer than the rest of the well, even during shut-in periods. This corresponds to the Panonian sand section, following a long section of carbonate rock.
- Non-Uniform Steam Injection: The steam did not enter the reservoir uniformly. Instead, it migrated toward zones of least resistivity, such as highly permeable zones, gas zones, or areas near the end of the injection tubing string.
- Effect of Gas Production: The temperature profile did not change significantly with increased gas production.
- Water Cut Influence: Higher water cuts resulted in lower mid-well section temperatures compared to periods of lower water cut.
- Unclear Water Source: The increase in water cut suggests an external water source, potentially from a neighboring well, an aquifer, displaced combustion water, or injected produced water.

The graph below illustrates temperature variations over time:

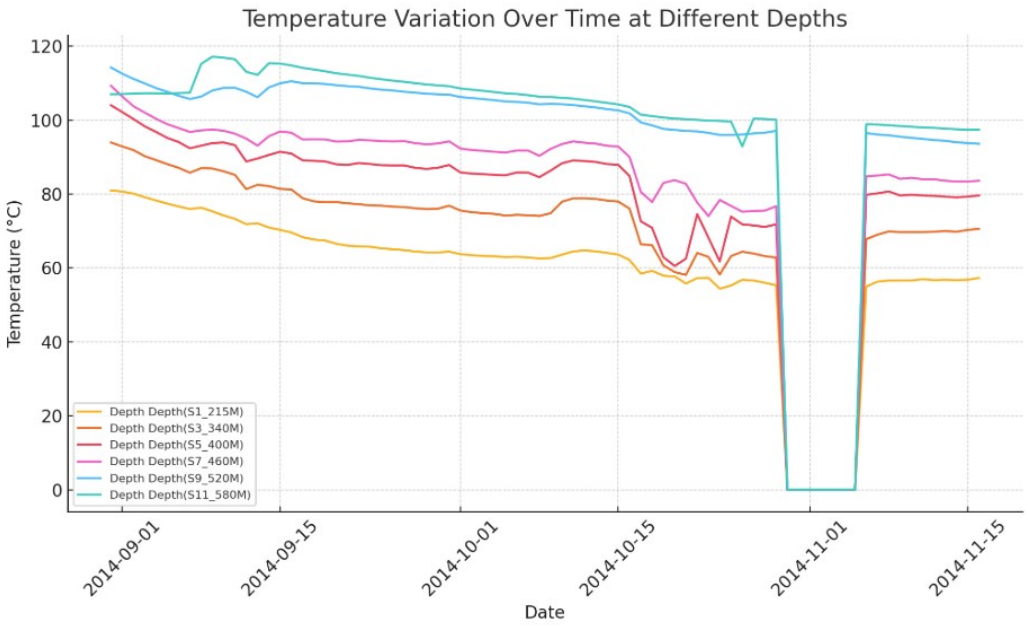

Fig. 5. Temperature changes recorded over different well depths

4.3. Pressure behavior over time

Pressure readings were also analyzed over the same period, with a focus on detecting operational trends and anomalies. A multi-line graph was generated to illustrate pressure fluctuations at various depths.

Key observations from the pressure data:

- Stable Pressure Trends: Throughout most of the period, pressure remained relatively stable across different depths.
- Electrical Break Impact: A sudden and significant drop in pressure was observed during the electrical outage (30 October - 5 November), confirming system shutdown or sensor inactivity.
- Post-Break Recovery: After November 5, pressure readings returned to normal, indicating system restoration.
- Potential Measurement Error: During steam injection, recorded temperature and pressure values did not match expected saturation conditions, raising concerns about data accuracy. The expected pressure for steam saturation should be ~2 bar lower than recorded. Possible reasons include measurement error (~22%) or pressure gauge disruption due to high temperatures.

The pressure graph is shown below:

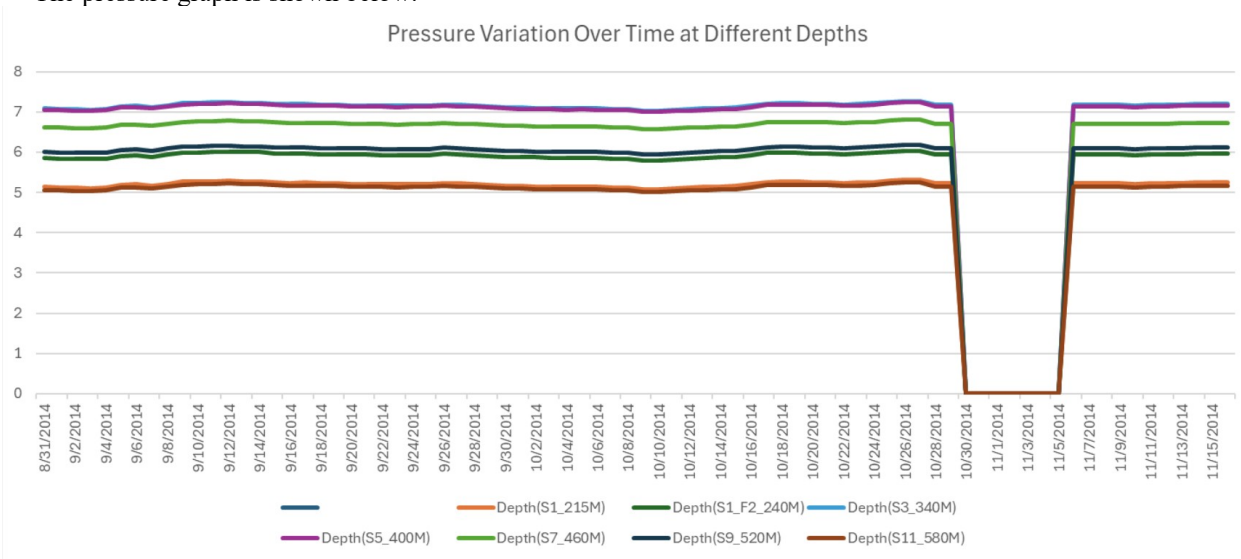

Fig. 6. Pressure trends recorded at different well depths

5. CHALLENGES, LESSONS LEARNED AND FUTURE APPLICATIONS OF FIBER OPTIC MONITORING

5.1. Fiber Optic vs. Standard Pressure and Temperature Monitoring

Standard monitoring techniques for heavy oil horizontal wells typically rely on downhole pressure gauges and temperature sensors placed at specific depths. These tools provide valuable but localized data points.

Fiber optic monitoring, on the other hand, enables continuous distributed sensing, providing a detailed temperature and pressure profile along the entire wellbore.

Table 2. Standard vs Fiber Optic monitoring

Feature	Standard Monitoring	Fiber Optic Monitoring
Coverage	Discrete measurement points	Continuous data along wellbore
Response Time	Periodic logging	Real-time data collection
Data Resolution	Low (fixed sensor locations)	High (continuous measurements)
Durability	Limited sensor lifespan	Long-term monitoring
Operational Cost	Higher maintenance costs	Initial cost higher, but long-term savings
Detection of Anomalies	May miss transient changes	Detects rapid variations accurately

5.2. Challenges and Lessons learned from Field Deployment

Several challenges were encountered during data collection and analysis:

- Technical Challenges: Issues such as sensor reliability, data noise, and calibration errors impacted accuracy. Temperature-induced fluctuations in fiber optic cables also needed correction.
- Operational Limitations: Environmental factors, wellbore conditions, and the complexity of installing fiber optic cables in horizontal wells made deployment more challenging.
- Data Interpretation Issues: Translating raw DTS (Distributed Temperature Sensing) and DPS (Distributed Pressure Sensing) data into actionable reservoir insights required specialized expertise and interpretation tools.
- Steam Injection Quality: Observations suggest that only hot water might be entering the reservoir instead of high-quality steam, requiring further validation.

Despite these challenges, fiber optic sensing has provided critical insights into well behavior, guiding future optimization efforts.

5.3. Future Applications and Optimization Strategies

Integrating fiber optic data with reservoir models can significantly improve forecasting accuracy. Real-time monitoring of thermal and pressure behavior allows for better modeling of steam chamber growth, optimizing well productivity, and extending reservoir life.

Machine learning and AI-driven analytics offer promising advancements in automating DTS/DPS interpretation. These technologies can enhance early anomaly detection, optimize steam injection strategies, and improve predictive maintenance for wells. AI-powered models can analyze vast amounts of data quickly, reducing interpretation errors and improving reaction times to wellbore changes.

The use of fiber optic sensing extends beyond thermal recovery wells. It can be applied in water breakthrough detection by identifying temperature variations caused by unexpected water ingress. Additionally, it plays a key role in gas injection monitoring in enhanced oil recovery (EOR) methods, tracking temperature and pressure changes associated with gas movement. Fiber optics can also be used for geo-mechanical monitoring, detecting fracture propagation and identifying sand production risks.

To maximize the benefits of fiber optic sensing, operators should prioritize hybrid monitoring systems that combine traditional downhole gauges with fiber optic sensors to ensure data redundancy and accuracy. Investing in advanced data analytics tools can improve real-time decision-making and optimize well operations. Cost-sharing strategies should be considered to offset the high initial investment in fiber optic technology while benefiting from long-term operational savings.

6. CONCLUSION

The use of fiber optic monitoring in heavy oil horizontal wells represents a significant advancement in well surveillance technology. Unlike traditional monitoring systems, fiber optic sensing provides continuous, high-

resolution measurements of temperature and pressure along the entire wellbore, enabling more accurate interpretation of reservoir behavior.

The data collected through Distributed Temperature Sensing (DTS) and Distributed Pressure Sensing (DPS) has provided valuable insights into steam injection efficiency, fluid movement, and pressure variations. One of the key findings is that steam distribution is non-uniform, with more injection occurring in areas of lower resistivity or near the end of the injection tubing string. Additionally, the well toe consistently remains warmer than the rest of the well, suggesting localized heat retention that could impact production efficiency.

Despite the benefits of fiber optic sensing, several challenges were identified, including sensor calibration errors, data noise, and operational constraints related to installation in horizontal wells. The accuracy of pressure measurements in high-temperature environments remains an area that requires further investigation, particularly regarding discrepancies between measured and expected saturation conditions.

The future of fiber optic sensing in reservoir management is promising, particularly with the integration of AI and machine learning for automated data interpretation. Advanced models will enable real-time anomaly detection, improved reservoir simulations, and better decision-making for steam-assisted gravity drainage (SAGD) and other thermal recovery processes.

Overall, the deployment of fiber optic monitoring in this field trial has proven to be a highly effective method for well surveillance, improving data accuracy, operational efficiency, and reservoir management strategies. Continued research and technology development will further enhance the reliability and application of this technique, paving the way for more efficient and sustainable oil production.

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Application of Micro Teaching in the Education of Basic Teaching Skills

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Abstract

Micro-teaching is a training concept that can be used in various stages of competency and professional development of education and teaching staff, both for pre-service training for prospective teachers and for education and training for in-service teachers. In micro-teaching, the implementation of learning is simplified so that it can reduce the complexity that is usually found in the learning process. Teachers also directly receive feedback on their performance, so that if there are weaknesses and deficiencies, they can be corrected. In fact, micro-teaching has proven successful in training, developing and improving teachers' professional teaching abilities. In the study, under the light of the literature, we have the conclusion that micro teaching means a training method designed in such a way as to improve the teaching skills of prospective teachers and develop the professional experience of teachers, especially teaching skills by simplifying or reducing aspects of learning such as the number of students, time, focus of teaching materials and limiting the application of certain teaching skills, so that various strengths and weaknesses in teachers or prospective teachers can be identified accurately.

Keywords: Micro Teaching, Micro Learning, Teacher Training, Educational Management, Teaching Skills

1. INTRODUCTION

Learning is any activity designed by a teacher and educator to help someone learn a new skill and/or value in a systematic process through the design, implementation and evaluation stages in the context of teaching and learning activities. Thus, learning is a harmonious combination of teaching activities carried out by teachers and learning activities carried out by students. Learning is a process and involves various aspects, therefore, skills are needed to create creative learning.

Teaching is one of the main tasks of teachers. Therefore, professional competencies that support teachers' ability in teaching must receive serious attention and become an emphasis in the teacher candidate preparation program.

Teaching is a complex activity that contains elements of technology, art, and value choices. From a technological aspect, teaching is seen as a work procedure with mechanisms and the use of tools that can be tested and trained empirically. In the actual context, teaching contains many actions that include basic teaching skills. In its implementation in the classroom, teaching uses a number of integrated skills, based on values and utilizing technology. Teaching activities, thus, require quite complex professional competencies, as an integration of teacher competencies as a whole and comprehensively (Kayalar, 2022; Mayer, Allard, Bates, Dixon, Doecke, Kline & Hodder, 2005).

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According to Brown (2001), although teaching activities are very complex, especially for prospective teachers who are just learning about teaching, the elements of skills included in them can be learned and practiced. This is because teaching activities can be broken down into several basic teaching skills such as opening and closing learning skills, class management skills, motivation and reinforcement skills, skills in choosing and using relevant learning methods and strategies, questioning skills, skills in using learning media, and so on. All of these skills can be practiced and mastered by teachers/prospective teachers through the training process, either in the form of isolated skills training or complete and integrated training.

Complete and integrated teaching such as training in Field Experience Practice must be preceded by training in the component parts of the teaching process separately through micro teaching so that teachers or prospective teachers can master each of these basic teaching skills. Through micro-teaching, skill formation can be done systematically starting from understanding, planning, implementation and observation, then the results of observations and video recordings are used as feedback for improvement.

2. MICRO-TEACHING

In micro-teaching, the implementation of learning is simplified so that it can reduce the complexity that is usually found in the learning process (Ledger and Fischetti, 2020; Nahar, Zulheddi and Ghifari, 2022). Teachers also directly receive feedback on their performance, so that if there are weaknesses and deficiencies, they can be corrected. Likewise, they will receive reinforcement if the skills they display are good. Through the training process in micro-teaching, the knowledge, attitudes and skills obtained are then developed through Field Experience Practice in schools under the supervision of the principal, mentor teachers and supervisors or Field Experience Practice mentors. Thus, teacher competency development is carried out in an integrated and sustainable manner in a systematic program.

It is not uncommon for teachers who are already in office to experience problems related to teaching competence and skills. Junior teachers who have just graduated from college are still not skilled in carrying out this task. Meanwhile, other problems can also be found in senior teachers, who tend to use a conservative approach and conventional methods in learning. Micro-teaching can be a smart solution to solve this problem. Junior teachers can hone their skills and improve them with micro-teaching practice. On the other hand, senior teachers can try new teaching methods and techniques in micro teaching laboratories with colleagues through peer teaching strategies and evaluate them without any moral and social burden.

It can be understood from the description above that micro teaching is a training concept that can be used in various stages of competency and professional development of education and teaching staff, both for pre-service training for prospective teachers and for education and training for in-service teachers (Asmuni, 2001; Helmiati, 2013). In fact, micro teaching has proven successful in training, developing and improving teachers' professional teaching abilities. Thus, the rationale for implementing micro teaching is:

- Teachers as professionals should have three basic assets, namely a deep understanding of philosophical, conceptual, and skill matters.
- Learning is a process and involves various aspects. Therefore, to create creative learning, skills are needed.
- Teaching skills are quite complex professional competencies, as an integration of teacher competencies as a whole and comprehensively.
- A collection of theories obtained in lectures will not be able to automatically make prospective teachers face various problems in the classroom. Problems related to mastery of material, relevance of methods and strategies, classroom management, practice places and time management mechanisms will emerge simultaneously, giving rise to new situations that have never been encountered by students and prospective teachers before.

Good teachers/educators are those who succeed in bringing students to achieve learning goals and outcomes in accordance with the applicable rules in education. The success and effectiveness of learning are determined by whether or not the goals and learning outcomes are achieved. To achieve the level of learning effectiveness, prospective teachers/educators must have a good understanding of how to implement learning and have basic teaching skills before they carry out their duties as educators. This understanding and skills can be obtained through practice and learning experience. This practice and experience can be obtained by prospective educators through micro-teaching. Micro learning aims to equip prospective educators with several basic teaching skills. For prospective educators, this method will provide real teaching experience and the opportunity to practice a number of basic teaching skills separately and in stages. In addition, micro learning is intended to provide prospective educators with an understanding of when and how to apply various basic teaching skills in the learning process.

2.1. History of Micro Teaching

In traditional teacher education programs, after prospective teachers graduate from a teacher training school or college, they immediately practice teaching at a training school (lab school) without undergoing training first. Since the 50s, this approach has received some criticism as:

- The approach taken by prospective teachers is too theoretical, philosophical and abstract.
- Guidance in training is less effective and efficient, the instructors are also less trained.
- Feedback is not given immediately to prospective teachers and tends to be less objective
- Teachers do not have good teaching competence and skills.

Based on the these facts, around 1963 Micro teaching was introduced by Stanford University USA, as one of the programs intended to improve teacher competence, especially in teaching skills. In order to develop teaching skills, complex teaching activities are broken down into a number of skills so that they are easy to learn. The first idea arose in the form of a teaching demonstration with groups of students playing roles. At the same time, research was conducted on how to use the method flexibly and effectively accompanied by questions as reinforcement.

2.2. Definition, Function and Benefits of Micro Teaching

Etymologically, micro teaching comes from two words, namely micro which means small, limited, narrow and teaching which means instructing and training. Terminologically, micro teaching is defined with different wordings, but has the same meaning substance. The following are some definitions of micro learning according to several experts:

- Micro teaching is a teaching activity on a small scale (micro) designed to develop new skills and improve old skills.
- According to Roestiyah (2008), micro teaching is a teaching activity where everything is reduced or simplified.
- Micro teaching is an effective method of teaching. Therefore, micro teaching is the same as teaching to teach or learning to teach.
- According to Wallace (1980), micro teaching is simplified teaching. The learning situation is reduced in scope, the teacher's task is simplified, the subject is shortened and the number of students is reduced.
- Cooper and Allen (1971) argued that micro teaching is a study of a learning situation that is carried out in a certain time and amount, namely for four or up to twenty minutes with three to ten students, the form of learning is simplified, the teacher focuses on only a few aspects. Learning takes place in its real form, only it is held in a micro form.
- Micro teaching is a training method that is designed in such a way by isolating the component parts of the learning process so that prospective teachers and educators can master skills one by one in a simplified teaching situation.

From these descriptions, it can be concluded that micro teaching means a training method designed in such a way as to improve the teaching skills of prospective teachers and develop the professional experience of teachers, especially teaching skills by simplifying or reducing aspects of learning such as the number of students, time, focus of teaching materials and limiting the application of certain teaching skills, so that various strengths and weaknesses in teachers and prospective teachers can be identified accurately. Thus, it is expected that complex teaching activities, which require various basic skills, can be mastered one by one by teachers and prospective teachers. In accordance with the term "micro", the simplified situations and aspects are in terms of (1) the number of students consisting of 5 to 10 people, (2) allocation of teaching time, consisting of 10 to 15 minutes, (3) learning materials that only cover 1 or 2 simple aspects, and (4) teaching skills are focused on 1 or 2 skills only.

The simplification of these aspects is based on the assumption that complex teaching activities will be easier to implement, assess and improve, if teachers or prospective teachers are trained to master the components of the teaching process one by one. Thus, the differences between micro teaching and macro teaching are as follows:

Based on the research results conducted by Brown & Armstrong, it was concluded that prospective teachers who participated in micro teaching:

a) had better teaching performance in teaching practice (Field Practice Program).
b) were more skilled than prospective teachers who did not do micro teaching.
c) had high scores in the Field Practice Program.
d) had better interaction between prospective teachers and students

Thus, the function of micro teaching for teachers and prospective teachers is to:

a) obtain feedback on their performance in learning. This feedback is in the form of information about strengths and weaknesses. The strengths can be maintained or improved, while the weaknesses can be improved so that basic learning skills can be mastered well.
b) provide opportunities for prospective teacher students to find themselves as prospective teachers.
c) find models of a teacher's performance in learning, by using the results of supervision as a basis for diagnostics and remediation (improvement) to achieve the goals of skill training.

With the provision of micro teaching, there are several benefits that can be taken by teachers and prospective teachers, including (1) developing and fostering certain skills of teachers and prospective teachers in teaching, (2) practicing new methods and strategies in a supportive environment, (3) getting immediate feedback from their performance by replaying video recordings, (4) preparing and implementing learning by reducing anxiety, (5) gaining valuable experience with minimal risk, (6) regulating their own behavior as naturally as possible in a systematic way, and (7) having better mastery of teaching skills by teachers and prospective teachers.

3. CHARACTERISTICS OF MICRO TEACHING

Micro teaching takes place in its real form, only it is held in a micro form with the following characteristics:

a) The number of students ranges from 5-10 people
b) Teaching time is limited to around 10-15 minutes
c) Practice focuses on basic teaching skills.
d) It is practiced through only 1 or 2 basic teaching skills, which are part of complex teaching skills.
e) Limiting the focus or scope of the subject matter according to the availability of time.
f) Reviewed from the practicum, prospective teachers and educators will learn how to conduct learning, while friends who become students will be able to observe how their friends' teaching styles are and can assess whether or not the basic learning skills carried out are appropriate, such as the use of learning methods and strategies, use of learning media, assessment, etc.
g) Micro teaching is real teaching. Practitioners must make teaching plans, carry out teaching according to the teaching plans that have been made, manage the class and prepare other teaching devices that can support the learning process.
h) Micro teaching is not a simulation. Therefore, colleagues are not treated as students but they remain real friends with the position of students. This is to avoid fake peer behavior that results in the teaching process between colleagues being unconditioned.
i) Teaching is expected to be recorded so that the recording results can be used as discussion material between teachers and prospective teachers to be corrected and given input (feedback) to improve the shortcomings of the practicum.

In short, it can be stated that the characteristic of micro teaching is real teaching that is micro-scaled including the number of students, time allocation, skill focus, basic competencies, learning outcomes and limited teaching material.

4. BASIC SKILLS IN MICRO TEACHING

In micro-learning, so that prospective teachers can master various basic teaching skills and deepen the meaning and strategies for using them in the learning process, prospective teachers and educators need to practice these skills one by one. Therefore, micro-learning is very necessary in the form of peer teaching with the hope that prospective teachers and educators can also become observers of their fellow prospective teachers/educators, with the hope that each prospective teacher and educator can provide correction and input to each other to improve their lack of mastery of basic skills in teaching.

The basic teaching skills referred to are:

- Opening and closing learning skills
- Explaining skills
- Questioning skills
- Variation skills
- Reinforcement skills
- Classroom management skills
- Guidance skills for small group discussion
- Leadership skills in small group discussion

Micro teaching is considered important for both prospective teachers and in-service teachers based on several basic assumptions as:

a) In general, teachers are not born but are formed first.
b) A person's success in mastering more complex things is determined by their success in mastering simpler things. By first mastering various basic teaching skills, teaching activities can be carried out as a whole which are complex in nature.
c) By simplifying the training situation, attention can be fully paid to the development of certain skills which are components of teaching activities.
d) In very limited training, prospective teachers find it easier to control their behavior when compared to teaching globally which is complex in nature.
e) By simplifying the training situation, it is hoped that it will facilitate more systematic, objective observations and more accurate recording. The results of the observation are expected to be information for prospective teachers regarding their shortcomings so that they can be improved in the next training opportunity.

As a teacher and educator, mastery of basic teaching skills is one of the main requirements in the learning process in addition to other requirements. The basic skills in question are:

1. Skills in opening and closing learning.
Opening a lesson is an activity of a teacher/educator in preparing students to take part in learning which includes; conditions for creating an atmosphere of mental readiness for students, creating a communicative atmosphere between the teacher/educator and students, attracting students' attention to what will be learned in this case it can start from the daily situation of students to the material to be learned. Closing a lesson is an activity of a teacher/educator ending the core learning activities. In ending this lesson, the activities carried out are to provide a comprehensive overview of all the materials that have been studied, to find out the level of student absorption of the material and to find out the level of success of the teacher/educator in the teaching and learning process.

2. Explanation skills
This skill is interpreted as the skill of the teacher/educator in presenting oral information that is systematically organized with the aim of being able to show the relationship between the materials that have been collected and mastered and prepared to be presented. In addition, the emphasis on providing explanations is the process of student reasoning and not indoctrination.

3. Questioning skills
Questioning skills are verbal statements by the teacher/educator that ask for responses from students. The responses given can be in the form of knowledge to things that are the result of consideration. Thus, asking is an effective stimulus that encourages students' thinking skills.

4. Skills in using variations
Skills in using variations are interpreted as the actions of the teacher/educator in the context of the teaching and learning process that aims to overcome student boredom so that in the teaching and learning process, students always show perseverance, enthusiasm and play an active role.

5. Reinforcement skills
Reinforcement skills are the behavior of teachers/educators in responding positively to certain student behavior that allows the behavior to be repeated.

6. Small group and individual teaching skills
Small group and individual teaching skills are defined as the actions of teachers and educators in the context of the teaching and learning process that only serves 3-8 participants.

7. Classroom management skills
Classroom management skills are the skills of teachers and educators to create and maintain optimal learning conditions and return them to optimal conditions if something happens that could possibly disrupt activities, by either disciplining or carrying out remedial activities.

8. Guidance skills for small group discussion
Guidance skills for small group discussion are an orderly process involving a group of students in optimal cooperative face-to-face interactions with the aim of sharing information or experiences in making decisions or solving a problem.

5. CONCLUSION

The theoretical framework of the microteaching is based on behaviorism and cognitive psychology theories. According to behaviorism theory, learning is observable behavioral change. The microteaching technique focuses on teacher candidates developing certain teaching skills in an observable and measurable way. According to cognitive psychology theory, learning is processing and making sense of information. The microteaching technique helps teacher candidates understand how they will affect students' cognitive processes and develop teaching skills in a way that will optimize these processes. The main purpose of microteaching is to break down complex teaching action into manageable components. Educators focus on specific skills such as questioning techniques, classroom management and teaching strategies that enable targeted development. Microteaching encourages teachers to critically analyse their own teaching methods by encouraging reflective practice. Through video recordings and peer feedback, educators gain insights into their strengths and areas for improvement, encouraging a continuous improvement cycle. The controlled environment of microteaching provides a safe space for student teachers to experiment with a variety of teaching approaches. This experience allows educators to explore their own teaching style and adapt strategies that best suit their unique strengths.

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Multidimensional Impacts of the COVID-19 Pandemic on Urban Development and City Marketing

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Abstract

The COVID-19 pandemic has prompted significant changes in urban environments and city marketing strategies, highlighting the need for resilience in the face of crises. The smart city concept emerges as a crucial framework for revitalizing urban areas through technological advancements and enhanced citizen engagement. This study aims to explore how the smart city concept can facilitate effective crisis management and promote resilience in small and medium-sized cities. Specifically, it investigates the role of artificial intelligence, data analytics, and citizen participation in enhancing urban adaptability and improving city marketing strategies. A mixed-methods approach was employed, combining quantitative data analysis with qualitative case studies from various cities that have integrated smart technologies. Surveys and interviews with urban planners, policymakers, and residents provided insights into the effectiveness of smart city initiatives in addressing pandemic-related challenges. The findings indicate that cities utilizing smart technologies, such as AI and big data, have improved their capacity to manage public health crises. Additionally, the implementation of virtual tourism has allowed cities to maintain cultural connectivity and attract visitors despite travel restrictions, thereby benefiting local economies and enhancing city marketing efforts. The COVID-19 pandemic is driving technological advancements that enable cities to address current and future challenges efficiently. By integrating citizen participation and leveraging smart technologies, cities can strengthen their resilience and adaptability. This research underscores the importance of the smart city paradigm in fostering sustainable urban development and enhancing the overall quality of urban life in the post-pandemic era.

Keywords: Smart City, coronavirus, artificial intelligence, COVID-19, Virtual tourism, City marketing, sustainable urban development, digital transformation, pandemic prevention, healthcare

1. INTRODUCTION

Urban areas have long been attractive to populations due to their numerous amenities and opportunities. In 1950, only about 30 percent of the global population resided in cities; however, projections indicate that by 2050, this figure will rise to over 65 percent (Statista, 2022). This significant shift is primarily driven by the migration of individuals from vast rural areas to densely populated urban centers, where modern, technologically advanced infrastructures cater to their diverse and growing needs. The digitization of processes, alongside technological advancements and economic

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growth, has substantially enhanced the prosperity of urban environments, making them increasingly appealing to residents (Siokas et al., 2021).

However, the COVID-19 pandemic has introduced a myriad of challenges for cities worldwide. Efforts to revive faltering economies and strengthen social cohesion have highlighted the necessity of leveraging opportunities that emerge from crises for innovative developments (Gorynski et al., 2021). The pandemic has also prompted a reevaluation of city marketing strategies, necessitating new communication approaches to revitalize urban areas in the contemporary age of information and communication technologies. In this context, virtual tourism presents significant potential that cities can harness to adapt to current demands (Martins, 2022).

The pandemic coincided with the digital revolution, positioning cities as cultural hotspots that facilitate optimized social networking and utilize innovative technologies to address emerging challenges effectively. This situation raises critical questions about how cities adapt their behaviors and strategies in this rapidly changing landscape (Kunzmann, 2020; Thambiran, 2020). The smart city concept has emerged as a pivotal framework through which cities can navigate these transformations, integrating technological achievements to enhance resilience and sustainability (cf. Gorynski et al. 2021, p. 165; Thambiran 2020, n.p.).

This article aims to explore the interplay between the COVID-19 pandemic and the smart city concept, examining how urban areas can leverage technological advancements, including artificial intelligence and digital tools, to improve city marketing, promote virtual tourism, and support sustainable urban development. By addressing these interconnected issues, this research seeks to provide insights for policymakers and urban planners on the effective management of urban environments in the post-pandemic era.

2. EFFECTS OF THE CORONA-PANDEMIC ON URBAN DYNAMICS

The COVID-19 pandemic has had a myriad of unprecedented impacts on individuals and society as a whole. While the virus initially appeared to affect only China, outbreaks, restrictions, hospitalizations and greatly increased death rates quickly erupted around the world. Most cases initially occurred in urban areas. The economic recession that has accompanied the pandemic has affected many sectors, including government, academia and business. The budgets of the cities were also readjusted, which raised concerns about the financing of technological innovations (cf. Thambiran 2020, n.p.).

2.1. Virtual Tourism

The pandemic caused travel restrictions. Whole cities or even states have been closed to protect the health of individuals and communities and to save lives (cf. Jamal et al. 2020, n.p.). The population spent most of their time at home, which severely affected the tourism industry (cf. Soumia & Assia 2021, p. 87). In 2019, 1.461 million people traveled worldwide, while in 2020 there was only 381 million people traveling (cf. Verma et al. 2022, n.p.).

In order to revitalize and market tourism cities, tourism authorities have used innovative technologies such as virtual reality or gamified virtual experiences (cf. Martins et al. 2022, p. 123).

The motto of Virtual tourism is "no tickets, no bags and no hassles" and this is seen as a great opportunity for the future of the tourism sector and describes a new type of unconventional tourism. It is based on information technologies that are used to offer certain services (cf. Soumia & Assia 2021, p. 87).

The following advantages result from virtual tourism in general and for city marketing:

- In contrast to traditional tourism, the costs are significantly lower.
- Tourist attractions can be explored without having to leave your own four walls.
- Virtual tourism can also be used during lockdown periods.
- Virtual reality technologies can be used in a simple manner. Surfing the net is almost free.
- Lockdown times can be used to familiarize yourself with new cultures.
- Through virtual tourism, visitor data can be analysed. This makes it clear what interests they are pursuing, which tourist attractions are perceived as attractive and which cities are particularly popular destinations for tourists.
- The implementation of virtual tourism can also take place when the modern technologies, including virtual reality, do not yet correspond to the highest level of research (cf. Soumia & Assia 2021, p. 95).

In conclusion, virtual tourism is considered an excellent opportunity to drive the marketing strategy and promotion of cities despite restrictions due to the corona pandemic (cf. Soumia & Assia 2021, p. 95).

2.2. Transformation to Smart City due to COVID-19

The corona pandemic once again showed how important it is for cities to take the step towards a smart city in order to positively deal with current and future challenges. However, in order for this transformation process to succeed, networking and cooperation between civil society, business, administration and science is required (cf. Gorynski et al. 2021, p. 165).

Technological achievements are to be used more intensively and investments in digitization projects are to be increased (cf. Allam et al. 2019, pp. 80-91). In the future, big data will play a central role in combating pandemics (cf. Inn 2020, p. 2). Furthermore, the use of artificial intelligence (AI) and the use of data analysis can make a contribution towards smart cities (cf. Yang et al. 2020, pp. 3-4). In the event of an outbreak of viral infections, AI can play a crucial role in various areas that characterize a modern, data-driven smart city, such as diagnosing infections, supplying essential medicines and traffic management (cf. Xu et al. 2020, pp. 639-644). In addition, AI-based indoor ventilation systems can curb the spread of viral infections (cf. Ren & Cao 2020, n.p.).

Based on the solutions of innovative technology and digitization are no longer seen by cities and municipalities as a goal, but as a means to an end, since their use is not sufficient to successfully master the existing and emerging urban challenges. Instead of top-down approaches, the focus is on participatory concepts that focus on citizen involvement. (Gorynski et al., 2021) emphasize the strengthening of “community resilience” and the focus on “citizen-centered needs” (Gorynski et al. 2021, p. 165) in order to promote quality of life and thus sustainability and social justice. Ultimately, with the help of the smart city concept, future challenges and crises caused by pandemics, among other things, should be managed in the best possible way and cities made resilient (cf. Gorynski et al. 2021, p. 165).

Kamolov & Kandalintseva (2020) state similarly, calling the current phase, in which citizen participation, data sharing, and technological progress play an elemental role in improving daily urban actions, "Smart City 3.0" (cf. Kamolov & Kandalintseva 2020, p. 256) cities.

2.3. Smart Cities Concepts in response to COVID-19: Best Practice

Numerous cities introduced various smart city concepts to help cope with the COVID 19 pandemic, which is still currently being perceived, and future crises. All concepts have one thing in common: the ability to react quickly is the main focus and is considered the overriding principle in combating crises (cf. Thambiran 2020, n.d.).

It should be mentioned at the outset that the concepts presented below also raise concerns about the protection of privacy and fundamental human rights. This is particularly the case when contact tracking and monitoring tools are applied with the help of digital technologies. For example, personal information can be found in COVID management apps. As a result, hacking attacks and stalking occur repeatedly in the process. Likewise, individuals infected with COVID-19 can be discriminated against. Data protection and security are therefore always the top priority (see Thambiran 2020, n.d.).

2.3.1. Amsterdam

Amsterdam relies on platforms to develop and implement smart city concepts in a collaborative manner (Amsterdam Smart City 2021, n.d.).

2.3.2. United Arab Emirates

In the United Arab Emirates, various smart city technologies were deployed to contain the spread of the virus. The government itself implemented an AI-based system and was able to ensure that the measures and social distancing associated with lockdown periods were followed. Local police wore smart helmets equipped with a thermal camera that allowed them to locate people infected with COVID-19 from a certain distance. The AI-based system also made it possible to read license plates of vehicles and consequently identify people who violated the lockdown (see Thambiran 2020 n.d.).

2.3.3. India

As part of the Smart Cities mission, the Indian government set up command and control centers in various cities with the aim of making decisions in emergency situations, simplifying searches for contact persons and monitoring lockdown measures (see Eichenmüller 2021, pp. 51-71). Similarly, a GIS-based dashboard has been applied in the

city of Varanasi to detect disregard of lockdown measures, send out warnings in case of emergency and deliver essential goods (cf. Thambiran 2020, n.d.).

2.3.4. China

The pandemic caused by the COVID-19 virus is also considered to be a driver of innovation in terms of urban planning. In China, there are numerous developments with regard to the idea of sustainability. Among other things, more roofs are to be greened and the infrastructure for cars is to be contained. Furthermore, steps are being taken with regard to resilience and health care (see Chen et al. 2020, pp. 764-766).

The following four categories have been established within the smart city concept to help respond to pandemics:

SMART COMMUNITY
Here, the focus is on avoiding contact during the pandemic. Smart community technologies are designed to provide information about emergencies in the community or reduce unnecessary travel by citizens. Furthermore, the focus is on e-commerce services. The smart platform "micro-neighborhood" is intended to enable people to check themselves or report pneumonia (see Yang & Ching 2021, p. 2).

SMART GOVERNMENT
Smart government should make it possible to react quickly to emergency situations with the help of an AI-based platform. The "City Brain" platform, which was set up in the Chinese city of Hangzhou, shows the number of people suffering from COVID-19 in real time. This data is of great value for the government to make appropriate decisions quickly (cf. Yang & Ching 2021, pp. 2-3).

SMART HEALTHCARE
Healthcare occupies an important position in China. To meet health challenges accordingly, technological achievements such as Big Data, Machine Learning, Internet of Things (IoT) and Artificial Intelligence (AI) are used (cf. Allam et al. 2020, pp. 156-157). Smart healthcare can optimize the diagnosis and treatment of patients suffering from COVID-19, and medical resources can be better coordinated. For example, on the part of the People's Hospital of Henan Province, an online consultation service for COVID-19 has been established to provide support not only locally but also in other cities (cf. Yang & Ching 2021, pp. 3-4).

SMART INFORMATION
This category focuses on information sharing. Sick patients and their geographical location can thus be quickly identified, which in turn is an important step in preventing and combating COVID-19 as part of the smart city concept (cf. Yang & Ching 2021, p. 4).

The concepts just described are largely based on the willingness of citizens to pass on and share their data. Therefore, governments, cities and municipalities must take care to maintain the trust of their citizens and demonstrate that data protection is taken seriously (see Thambiran 2020, n.d.).

3. DISCUSSION AND RECOMMENDATIONS

In this section, the researcher interprets the findings from the research on the impact of the COVID-19 pandemic on urban environments and the role of the smart city concept in fostering resilience and adaptability in small and medium-sized cities. The integration of advanced technologies and citizen engagement emerged as pivotal elements in shaping effective crisis management strategies.

3.1. Technological Adaption and Crisis Management

The results of the study highlight the critical role of smart technologies, particularly artificial intelligence (AI) and data analytics, in enhancing urban adaptability during crises. The ability of cities to manage public health challenges through these technologies signifies a shift in urban management paradigms and underscores the necessity for cities to embrace digital transformation as a core component of their operational frameworks. The successful implementation of AI in diagnosing infections and optimizing essential services illustrates how technology can be

leveraged to create resilient urban ecosystems. This transformation is essential for preparing cities for future crises, enabling rapid responses to emerging challenges.

3.2. Citizen Engagement and Community Resilience

The findings also emphasize the importance of citizen participation within the smart city paradigm. The shift towards participatory governance models, where citizens actively engage in decision-making processes, fosters a sense of community resilience. This is particularly relevant in the context of the COVID-19 pandemic, where social cohesion became paramount. By integrating citizen feedback and utilizing data analytics to understand public needs, cities can develop tailored responses that enhance quality of life and address specific urban challenges. This participatory approach not only strengthens community ties but also builds trust between citizens and local authorities, which is essential for effective crisis management.

3.3. Virtual Tourism as a Marketing Strategy

The exploration of virtual tourism as a response to the pandemic reveals its potential as a strategic tool for city marketing. As traditional tourism faced unprecedented restrictions, cities that adopted virtual tourism strategies were able to maintain cultural connectivity and attract visitors in innovative ways. This shift not only supports local economies during downturns but also positions cities as forward-thinking destinations that embrace technological advancements. The advantages of virtual tourism, such as cost-effectiveness and accessibility, suggest that cities can continue to leverage these strategies even in a post-pandemic context, diversifying their tourism offerings and enhancing their marketing strategies.

3.4. Ethical Considerations and Data Privacy

While the adoption of smart technologies presents numerous benefits, the research raises important ethical considerations regarding data privacy and security. The implementation of contact tracing and monitoring tools, although essential for public health, poses risks related to the protection of personal information. It is imperative that cities prioritize data security and transparency to maintain citizen trust. As cities navigate the balance between utilizing data for crisis management and safeguarding individual rights, establishing robust frameworks for data protection will be crucial in ensuring that smart city initiatives are both effective and ethically sound.

Recommendations

Based on the findings and discussions presented, the following recommendations are proposed:

1. **Embrace Digital Transformation**: Cities should prioritize the integration of advanced technologies into their operational frameworks. This includes investing in AI and data analytics capabilities to enhance crisis management and improve overall urban governance. Training programs for city officials on the use of these technologies should also be established to ensure effective implementation.
2. **Foster Participatory Governance**: Policymakers must promote participatory governance models that encourage citizen engagement in decision-making processes. This can be achieved through regular community forums, digital platforms for feedback, and collaborative decision-making initiatives. Such engagement will not only enhance trust but also ensure that urban policies reflect the diverse needs of the community.
3. **Develop Virtual Tourism Initiatives**: Cities should continue to invest in and promote virtual tourism strategies as part of their marketing efforts. By creating immersive online experiences, cities can maintain cultural connectivity and attract visitors, even amidst restrictions on physical travel. Collaboration with local businesses and cultural institutions can further enhance these initiatives.
4. **Strengthen Data Protection Frameworks**: It is essential for cities to establish clear and robust data protection policies that safeguard personal information while allowing for effective crisis management. Transparency about data usage and the implementation of privacy measures will help build public trust in smart city initiatives.
5. **Conduct Further Research on Smart City Implementation**: Future research should expand the scope to include a broader range of cities and contexts, allowing for a more comprehensive understanding of how smart city initiatives can be tailored to meet diverse urban challenges. Investigating the ethical implications

of data privacy and citizen participation will also be critical in ensuring that these systems bolster resilience while upholding fundamental rights.

In summary, the interplay between the COVID-19 pandemic and the smart city concept has illuminated the potential for technological advancements to enhance urban resilience. By fostering citizen engagement, embracing virtual tourism, and addressing ethical considerations, cities can adapt to current challenges while laying the groundwork for sustainable urban development in the future. This research underscores the necessity for policymakers and urban planners to integrate these insights into their strategies, ensuring that cities are well-equipped to navigate the complexities of a rapidly changing world.

4. CONCLUSION

The COVID-19 pandemic has catalyzed transformative changes in urban environments, underscoring the critical role of the smart city framework in crisis management and resilience building. Different measures, lockdowns, travel restrictions, economic recession and many more occurred.

The smart city concept plays a leading role in overcoming crises and identifying effective solutions. This research demonstrates that cities leveraging smart technologies, such as artificial intelligence (AI) and data analytics, significantly enhance their capabilities to address public health challenges. The findings reveal that AI can facilitate the diagnosis of infections, streamline the distribution of essential supplies, e.g. medicines and optimize urban traffic management, thereby contributing to more effective and responsive city governance during crises. Moreover, the adoption of virtual tourism strategies has emerged as a valuable tool for cities to sustain cultural engagement and stimulate local economies and can provide valuable information about visitors travel preferences and even amidst travel restrictions.

A pioneering role in this respect is being played by China, where the pandemic caused by the COVID-19 virus is regarded as a driving force for innovations in terms of urban planning. With the help of the four categories Smart Community, Smart Government, Smart Healthcare and Smart Information, the aim is to react quickly and efficiently to crises and contain the spread of viral infections.

The significance of this study lies in its exploration of the interplay between technological advancements and urban adaptability, providing insights for policymakers and urban planners aiming to foster sustainable urban development in a post-pandemic context. However, the research is not without limitations; the case studies examined are primarily drawn from specific geographic locations, which may affect the generalizability of the findings. Future research should expand the scope to include a broader range of cities and contexts, allowing for a more comprehensive understanding of how smart city initiatives can be tailored to meet diverse urban challenges. Additionally, further investigation into the ethical implications of data privacy and citizen participation in smart city frameworks is warranted to ensure that these systems bolster resilience while upholding fundamental rights.

In summary, the integration of smart technologies and citizen engagement is essential for cities to navigate current and future crises effectively, reinforcing the importance of the smart city paradigm as a pathway towards enhanced urban resilience and quality of life.

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Gamification in Vocabulary Learning: A Case Study of Duolingo's Effects

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Abstract

The research explores Duolingo's game-based method for vocabulary learning among English as a Foreign Language students and their assessment of the platform's effectiveness. This research used an action research design that studied 43 university students from Hanoi, Vietnam, through pre- and post-vocabulary tests and Technology Acceptance Model (TAM) questionnaire administration. The data from this research showed that vocabulary test scores improved significantly following Duolingo usage among test participants. Student attitude data revealed that students rated the platform's usefulness very high for vocabulary improvement capability and across all evaluation criteria. Students gave mixed responses about their experience using Duolingo because they faced obstacles in learning to use its features. The research indicates Duolingo successfully teaches vocabulary, but its users struggle navigating the system. The research adds to the understanding of gamified education software's effects on vocabulary acquisition while showing the need to maintain a proper balance between learning achievement and student enjoyment. New knowledge gained from this research aims to help developers create easier-to-use digital language teaching platforms while instructing teachers about effective gamification integration for complete language acquisition systems.

Keywords: Duolingo, gamification, vocabulary learning, TAM by Davies (1989)

1. INTRODUCTION

The development of language competence depends on vocabulary because vocabulary acts as an essential core element for Second Language Acquisition (SLA) (Nation, 2001). Language teaching targets this vocabulary strength because it enables learners to interact with the language and achieve fluency (Huckin & Coady, 1999). Digital tools have gained rapid prominence throughout the past decades to transform educational approaches in modern language teaching through gamification-based strategies. Digital vocabulary instruction now benefits from interactive elements drawn from games that use points, badges, and streaks to increase learner participation, as described in Daniels (2024). Duolingo is one prominent language-learning platform that has implemented gamification, creating an addictive yet enjoyable experience for students. People worldwide have adopted Duolingo because of its daily practice features and swift feedback delivery through personalized challenge sessions (von Ahn & Hacker, 2012). By implementing gamification, the system develops a motivational learning environment where users obtain instant feedback for their steady practice and receive rewards whenever they advance (Daniels, 2024). Digital learning environments continue developing, which makes gamification principles in vocabulary acquisition show promise in improving language learning outcomes and closing the theoretical-practical divide in SLA.

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Despite the growing literature on digital tools and gamification in language learning (Nation, 2001; Daniels, 2024), empirical research targeting gamified vocabulary learning remains sparse. While studies have demonstrated that gamification elements, such as points, badges, and streaks, can boost overall learner engagement and motivation (von Ahn & Hacker, 2012), few investigations have isolated their impact on vocabulary retention. In many cases, research on Mobile-assisted Language Learning (MALL) addresses broad language proficiency rather than focusing on the nuanced domain of vocabulary acquisition (Huckin & Coady, 1999). This gap is particularly evident in studies of popular platforms like Duolingo, where anecdotal evidence suggests high engagement. However, little rigorous analysis exists regarding how its gamified features contribute to long-term vocabulary learning. Thus, there is a clear need for a focused case study that examines not only the effectiveness of Duolingo's gamified design on vocabulary retention but also the learners' perceptions and intrinsic motivation in a controlled empirical setting. The current study has two main aims: to assess vocabulary acquisition following Duolingo usage among second-language learners and to evaluate the perception and motivational factors of gamified vocabulary learning. Therefore, two research questions are:

- How effective is Duolingo in enhancing vocabulary retention among EFL learners?
- What are learners' attitudes regarding the use of Duolingo for vocabulary learning?

2. LITERATURE REVIEW

2.1. Vocabulary learning in second language acquisition

Vocabulary acquisition is the fundamental component in SLA, enabling language learners to develop their listening, speaking, reading, and writing abilities (Schmitt, 2000). According to Nation (2001), vocabulary learning consists of word meanings, knowledge of word forms, and how words appear with other words in typical contexts. An approaching vocabulary study from multiple angles has generated research interest in assessing learner word knowledge quantity and quality (Read, 2004). The study examines how vocabulary acquisition occurs naturally without formal intention (Huckin & Coady, 1999). The process of incidental learning occurs during extensive reading or listening tasks because it strengthens the retention of encountered lexical items through continued exposure. Slow gains are typically observed during incidental learning, but when students engage in direct instruction or memorize words intentionally, they experience faster learning, particularly for less frequent words (Laufer & Hulstijn, 2001). According to the Involvement Load Hypothesis, tasks involving comprehensive content-based evaluation, search operations, and need identification to enable superior retention (Laufer & Hulstijn, 2001). The research now investigates technological learning through MALL that integrate gaming features (Zou & Li, 2015). The digital vocabulary learning tools employ spaced repetition systems that apply cognitive principles to maximize vocabulary retention (Webb & Nation, 2017). Despite offering great potential, researchers point out that instruction needs equilibrium by merging traditional teaching practices with contextual exploration and consistent review processes (Schmitt, 2008). Strong vocabulary skills develop when learners experience broad exposure to vocabulary while actively using their language skills with properly designed teaching methods that promote lexical skills at various levels of detail and depth.

2.2. Overview of gamification in education

Incorporating game design principles into educational settings increases student engagement and motivation and improves learning achievements (Deterding et al., 2011). Through this method, educators convert traditional learning activities into dynamic interactive exercises that bring in core game elements. The core gamification elements include specifying goals, immediate feedback, progressive tasks, and reward structures that drive learners toward persistence and accomplishment (Hamari et al., 2014). The principles find a theoretical foundation within self-determination theory by showing how intrinsic motivators such as autonomy, competence, and relatedness matter (Deci & Ryan, 1985).

The educational implementation of gamification elements often consists of points alongside badges, while leaderboards and levels also serve as important components and progress bars. Points and badges are visible indicators of academic attainment while showing learners how far they have progressed. The combined elements function to build a delightful educational space where growth leads to continual motivation because challenges trigger appropriate incentives. Educational institutions with Duolingo and their staff use these components to build a more effective learning environment that engages students. However, ongoing research examines how well these systems drive long-term learning outcomes (Hamari et al., 2014; Werbach & Hunter, 2012).

2.3. Gamification in English language learning

Language learning benefits tremendously from gamification as an educational strategy combining game elements such as points, leaderboards, and progress bars into learning environments to support student engagement and motivation (Deterding et al., 2011). Any gamified language platform such as Duolingo can utilize reward systems and interactive functions to boost student activity rates and generate exciting active learning spaces where learners stay dedicated to their studies (Hamari et al., 2014; von Ahn & Hacker, 2012). By providing instant feedback and step-by-step challenges, gamified tools enable students to monitor their progress and obtain small successes that strengthen good behaviors and self-motivation. Through friendly competition and visible progression, people find excitement in what used to be an intimidating project, so it becomes their daily pleasure to engage with it.

Literature shows that gamified tools deliver positive effects, yet multiple obstacles have been discovered. Repeated external rewards such as points and badges can damage internally driven motivation in long-term learners as students start paying greater attention to earning points rather than achieving language fluency (Deci et al., 1999). Implementing leaderboards in gamified learning systems undermines students with competitive elements because ongoing comparisons lead some learners to experience anxiety while others become frustrated, resulting in reduced long-term commitment. Through gamification, learners usually practice repeatedly, yet they could develop a superficial understanding of language, which might prevent them from achieving more profound linguistic abilities. The design requires a combination of motivational benefits from player-centric features with strong pedagogical mechanisms to maintain learning effectiveness and meaningful educational value.

2.4. Duolingual as a gamified learning tool

Duolingo achieves successful gamification in language education by implementing features to support student engagement and continuous and Duolingo implements adaptive learning algorithms to customize lesson difficulty levels based on student advancement in addition to daily streaks reward systems (badges and experience points), competitive leaderboards, and its platform design (von Ahn & Hacker, 2012; Deterding et al., 2011). Several carefully integrated features cooperate to build dynamics that drive motivation in the platform by utilizing frequent lesson completion streaks with competitive additions, including rewards and leaderboards. The adaptive system helps each user by detecting their specific knowledge gaps, which enables the system to optimize content delivery, thus strengthening vocabulary retention through spaced repetition.

Many empirical studies confirm Duolingo works efficiently to acquire vocabulary, but its effectiveness may show different outcomes depending on learner backgrounds and usage settings. Users who spent three months using the platform experienced both important vocabulary growth and enhanced language capabilities (Smith et al., 2024). The systematic review of Rahman et al. (2024) proved that Duolingo's interactive interface specifically aids vocabulary memorization processes and maintains learner engagement through entertaining and interactive practice methods. The platform demonstrates promising results, but research focuses on receptive language skills over production skills (Loewen et al., 2020), indicating that Duolingo best serves as a supplemental vocabulary development tool that needs integration with speaking language activities to reach advanced learning goals. The combination of Duolingo's entertaining gamification features with adaptive learning functionalities creates strong evidence that demonstrates their role in boosting vocabulary learning in language education.

3. METHODOLOGY

3.1. Research design

Action research design was utilized to explore continuous educational practice development (Creswell, 2012). Educators use this design to assess interventions in realistic conditions by collecting numerical test scores and procedures, deep observational data, and interview findings. The research on vocabulary acquisition with digital tools uses action research design to evaluate digital tool effects in language learning (Rahman et al., 2024). Researchers use statistical analyses with participant feedback to create triangular findings and discover successful strategies and required changes. The integrated system reinforces outcome validity and facilitates continuous classroom practice adjustments, which is suitable for research in active educational spaces (McNiff & Whitehead, 2011).

3.2. Participants

Forty-three students from the traditional EFL (English as a Foreign Language) programs enrolled in focused English learning programs for English 1 classes at a public university in Hanoi, Vietnam, comprised the study participants. The research included 28 male (65.1%) and 15 female participants (34.9%), with male participants being more abundant than female participants. Students from different academic fields completed the survey, and responses

were gathered from various participants. Despite their varying proficiency levels, the research participants showed between 3–5 years of English language education. Students maintaining this learning experience show mainly intermediate to advanced proficiency in language skills (Hinkel, 2018). The specific experience level of students studying language learning interventions creates advantageous conditions because it establishes English fluency yet allows targeted intervention approaches to drive further improvement (Bennett, 2021). Different areas of study in the participant group allow researchers to study academic discipline's effects on language outcome results because their learners approach language acquisition differently (Taguchi, 2019).

3.3. Data collection instruments

The pre-and post-vocabulary tests must include receptive and productive assignments to measure learners' vocabularies comprehensively (Nation, 2001). The item selection process includes Multiple-choice questions, gap-fills, and short-answer tasks that present authentic language examples. Tests require pretesting on representative groups to confirm reliability by using both Cronbach's alpha ($\alpha > 0.70$ for acceptable results) and testing reliability methods (Webb, 2008). The assessment maintains content validity through objective-item alignment with program instruction and expert evaluators, along with construct validity parameters such as confirmatory factor analysis provide evidence that testing measures the intended content correctly.

Students' attitudes regarding the learning tool are evaluated using questionnaire items that follow the principles of the Technology Acceptance Model (TAM) (Davis, 1989). The survey must contain Likert-type items that evaluate student perceptions about the instrument's usefulness and ease of use. The constructs of perceived usefulness (PU) and perceived ease of use (PEU) have been documented by Venkatesh and Davis (2000) to impact user acceptance alongside continuous engagement. The instrument's reliability depends on pilot testing followed by a check of internal consistency and test-retest reliability. The study's validity would be strengthened through exploratory factor analysis and content verification from subject experts. A 5-point rating scale should be used in the questionnaire for producing detailed responses and statistical breakdowns (Venkatesh & Davis, 2000). The researchers modified original phrases to match each tool and context examined (e.g., using Duolingo in my language class would enhance my vocabulary outcomes). A pilot testing phase must be carried out before performing large-scale questionnaire distribution. Researchers disperse the draft questionnaire to participants with matching backgrounds to gather marks on questionnaire comprehension of relevant content and item duration. The revised instrument should complete reliability tests using Cronbach's alpha to determine construct consistency and exploratory factor analysis to verify correct item association according to intended factors. The methodical procedure guarantees that the TAM questionnaire properly detects learners' usefulness and ease of use perceptions to produce reliable data for technology acceptance research.

3.4. Data analysis

The analysis of quantitative data through SPSS Version 27.0 aimed to answer two primary research questions about vocabulary acquisition between pre-test and post-test measurements and student learning performance about their PE and PEU attitudes. The data from the vocabulary tests underwent paired-sample t-tests to ascertain that post-test performance had exceeded pre-test performance levels, which reached statistically significant thresholds. Cohen's d figures helped evaluate the meaningful improvement levels observed during the study. Research analysts used descriptive statistics, which included means and standard deviations, to understand the students' general attitudes toward the tool through their questionnaire responses. The study used Cronbach's alpha coefficients of 0.75 to verify the reliability of PU and PEU scales while exploratory factor analysis validated the constructs. The research used correlation analysis to study connections between vocabulary learning improvements and attitude measurements, which supplied all-inclusive results for both study questions.

4. FINDINGS AND DISCUSSIONS

4.1. The impacts of Duolingo on students' vocabulary after the intervention

Research findings show that student vocabulary growth reached a statistically significant milestone due to their use of Duolingo, as demonstrated by the t-test results of paired samples in Table 1.

Table 1. Paired sample t-test of the impacts of Duolingo on students' vocabulary after the intervention

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	Post - Pre	1,0233	0,5665	0,0864	0,8489	1,1976	11,845	42	0,000

Students achieved a mean difference of 1.0233 points (standardized deviation = 0.5665) in both tests, which demonstrated a significant level of p-value ($p < 0.001$, $t(42) = 11.845$). According to the confidence interval, the mean difference between the mean difference of the study group's actual population is 0.8489 and 1.1976. This confirms that the intervention produced reliable positive results among all participants. The observed significant vocabulary progress from Duolingo use confirms the findings presented in Smith et al.'s (2024) research. Duolingo's gamified vocabulary learning system enables effective knowledge acquisition based on the improvement of 1.02 points observed, thus validating von Ahn and Hacker's (2012) educational value claims about the platform. The research validates Rahman et al.'s (2024) conclusion that interactive Duolingo practices enable better vocabulary retention when students use dynamic educational methods. The vocabulary retention gains during the study corresponded with spaced repetition systems that Duolingo uses, according to Webb and Nation (2017). The platform meets the requirements of the Involvement Load Hypothesis (Laufer & Hulstijn, 2001) because its learning tasks combine complete content assessment and search queries with need recognition capabilities.

However, the substantial statistical results need interpretation considering that Duolingo typically improves only receptive language abilities (Loewen et al., 2020). The observed improvement shows primarily receptive vocabulary knowledge instead of productive vocabulary use. Nation (2001) demonstrates that vocabulary knowledge demands simultaneous attention to both receptive and productive aspects, and this analysis supports his definition. All participant results demonstrated continuous improvement, validating Hamari et al.'s (2014) investigation about gamification elements being effective for student engagement maintenance. According to the significant findings, the complete system of points and adaptive difficulty combined with badges served as compelling motivations for students to perform frequent vocabulary learning activities. The observed engagement method matches findings from Deterding et al.'s (2011) study, which explored gamification elements for improving educational results by boosting student participation and interest. Despite the new evidence, the research team must consider Deci et al.'s (1999) conclusion, which states that external rewards could negatively affect motivation over time. Research must now investigate how well students retain their vocabulary knowledge following the initial intervention phase because current findings showed short-term improvement. Schmitt (2008) suggests that ideal vocabulary development needs a match between digital tools and traditional teaching practices; thus, Duolingo functions better as part of a well-rounded language learning strategy than independent use.

4.2. Students' attitudes toward the application of Duolingo in learning vocabulary

Based on the statistics in Table 2, students had differing perspectives on how helpful and easy Duolingo was for learning vocabulary.

Table 2: Descriptive statistics about students' attitudes towards the application of Duolinguo in learning vocabulary.

	N	**Mean**	**Std.**
Perceived usefulness (PU)			
Using Duolingo would enable me to accomplish vocabulary tasks more quickly	43	4,12	0,391
Using Duolingo would improve my vocabulary ability	43	4,47	0,505
Using Duolingo would increase my vocabulary points	43	4,35	0,613
Using Duolingo would enhance my effectiveness on the vocabulary tasks	43	4,37	0,489
Using Duolingo would make it easier to complete vocabulary tasks	43	4,12	0,324
I would find Duolingo useful in learning vocabulary	43	4,30	0,465
Perceived Ease-of-Use (PEU)			
Learning to operate Duolingo would be easy for me	43	3,26	0,441
I would find it easier to get Duolingo to do what I want it to do	43	4,40	0,495
My interaction with Duolingo would be clear and understandable	43	3,21	0,559
I would find Duolingo would be clear and understandable	43	3,58	0,499
It would be easy for me to become skillful at using Duolingo	43	2,74	0,441
I would find Duolingo easy to use	43	3,47	0,505

The students exhibited positive perceptions of PU, which remained above 4.0 throughout the research using a five-point scale. Students rated vocabulary improvement capabilities (M=4.47, SD=0.505) the most highly in PU measurements before effectiveness enhancement (M=4.37, SD=0.489) and vocabulary point increments (M=4.35, SD=0.613). The reported findings by von Ahn and Hacker (2012) demonstrate that gamified features in Duolingo create positive perceptions of learning effectiveness. Students consistently evaluated Duolingo at high PU scores, which indicates their understanding of how effective Duolingo can be for vocabulary learning, according to Rahman et al.'s (2024) systematic review findings.

The PEU results show a complex situation compared to other findings. Most students reported simple task execution on Duolingo (M = 4.40, SD = 0.495) but showed lower confidence toward other ease-of-use aspects. Students rated the ability to master Duolingo platform features as their most challenging aspect among all PEU measures (M = 2.74, SD = 0.441). Student evaluations reveal moderate ratings between 3.58 and 3.47 (SD = 0.499 and 0.505, respectively), which indicates that platform navigation poses some difficulties. The results partially oppose Deterding et al.'s (2011) viewpoint on gamification accessibility, yet they parallel Loewen et al.'s (2020) observations regarding usability issues in digital language learning platforms. Research findings from Mogavi et al. (2022) validate the unique pattern where PU scores outpace PEU scores, which appears in this study. Students recognize Duolingo's potential vocabulary learning advantages yet encounter obstacles that limit their complete use of the platform. Perceived usefulness emerges as a more decisive factor for user acceptance than ease of use does in such acceptance evaluations (Davis, 1989).

The measurement variability is substantial for student experiences with vocabulary points and clear interaction because their standard deviations reached 0.613 and 0.559, respectively. The observed data patterns agree with Smith et al.'s (2024) conclusion that Duolingo delivers different success rates because learners have different traits and ways of utilizing the platform. Users who received lower PEU scores might share similar issues identified by Deci et al. (1999) since they experienced difficulties with the technical aspects of the gamified system. According to the gathered data, students may tolerate usability hurdles if they recognize their exposure to significant learning advantages. Research conducted by Hamari et al. (2014) demonstrates that users remain in gamified learning systems when they recognize the educational advantages of their experience. According to Werbach and Hunter (2012), the success of gamified learning tools emerges from maintaining features that promote engagement with interfaces that users find easy to navigate. Research implies that Duolingo effectively convinces students to recognize its value in vocabulary learning, although its current interface and learning difficulty require additional improvement. Results show that better onboarding mechanics and support services need better development, particularly in aspects students struggle to understand during the learning process. Bennett's (2021) research supports providing access to scaffolded assistance according to his study on digital language learning environments.

5. CONCLUSIONS

The study shows that Duolingo produces notable vocabulary improvement for EFL students, exposing researchers to essential knowledge about student perspectives on gamified education platforms. Vocabulary score enhancements generated by Duolingo create strong evidence that supports its role as an effective vocabulary teaching platform. Student evaluations show continuous high ratings on perceived usefulness mainly because they understand Duolingo enhances their language learning experience by advancing their vocabulary skills. A critical utilization barrier exists in implementing gamified learning tools because students demonstrate different levels of perceived usefulness than ease of use. Students experience difficulties understanding how to use Duolingo because their scores for skill learning show low results. This double nature indicates that despite the educational value of the platform, it still has significant potential areas to improve user experiences and reach accessibility goals.

Nevertheless, the study results have multiple interpreting limitations that should be taken into account. The limited timeframe in the study might fail to demonstrate the complete long-term effect that gamified vocabulary education generates. The small number of students involved and their exclusive enrollment at a single institution reduces the potential for high generalization of these research results. Future studies must employ longitudinal designs to measure vocabulary retention across various time intervals since this study's limitations involve sample size and testing period. Researchers should study permanent student engagement and educational results acquired from gamified platforms. To create tailored educational methods, scientists should research the relationship between individual learning styles and gamified platform success.

The results demand several functional implications that educators and platform designers must implement according to our findings. Educational institutions should adopt Duolingo as an additional resource in their language teaching curriculum instead of using it independently from standard teaching methods. Duolingo platform development should center around a simplified interface design that preserves its entertainment aspects to resolve user experience complications. Instructors must offer hands-on support to students throughout Duolingo implementation since it aids students with technical challenges and the use of the platform to achieve its educational objectives.

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