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LAND REFORM POLICY FORMULATION IN SOUTH AFRICA AND ZIMBABWE: IMPLICATIONS FOR SOCIO-ECONOMIC AND POLITICAL DEVELOPMENT

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Abstract. Intense ideological and political standoffs persist over land and agrarian reform in former settler countries where land access, ownership, and utilisation wield enormous socio-economic and political implications. Focusing on South Africa (SA) and Zimbabwe, this article contributes to the ongoing debate on land reform. Drawing on qualitative secondary literature review and abstraction, this article identifies land reform policy evolution in SA and Zimbabwe and explores the implications of land reform policy on socio-economic and political development. The article shows that since colonial times, asymmetrical land access, ownership, utilisation, and widespread land expropriation by settlers have been the major source of political instability, landlessness, rural poverty, high population densities, and poor land management in SA and Zimbabwe. The article argues for the need for theoretically and conceptually mature land reform debates located within the broad framework of trajectories of transformation, not only economic but also structural.

Keywords: *Agrarian reform, colonialism, development, land reform, imperialism, sovereignty.*

Rezumat. Confruntări ideologice și politice intense persistă cu privire la reforma funciară și agrară în fostele țări colonizate, unde accesul, proprietatea și utilizarea terenurilor au implicații socio-economice și politice enorme. Concentrându-se pe Africa de Sud (SA) și Zimbabwe, acest articol contribuie la dezbaterea în curs privind reforma funciară. Bazându-se pe o analiză și o abstractizare calitativă a literaturii secundare, acest articol identifică evoluția politicii reformei funciare în Africa de Sud (AS) și Zimbabwe și explorează implicațiile politicii de reformă agrară asupra dezvoltării socio-economice și politice. Articolul arată că încă din epoca colonială, accesul asimetric al terenurilor, proprietatea, utilizarea și exproprierea pe scară largă a terenurilor de către colonești au fost sursa majoră de instabilitate politică, lipsă de pământ, sărăcie rurală, densități mari de populație și management deficitar al terenurilor în AS și Zimbabwe. Articolul argumentează necesitatea unor dezbateri mature, teoretic și conceptual asupra reformei funciare situate în cadrul larg al traiectoriilor de transformare, nu doar economică, ci și structurală.

Cuvinte cheie: *Reforma agrară, colonialism, dezvoltare, reformă funciară, imperialism, suveranitate.*

1. Introduction

The land reform policy formulation of South Africa (SA) and Zimbabwe is tied to the history, nature, and result of their colonial encounter with Europe. To understand the source of the land conflicts and motivations for land reform in these countries, a thorough understanding of the multi-layered social and political inconsistencies emerging from pre- and post-independence land policies together with the continent's 'development' as well as white capital accumulation trajectories, regarding, especially land access, ownership, and utilisation, is required. For most of the pre-colonial African populace, land has been the major source of wealth and livelihood which defined and determined belonging [1,2]. It is a vital production asset that provides the basis for the socio-economic growth of nations. Today, in Zimbabwe where about 70% of the population engages in agricultural activities for income and livelihood [3], land is a basic asset for livelihood. There is also growing evidence that land is the most vital available asset which rural communities can easily and meaningfully utilise to meet a variety of livelihood needs [4, 5]. Poverty is also intimately linked to landlessness in most agrarian communities [6]. As a result, land reform has been one of the major mechanisms for socio-economic and political transformation.

Studies on land and agriculture as the engine for development in Africa have been increasing [7-9]. The land has been a subject of policy formulation in SA and Zimbabwe, and the increasing campaigns for land reform since independence are manifestations of the deep-rooted land dispossession. SA and Zimbabwe are former settler colonies. Europeans did not only colonise these countries to loot resources but also to settle due to favourable climatic conditions and other reasons best known to themselves. According to Moyo [10], land battles and agroecological conditions, together with the splendour of a land and its inhabitants, all brought about strong emotional ties between the settlers and their colonies. To appease the European gluttonous land-wrenching zeal, the colonial government, of necessity, adopted policies that instituted the enterprise. Studies that explore land policy formulation in SA and Zimbabwe are scant. In the case of Zimbabwe, available studies on colonial land policies focus mainly on the pre-independence period [11, 12].

In SA, there has not been a comprehensive study that traces land policy formulation. Land policies are simply touched on by scholars as they emphasise particular points. As a result, there are no references that provide detailed land reform policy formulation in the two countries from the colonial period until now. This is a gap that has policy and scholarly implications, particularly for emerging academics and land activists seeking to engage in the land reform debate. This article seeks to contribute towards narrowing this gap by providing a detailed outline of land reform formulation in SA and Zimbabwe since the advent of colonialism until now.

This article (i) identifies land reform policy evolution in SA and Zimbabwe and (ii) explores the implications of land reform policy on socio-economic and political development. The study has the potential to contribute to ongoing debates on land reform policy by providing details that may guide debate and policy formulation. It can also serve as the basis for further theorisation and conceptualisation by academics and land activists.

The article is organised as follows: After the current introduction, the following section presents the research methodology for the study. This is followed by a discussion of land reform policies and their implications in SA and Zimbabwe under two sub-sections. Thereafter, the article proposes a transformative social policy-based land reform trajectory. Lastly, conclusions and recommendations are drawn from the discussion.

2. Materials and Methods

This article is based on a qualitative secondary literature review. Both grey and academic literature identified using 'land reform' as the key word in SA and Zimbabwe were reviewed. Literature review was combined with abstraction since some of the issues raised in the article require in-depth analysis and not mere empirical evidence that is in the form of numbers as in quantitative studies or direct quotations of qualitative studies. The authors are widely published on land reform issues and therefore, believed that the article could benefit from their sectorial expertise. There was no rigid criterion used to identify the texts that were used in this article. Instead, the authors relied on texts that provided detailed information on particular land reform policies that are summarised in this study. This loose research approach, however, presents a particular limitation. It is the authors' conviction that future researchers will be motivated to problematise the debate made here and engage in more detailed analyses of land reform evolution in the two countries.

3. Land Reform Policy Formulation in South Africa

This section discusses key land reform policies in SA and Zimbabwe since the advent of colonial enterprise to the present. Since the advent of the colonial project, several land-related policies were adopted and implemented in SA as detailed below.

3.1 Natives Land Act of 1913

The Natives Land Act of 1913 was a pivotal piece of legislation that formalised and intensified racial segregation in land ownership [13]. It restricted blacks from owning land outside of specific areas known as reserves, which comprised only about 7% of the country's territory. The Act aimed to confine blacks to designated areas while reserving the majority of the land for white ownership and agricultural development. Socially, the Act reinforced racial divisions and entrenched inequalities by systematically dispossessing blacks of their ancestral land [14]. It led to widespread forced removals and the creation of overcrowded and impoverished rural reserves. The Act perpetuated social segregation and undermined the social fabric of South African society by limiting opportunities for interaction and integration between racial groups [15].

In addition, economically, the Natives Land Act severely restricted blacks' access to productive agricultural land, stifling their economic opportunities and perpetuating poverty and dependency [16]. It entrenched a dual economy characterised by racial disparities in land ownership, access to resources, and economic opportunities. The Act contributed to the concentration of wealth and power in the hands of the white minority, exacerbating economic inequalities. Politically, the Act reinforced the apartheid government's agenda of white supremacy and control over land and resources [14]. Conradie [17] mentions that the Act disenfranchised blacks and limited their ability to participate in the political process by depriving them of land ownership and economic independence. The Act fueled resistance and opposition to apartheid policies, laying the groundwork for future political mobilization and activism among blacks.

3.2 Group Areas Act of 1950

The Group Areas Act of 1950 further institutionalised racial segregation by allocating specific areas for different racial groups [18]. It divided urban areas into racially segregated zones and forcibly removed black communities from areas designated for white settlements. The Act aimed to create racially homogeneous neighborhoods and reinforce the apartheid

government's policy of separate development. The Act deepened social segregation and fractured communities by forcibly relocating people based on their race. It led to the creation of racially segregated townships and urban areas characterized by unequal access to services, amenities, and opportunities. The Act exacerbated social tensions and contributed to the marginalisation and alienation of blacks from urban centers.

Economically, the Group Areas Act disrupted established economic networks and forced many blacks to live in overcrowded and underdeveloped townships with limited economic opportunities [17]. It reinforced racial inequalities in housing, employment, and access to services, perpetuating economic marginalisation and deprivation among black communities. More so, Mbatha and Tembe [19] argued that politically, the Act reinforced the apartheid government's control over urban spaces and resources while disenfranchising and disempowering blacks. For Sihobo and Kirsten [20] mentioned that the Act fueled resistance and protest against apartheid policies, particularly among urban black communities who faced the brunt of forced removals and social dislocation. The Act underscored the inherently oppressive and discriminatory nature of apartheid, galvanizing opposition and solidarity among anti-apartheid activists.

3.3 The Native Trust and Land Act 18 of 1936

This Act extended the apartheid government's control over land owned by blacks. It established Native Trusts through which the government could acquire and administer land on behalf of black communities, further entrenching segregation and dispossession [21]. Socially, the Act reinforced racial segregation and inequality by limiting blacks' access to land and confining them to designated reserves or "Bantustans" [20]. It perpetuated social divisions and undermined the dignity and autonomy of black communities. Additionally, in the economic context, the Act restricted blacks' access to productive land and resources, hindered their economic opportunities, and perpetuated poverty and dependency [15]. It contributed to the concentration of wealth and power in the hands of the white minority, exacerbating economic inequalities. Politically, the Act served the political interests of the apartheid government by consolidating its control over land and resources while disenfranchising and disempowering blacks [22]. It fueled resistance and opposition to apartheid policies, laying the groundwork for future political mobilisation and activism among black communities.

3.4 Bantu Authorities Act 1951

The Bantu Authorities Act of 1951 established a system of tribal and regional authorities for blacks, known as 'Bantustans' or 'homelands.' It sought to create separate and autonomous political entities for different ethnic groups within South Africa, effectively removing blacks from the political and economic mainstream [23]. Socially, the Act fragmented black communities along ethnic lines and undermined their sense of collective identity and solidarity. The Act facilitated the forced relocation of millions of blacks to designated homeland areas, disrupting social networks and traditional ways of life [14]. The Act contributed to the erosion of social cohesion and cultural heritage among black communities, as they were subjected to artificial divisions and political manipulation.

More importantly, economically, the Bantu Authorities Act further marginalized blacks by confining them to economically marginal and underdeveloped homeland areas. It deprived them of access to the resources and opportunities available in urban centers, causing poverty and dependency. The Act served the economic interests of the apartheid government by

maintaining a cheap and exploitable labor force in the urban areas while relegating blacks to subsistence agriculture and low-wage labor in the homelands [19].

Politically, the Act undermined blacks' aspirations for political equality and self-determination by relegating them to powerless and ineffectual tribal authorities. It reinforced the apartheid government's divide-and-rule strategy by co-opting and co-opting traditional leaders to administer the homelands on its behalf. According to Mukarati et al. [24] the Act contributed to the fragmentation and disempowerment of the anti-apartheid movement by isolating and weakening black communities' socio-economically, politically, and geographically.

3.5 The Group Areas Act 36 of 1966

This Act amended and strengthened previous legislation on racial segregation, further entrenching racial divisions and inequalities in urban areas. It expanded the scope of forced removals and demolition of homes in designated 'white' areas, leading to widespread displacement and dispossession [25]. The Act intensified social segregation and fragmentation by forcibly relocating black communities and destroying established social networks and community ties. It undermined the sense of belonging and identity among affected populations and perpetuated feelings of alienation and marginalisation.

By disrupting livelihoods and economic activities, the Act exacerbated economic hardships and poverty among displaced communities [20]. It deprived blacks of access to urban amenities, services, and employment opportunities, perpetuating cycles of deprivation and dependency. More importantly, the Act reinforced the apartheid government's agenda of racial segregation and control over land and resources [26]. It fueled discontent and resistance among affected communities, contributing to broader opposition to apartheid policies and demands for political change and justice.

3.6 Black Communities Development Act 1984

The Black Communities Development Act of 1984 aimed to promote separate development by conferring limited autonomy and self-governance on black local authorities and townships. It sought to create the illusion of progress and empowerment within segregated black communities while maintaining the overall structure of apartheid [27]. Socially, the Act perpetuated the illusion of empowerment and progress among black communities while reinforcing their subjugation and dependency within the apartheid system [20]. It marginalized alternative forms of political expression and resistance by co-opting and controlling local black authorities. The Act further entrenched racial divisions and inequalities by perpetuating the segregation and marginalisation of black communities [15].

Economically, the Act failed to address the underlying structural inequalities and disparities that characterized the apartheid economy. It perpetuated economic marginalisation and dependency among black communities by confining them to underdeveloped and resource-poor areas [28]. The Act reinforced the apartheid government's control over economic resources and opportunities while marginalising blacks from mainstream economic activities. Politically, the Act undermined the aspirations for genuine democracy and equality by maintaining the facade of black empowerment within the apartheid system [22]. It co-opted and neutralised potential sources of opposition and resistance by conferring limited powers and privileges on black local authorities. The Act contributed to the fragmentation and demobilization of the anti-apartheid movement by creating divisions and tensions within black communities.

3.7 The Abolition of Racially Based Land Measures Act 108 of 1991

This act repealed various apartheid-era laws that enforced racial discrimination in land ownership and allocation. It aimed to dismantle legal barriers to land ownership and promote non-racialism and equality in land rights [29]. Socially, The Act signaled a significant shift away from apartheid-era policies of racial segregation and discrimination, fostering greater social inclusion and cohesion [22]. It affirmed the principle of equality before the law and promoted the rights and dignity of all South Africans, regardless of race or ethnicity. More so, the Act removed legal barriers to land ownership and access, the act expanded economic opportunities and empowerment for previously disadvantaged individuals and communities [30]. It paved the way for more equitable distribution of land and resources, contributing to poverty reduction and economic development. Lastly, the Act represented a milestone in South Africa's transition from apartheid to democracy, signaling a commitment to democratic governance, human rights, and social justice [26]. It bolstered the legitimacy of the post-apartheid government and laid the groundwork for subsequent land reform initiatives and policies.

3.8 Constitution of the Republic of South Africa (1996)

Since gaining independence in 1994, South Africa has demonstrated a strong dedication to implementing a land reform process that is grounded in the constitution. This approach consists of three key elements: restitution, land redistribution, and tenure security. The concept of land restitution is enshrined in section 25(7) of the 1996 Constitution. This provision mandates that individuals or communities who have lost land due to historical racially discriminatory policies, such as the Native Land Act of 19 June 1913, are entitled to have their land returned to them or get fair compensation. According to Section 25(7) of the 1996 Constitution, individuals or communities whose land tenure is legally uncertain due to past racially discriminatory laws or practices have the right to either obtain legally secure tenure or receive comparable compensation, as determined by an Act of Parliament. Section 25(5) of the Constitution establishes land redistribution as a process in which the government is required to obtain land and distribute it to individuals who lack land or have insufficient access to it. Regarding this particular element, the state is legally obligated to: "...implement appropriate legislative and other actions, considering its existing resources, to create circumstances that allow citizens to obtain fair and equal access to land..."

Land tenure security is addressed by section 25(6) of the Constitution. This component aims to safeguard the rights of individuals who have resided on land held by white individuals for an extended period of time, but without legal protection. According to Section 25(6), if a person or community lost their property due to racially discriminatory legislation or practices before 19 June 1913, they have the right to either have their property back or get fair compensation, as determined by an Act of Parliament. The Constitution of South Africa has exerted influence on the country's land reform initiatives [31].

3.9 Restitution of Land Rights Act 22 1995

Land restitution has been a prominent and urgent matter in South Africa since gaining freedom. The Restitution of Land Rights Act 22 established a Commission on Restitution of Land Rights in 1995, headed by a Chief Land Claims Commissioner and seven Regional Land Claims Commissioners, each representing one of the country's nine provinces. The commissioners were tasked with providing assistance to individuals and groups seeking to

assert their ownership of property. They processed claims and provided applicants with updates on the progress of their claims. In 1997, the Restitution Act was revised to align it with the 1996 Constitution. This was done since it was found that the Act was inefficient in handling claims due to its focus on legal considerations rather than administrative concerns [32]. Claimants were granted direct access to the Land Claims Court, bypassing the lengthy process of the Commission on Restitution of Land Rights. The Minister of Land Affairs was then granted the authority to resolve claims through negotiation.

The Land Claims Commission and the Land Claims Court were founded in 1995, in accordance with Section 4 of the Restitution Act and Section 123 of the Interim Constitution. The Land Claim Commission's objective is to address the administration of claims, including compensation for present owners and restitution for claimants. In contrast, the Land Claims Court specifically handles land-related conflicts that remain unresolved by the Land Claims Commission. The Land Claim Commission thoroughly evaluates all land claims, assesses the eligibility of individuals based on the Constitution and the Restitution Act, and endeavors to settle claims through negotiation.

3.10 White Paper on South African Land Policy of 1997

The White Paper on South African Land Policy of 1997 was based on a market approach whereby the 'willing buyer, willing seller' arrangement prevailed. Promoted by the Settlement Land Acquisition Grant (SLAG), this approach made the redistribution of land very slow and dismal [33]. In 2001, the SLAG was replaced by the Land Redistribution for Agricultural Development which was meant to assist previously deprived groups (black, coloured, or Indian) to purchase land or agricultural inputs. Large amounts of up to R100.000 were granted to individuals in this programme [33].

Initially, the land redistribution programme sought to redistribute 30% of land from white farmers to black ownership. By March 2002, only 56 245 households had been settled on 427,337 hectares. By June 2009 only 5.5 million hectares (6.7%) had actually been redistributed [34]. In the same period, 75,400 land restitution claims had been processed with 1,551,249 beneficiaries while 4,296 claims were still outstanding [33]. By 2011, about 79,696 land claims had been lodged [34].

As with land restitution, by March 2002, 29,877 claims on about 427,337 hectares had been resolved to benefit about 56,245 families. Only R938 million was paid in monetary compensation. By 2019, the government had settled about 80,664 claims to benefit about 2.1 million people at the cost of R40 billion inclusive of compensation in the form of money. The state had also stored 3.5 million hectares of land which could be used for agricultural purposes or other economic development activities. These statistics are considered to be very slow as would be expected [15,20] The SA land reform, therefore, faces continued criticism from land activists and rural development practitioners for lack of satisfactory progress [34]. The Land Redistribution for Agricultural Development was also criticised for being biased towards resourced black South Africans who were more likely to succeed as commercial farmers instead of the rural poor whose livelihoods needed to be developed and strengthened [33].

4 Zimbabwe

Land access, utilisation, and ownership have always been a subject of policy formulation since the advent of white-settler colonialism in Zimbabwe as discussed below.

4.1 The Native Reserve Order in Council of 1898

The Native Reserve Order in Council was implemented with the purpose of establishing Native Reserves for Africans in order to facilitate the allocation of additional land for white immigrants. They ensured that Africans were resettled in low-potential economic areas to make them always available in the labour market [35]. The obvious intention was to underdevelop African communities and push them away from public goods and services required for social and economic development. The disintegration of communities also undermined the potential for political uprising as Africans from different tribes now suspected each other of cooperating with whites [34].

The colonial regime deliberately impoverished Africans to force them to offer labour in mines, farms, and factories. In addition to the above, Moyana [35] reports that pervasive land shortages were accompanied by pressing shortages of vital needs such as school fees, clothes, and food. The land-disenfranchised Africans were soon converted into commodities by the gluttonous land colonial project. The settler regime requested the British government (its headquarters) to adopt policies that prohibited Africans from purchasing land attached to farms owned by white settlers. White-settler officials also deployed many methods to force Africans to work on their farms and other projects without payment. This was at times achieved through African traditional leaders who were mandated to conscript their subjects to go and serve at white instruction. Labour was also needed in the construction of roads and rail lines. Violence was employed, such as the abduction of women until their husbands provided labor, or the capture of the chief until the necessary number of men stepped up. Unpaid labor was also extracted from individuals who did not pay their €10 hut tax. Africans residing on farms owned by white individuals were obligated to provide labor for these farmers without receiving any sort of remuneration, as a condition of their tenancy [36].

4.2 The Land Apportionment Act of 1930

The Land Apportionment Act emanated from the Morris Carter Commission which had been launched by the government in 1925 to make an urgent analysis and to provide a statement on the issues of biased land patterns in the Colony. Sir Morris Carter, the former Chief Justice of Uganda and Tanganyika, was the Chairman of the Commission which comprised three members including the Chief Native Commissioner -Sir Herbert Taylor -, and Mr. Atherson, Director of Lands, and former Surveyor General for the Brutish South African Company [35]. The Commission commenced in 1925; and before the end of the year, it had completed its work. The Commission recommended the institutionalisation of a policy that would ensure that there were separate areas from which Africans and Europeans would purchase land [12,35]. Drawing from the recommendations of the commission, the Land Apportionment Act was meant to justify and cement the racial legislation that had been developed since the inauguration of the land dispossession scheme in the 1890s.

The Land Apportionment Act, similar to the SA Native Land Act of 1913, allowed white individuals to fully dispossess and separate Africans from their traditional lands, confining them to designated Purchase Areas (Pas) [37].

The Land Apportionment Act distributed land in the following manner: The allocation of land was as follows: 8.8 million hectares were designated for Native Reserves, 3 million hectares for Native Purchase districts, 19.9 million hectares for white farming and urban districts, and 7.2 million hectares remained unallocated [38]. Table 1 provides a detailed description of landholding after the inception of the Act.

Table 1

Classification of Land after the Land Apportionment Act (1930)

Category of landholding	Size of landholding (Acres)	Percentage
Native Reserves	21.127.040	22
Native Purchase Area	7.464.566.	7.8
European Area	49.149.174	51.0
Unassigned Area	17.793.300	18.5
Forest Area	590.500	0.6
Undetermined Area	88.540	0.1
Total	**96.213.120**	**100**

The implementation of the Land Apportionment Act resulted in the communal areas becoming excessively crowded and overstocked [11]. Household livelihoods in the reserves became vulnerable and unable to be maintained in the long term. This was exacerbated by additional restrictions, such as the implementation of the Cattle Levy Act and Maize Control Act. The former imposed restrictions on Africans' access to marketing outlets, while the latter decreased the amount of cattle each individual could own by implementing higher taxes. The Land Apportionment Act served as the foundation for following laws that exhibited a preference for individuals of white ethnicity. By 1965, when the liberation struggle was at its peak, almost all the best lands were now in the hands of Europeans [38].

The Land Apportionment Act was an awful reality for Africans in many ways. Firstly, it disfigured the social formation of African life by disregarding native culture and religious systems which were tied to land ownership, access, and utilisation. It also disrupted the economic development trajectory by undermining, discouraging, and punishing traditional agricultural activities which were blamed for causing soil erosion [39]. The displacement of Africans and their subsequent abandonment into lowveld regions was accompanied by rapid livestock and flock loss and dismal crop production levels and thus fuelled resistant political activities [34].

Since Africans relied on land for social and economic development, the Act became the worst experience for Africans. For Chitiyo [37] reveals that before the Act, crop production stood at 3,483,650 bags of grain in 1923, whilst in 1939, the yield plunged to 3,160,999. The statistics of flocks (sheep and goats) also went on the negative. In 1923, there was a total of 262,432 sheep reared by indigenous households. However, after the Act, only about 234,748 sheep were recorded in the year 1939 - signifying a 10% difference over a period of 16 years. Despite the growing African population, their arid lands continued to endure significant strain, leading to the depletion of their cattle and flocks. The Land Commission was then established to regulate the permissible sizes of cattle and flocks that Africans were allowed to keep on the estates. By 1943, the majority of the 38 reserves had already become excessively inhabited, leading to significant soil erosion [37]. The scarcity of pasture and fodder resulting from excessive grazing significantly affected the African population's cattle, which consistently received the lowest rating in the market, greatly burdening their lives.

4.3 Land Husbandry Act of 1951

Due to the scarcity of land and insufficient pasture, the problem of soil erosion intensified. In response, the colonial government established the Land Husbandry Act of 1951 as an official policy. This legislation implemented land conservation protocols, recognized private land ownership, and implemented destocking measures in regions populated by

Africans whom the colonial government claimed were responsible for soil degradation due to their traditional farming methods [38]. The Land Husbandry Act transformed the ancient forms of land tenure into private landholding systems. Black farmers – whose agricultural practices were blamed for soil erosion - were now required to acquire a 'farming permit' to carry out their farming activities. Additionally, Black people had to obtain a "grazing permit" for their animals. Further steps were implemented to limit the maximum number of livestock that each farmer could own.

Land degradation, however, continued as Africans continued to prefer agricultural-based livelihoods over waged employment in white-owned businesses. The Act was later suspended in 1961 much to the chagrin of white farmers who then ensured the 1962 election victory of Ian Smith's Rhodesia Front which promised them to revive the Act once it ascended power. Once in power, the Smith regime enacted the Tribal Trust Land Act of 1969 to cement the separation of land between whites and blacks. The Act resulted in the launch of Tribal Trust Lands where traditional leadership regained the power to administer land [11]. These tribal segregations worsened racial and political tensions centred on land and land-related nationalistic activities.

4.4 The Land Tenure Acts (1969-1980)

Several land policies were adopted and implemented since the ascendency of the Rhodesian Front to power. In 1969, the Land Tenure Act was adopted to replace the Land Apportionment Act of 1930. This legislation classified lands into three categories: European, African, and National lands. Under this Act, both settlers and Africans were allocated 45,000 acres of land apiece, while National land was limited to 6,500 acres [12]. The Act distributed land evenly to white and black individuals, despite the fact that whites made up only 5% of the population, while blacks accounted for a significant 95% [11]. The Land Tenure Act was superseded by the Land Tenure Amendment Act of 1977, which subsequently led to the implementation of the 1978 Land Tenure Repeal Act. For the most part, these policies were meant to disenfranchise blacks socially, economically, and politically to drive them into the labour market where the colonial state would use their labour for primitive capital accumulation.

The enactment of racial land policies pushed blacks to the mountainous and peripheral lands where agricultural activities were unsustainable in the absence of irrigation systems while whites continued to secure more land in Regions I and II [34]. According to Moyo [7] notes that these colonial policies adversely affected African agriculture which markedly began to plummet with the launch of the Reserves in 1920, and further depreciated with the adoption of the 1930 Land Apportionment Act which culminated in over-crowding and overstocking, thus leading to waning agricultural returns [12].

4.5 Lancaster Constitution

The independence of Zimbabwe came in 1980 through the liberation struggle and negotiations chaired by the British government. The negotiations reached their climax with the signing of the Lancaster House Agreement, followed by the first democratic elections on 18 April 1980. Nevertheless, a number of factors, such as the provisions in the Lancaster House Agreement that safeguarded white citizens, limited the government during the first ten years. The provisions stated that the government would not forcibly seize land and that any transfer of land would be based on voluntary agreements between buyers and sellers. According to Chapter 3, Section 16 of the Constitution, it is necessary for the entity acquiring

land to promptly provide sufficient compensation for the acquisition. Additionally, if the acquisition is disputed, they must seek confirmation from the General Division or another court within thirty days of the acquisition. Consequently, the state was prohibited from confiscating any properties for redistribution, despite the fact that it had inherited a land ownership structure that was influenced by racial bias (34). During this time, the majority of the valuable land was inhabited by a limited number of individuals and groups, including 6,000 white farmers, a small number of agro-industrial estates, approximately 8,000 small-scale black commercial producers, and over 700,000 peasant households. Meanwhile, the remaining population resided on unproductive ground. Between 1980 and 1985, the government successfully relocated 60,000 homes. From 1985 to 1990, they resettled a total of 10,000 households [11].

The deficits of the Lancaster Constitution for land decolonisation ensured land disputes. The ban on compulsory land purchase resulted in inflated land prices and allowed whites to sell most of their unproductive lands to the state. Of all the land acquired between 1980 and 1992, hardly 19% of it was of prime agricultural value [11]. The market-based approach to land acquisition largely benefited whites who kept holding on to land knowing that their lands would not be expropriated [36]. For the first 10 years, the government acquired land totalling three million hectares at market value with the assistance of British funds (British Overseas Development Agency (ODA), including the 1981 Land Resettlement Grant which expired in 1996.

In 1992, the government reviewed the property rights part of the Constitution. The government implemented the Land Acquisition Act, which allowed for the forcible acquisition of land for the sake of redistribution. The Act also authorised the government to acquire land for settlement, subject to a fair payment reached by a designated committee of six persons deploying a set of procedures that included the limit to farm sizes. The Land Tenure Commission was also launched in 1994 as a way of improving the efficiency of land reform processes [40]. Yet still, land reform progressed at a very dismal pace much to the insult of household livelihoods which continued to deteriorate. Furthermore, according to [34], the government obtained fewer than one million hectares of land and successfully relocated no more than 20,000 residents during the 1990s. By 1999, almost 11 million hectares of valuable agricultural land remained under the ownership of a few 4,500 commercial farmers, predominantly white, due to the sluggish progress of land reform [41].

The Zimbabwe African National Union-Patriotic Front (ZANU-PF)-led government's land reform move from vote lobbying to radical policy ideas was significantly impacted by the consequences of the Economic Structural Adjustments Programme (ESAP) and opposition political activity in the 1990s. As a result, the 1998 Donor's Conference on Land was held, which then led to the creation of the Inception Phase Framework Plan (1998-1999) for the Land Reform and Resettlement Programme 2. The lack of effective resolutions and the conference, together with other contributing factors, led to the implementation of the Fast-Track Land Reform Programme (FTLRP) in the 2000s. The program was designed to be implemented efficiently, using local resources, to address the task of redistributing over 3,000 farms under the small-sized (A1) and commercial (A2) farming types [42]. As of October 2001, the state had obtained approximately 1,948 farms for redistribution. However, the number of individuals in need of land had significantly increased to 104,000, surpassing the predicted figure of 25,000 from the previous year [41]. At the conclusion of the program, there were significant changes in land ownership patterns. The land ownership in the large-scale

commercial sector decreased from 30% to 12%, while the small-scale agricultural sector expanded from 54% to 71% [43]. By 2010, the A1 program has allocated the land to almost 150,000 individuals living in urban areas, farm workers, rural peasants, and civil servants. In addition, 20,000 grantees were assigned A2 farms [7].

The FTLRP was widely recognized as a highly successful initiative in terms of property redistribution. It successfully finished the process of decolonization that was previously unfinished, bringing it into the sphere of economic liberation and achieving the much-awaited redistribution of justice. However, the claim made by what [44] refers to as the 'disaster school' was in disagreement with this. This perspective arises from the international community, particularly the influential countries in Europe and North America, who argue that the land reform has resulted in economic turmoil, leading to issues such as food insecurity, unemployment, environmental degradation, international boycotts, reduced agricultural output, and declining living standards. The school neglected to consider the economic embargo imposed on Zimbabwe as a result of the FTLRP. The sanctions imposed by the European Union on Zimbabwe involved halting financial assistance for all projects save those directly benefiting the public, as well as suspending fiscal support. Furthermore, government officials were subjected to a visa block, which prohibits them from traveling within the European Union. Additionally, the assets possessed by these officials abroad were frozen. The imposition of sanctions led to a decline in global trade, resulting in a lack of foreign money. This shortfall severely limited the ability to buy fuel, leading to the collapse of manufacturing and farming sectors. Zimbabwe Electricity Supply Authority (ZESA) stated on July 30, 2002, that the discontinuation of financial assistance from the World Bank, the International Monetary Fund, the European Investment Bank, and other organizations led to a loss of $18 million [34]. As a result of limited international trade and the cessation of credit, the unemployment rate in Zimbabwe sharply rose to 70% in about 2002, while during the same year, 75% of the population was categorized as impoverished [34].

The land reform itself also contributed to the negative economic impact. The land transfers between 2000 and 2003 had a significant impact on commercial districts, resulting in a decline in production ranging from 7% to 30% [34]. The rapid pace of the Faster-Than-Light Resource Production (FTLRP) led to the displacement of previous producers. At the conclusion of 2001, some 250 farmers, which accounted for around 7% of the total number of farmers in the Commercial Farmers Union, had voluntarily left their farms during the preceding year [45]. The replacement farmers also encountered substantial output deficits and encountered obstacles in terms of accessing resources, such as a lack of tillage and harvesting machines, limitations in energy supplies (including coal, fuel, and electricity), and financial constraints. The production levels also decreased as a result of the new farmers' low technical capabilities in terms of skills (for tobacco, wheat, oilseeds) and insufficient resources (finance and irrigation resources). The production of wheat, tobacco, soya beans, and sunflower was significantly and directly impacted by the land transfers. However, plantation crops such as sugar cane, tea, and coffee, as well as certain major export horticultural crops like flowers, paprika, and some vegetables, experienced only minor declines of less than 15%. This can be attributed to their profitability, the resources they retained, and the limited land transfers that occurred on these estates [46]. The profitability and availability of inputs for most crops also experienced a general decrease as a result of the uncertain macroeconomic conditions and associated supply shortages. The production of key crops such as maize, wheat, and tobacco was adversely impacted by the scarcity and

rising expenses of inputs, as well as the lack of foreign currency to import these inputs. Groundnuts, primarily cultivated by small-scale farmers, were impacted by agricultural policies that decreased the profitability of farming.

In 2016, Zimbabwe implemented the Command Agriculture (CA) program, which is a government-led initiative designed to support farmers who grow cereals for local consumption. The program provides farmers with resources and a guaranteed market for their products. The facility placed a higher importance on ensuring the security, tenure, and livelihood rights of farmers and the state, rather than prioritizing the interests of neoliberal capital. This was done to prevent poor farmers from being enticed by joint ventures and contract farming arrangements. Zimbabwe had a significant surge of 321% in maize production during the 2016/2017 season, thanks to the CA facility. In Mashonaland West, the average maize production per family was 739.2 kg, whereas in Matabeleland South, it was only 174.5 kg. This has been verified as the initial significant maize production since the beginning of the Fast Track Land Reform Program (FTLRP) [47].

In post-Robert Mugabe Zimbabwe, the land reform policy formulation trajectory is, however, no longer clear as neoliberalism recuperates under the 'Zimbabwe is open for business' development approach. Since assuming office in 2017, the Emmerson Mnangagwa government has implemented or announced policies that impact land access, ownership, and utilization. The new government follows a neoliberal approach in which land access is governed by commercial principles [3]. The Agriculture and Food Systems Strategy aims to revolutionize the agricultural sector by prioritizing the commercialization of farming [48]. In order to promote production in all sectors, the government implements supply-side policies that are favorable to investors and promote sustainability [45]. Specifically, the regime encourages foreign investors to freely operate in the agricultural sector by utilizing contract farming arrangements [46]. The government has implemented measures to reduce the expenses associated with conducting business, such as trade and labor restrictions [45]. The Indigenisation and Economic Empowerment Act, which previously limited foreign investors to owning a maximum of 49% of enterprises in various sectors, has been abolished, with the exception of diamond and platinum mining [47]. Monopoly-finance capital has been drawn to the countryside, displacing rural households on the pretext of investments [48]. The new government has expressed a lack of interest in the development or upkeep of current agriculture policies. Instead, they have made it clear that their focus is on pursuing investment opportunities that will lead to self-sufficiency and an abundance of food. Their goal is for Zimbabwe to once again become a significant contributor to agricultural production and regional food security in Southern Africa and beyond.

5. Towards a Social Policy-based Land Reform Trajectory

SA and Zimbabwe have different demographic compositions that differently impact their land reform trajectories. For instance, in Zimbabwe, out of the 17,020,321 population, about 70% of the population resident in rural areas where they engage in agricultural activities [49]. In SA, out of the population of 61,020,221, only 30.5% live in rural areas [50]. However, being both former white-settler colonies, the two countries face similar land reform issues that can be addressed by implementing an inclusive land reform approach. One such approach is the transformative social policy. This approach offers a wide-ranging analysis that transcends economic focus but also considers crucial aspects such as production, reproduction, and social protection.

Transformative social policy involves public actions designed to ignite social protection and development by the state [51]. It includes "joint actions that directly impact changes in social well-being, social institutions, and social connections... as well as access to sufficient and stable means of living and income" [52]. It is also a tool for guaranteeing a feeling of belonging to a community and a necessary condition for long-term economic progress.[51]. Social policy consists of five tasks: production, protection, reproduction, and redistribution [53,54], as well as social cohesion or nation-building [55]. The transformative social policy commitment of the state is reflected in its implementation projects to help the most vulnerable and by ratifying by-laws, rules, and regulations that protect these people.

Being largely pro-poor, the transformative social policy approach resonates with land reform policy development particularly since agricultural land is required most by vulnerable categories who use it as a source of livelihood but also elites who use it as an income source [56]. Using this development approach could enable SA and Zimbabwe to implement land reform policies that can enable their populace to participate in farming and thus contribute to the broader economy. In applying the social policy approach, the two governments can focus on production, social protection, social reproduction, social cohesion, and redistribution tasks of the transformative social policy.

5.1 Production

Targeted interventions are needed to promote broad-based agricultural production, particularly in Zimbabwe where 70% already engage in farming. In SA, the government can focus on the emerging black middle class that is showing increasing interest in farming [56,57]. The aim should be to release land to indigenous people particularly those who can demonstrate capacity to utilise it productively. With most indigenous people being resource-poor, governments should invest in financial, educational, and infrastructural provision that supports maximum productivity. Many indigenous farmers possess traditional farming expertise [34]. This might not be adequate in the context of contemporary changing environmental conditions. Thus, farmers may need training but also resources such as new crop and animal varieties that can thrive in contemporary conditions. Such measures should be integrated into countries' overall land and agrarian reform programmes. Such measures could assist in sustaining agricultural production and, thus, justify land reform.

5.2 Social protection

Social protection is a vital necessity for indigenous residents in countries that have just transitioned from a century of white-settler colonialism. Social protection is a fundamental aspect of transformative social policy. To ensure social protection, land reform must go beyond its economic focus and consider social interactions and institutions [58]. To address the repercussions of flawed land reform policies, it is necessary to go beyond the implementation of social assistance programs and also incorporate social security elements like healthcare, sanitation, and education [59]. Infrastructure, including transportation networks, healthcare and educational facilities, marketplaces, and water supplies, plays a crucial role in improving the lives of individuals who depend on agricultural operations for their livelihoods and incomes. Without enough social support, individuals who have received land through land reform programs choose to leave their farms and instead participate in off-farm activities as a means of dealing with challenges [60]. The departure from agricultural areas reduces food production, leading to congestion in other locations and creating favorable conditions for the spread of diseases and conflicts. It is essential for governments,

at both the local and national levels, to collaborate and physically provide social infrastructure and services in areas that have undergone land reform. This is a crucial step in achieving transformative outcomes through land reform.

5.3 Social Reproduction

The transformative social policy framework can also be used to achieve social reproduction by households engaging in agricultural activities. Social reproduction refers to practices by which population classes in an unequal society tend to maintain their status from one generation to another [61]. To ensure the social reproduction of land reform beneficiaries, governments (at local and national levels) could focus on the provision of facilities such as irrigation systems and agricultural inputs so that farming can thrive. Financial inclusion is also another strategy that can be used to achieve social reproduction under land reform conditions. Financial inclusion should encompass not only providing inexpensive financial services to the impoverished, but also extending financial support to farmers to enable them to finance their production activities and maintain productivity [62]. This will enable sustained and sustainable social reproduction under land reform conditions.

5.4 Social cohesion

Land reform is a crucial component of the decolonization agenda in South Africa and Zimbabwe. Consequently, land reform is expected to guarantee social unity. Therefore, for the black community, land reform encompasses more than only the elements of production and protection. It also aims to revitalize and strengthen social cohesiveness and cooperation. Social cohesion is an integral part of the transformative social policy framework. According to [63], multi-faceted refers to various aspects of a concept. They describe it as the degree to which individuals cooperate with each other, both inside and across different groups, without any form of compulsion or simply self-interested motive. Social protection, within the context of land reform, refers to the ability of beneficiaries to develop a collective identity and a feeling of inclusion. Social cohesiveness and cooperation, manifested through networks (both political and communal), cultural norms (such as the establishment of cooperatives), and other social characteristics, play a crucial role in facilitating the sharing of knowledge, exchanging of experiences, and fostering cooperation. The networks and cooperatives of farmers play a crucial role in enhancing the likelihood of achieving high levels of productivity.

5.5 Redistribution

Land redistribution is a transformative social policy aspect that underpins the land reform programme [39]. In SA and Zimbabwe, this is being achieved through government-initiated land redistribution to blacks from whom it was expropriated by white-settler colonialism. With agriculture as the main source of livelihood and income particularly in Zimbabwe [1,3], land redistribution, wields much potential as a transformative social policy tool. Land redistribution allows the majority of people, particularly those whom the form sector cannot absorb, to participate in the broader economy through agriculture and other related activities.

6. Conclusion

This article identified land reform policy evolution in two former white-settler colonies, namely, SA and Zimbabwe, and then explored the implications of land reform policy on socio-economic and political development. Underpinned by a qualitative secondary

literature review, the article discusses the major land reform policies of the two countries since the advent of colonialism to the present. It then demonstrates how racial policies during colonialism served to disenfranchise blacks socio-economic and politically. The article argues that the continuous displacements of blacks following particular colonial land reform policies were meant to suppress their collective voice for freedom: financially and politically. In the post-independence period, land reform is meant to reverse the racism of white-settler colonialism. The article, however, takes issues with encroaching tendencies of neoliberalism under the land reforms of the two countries. In South Africa, the 'willing buyer-willing seller' approach is criticised while in Zimbabwe, the 'Zimbabwe is open for business' approach is portrayed as regressive. The article then proposes the transformative social policy as having much potential to influence efficient and effective land reform policy in the two countries.

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THE NEXUS BETWEEN THE ABSENCE OF A SOCIAL COMPACT, SOCIETAL POLARIZATION AND ITS IMPACT ON SERVICE DELIVERY IN SOUTH AFRICAN LOCAL GOVERNMENT

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Abstract: South Africa, a nation marked by profound disparities, is deeply entrenched in the painful historical legacies of its past. The discourse on socio-economic transformation has been ongoing since the African National Congress (ANC) came into power in 1994, aiming to foster a social compact and reconcile the polarized society. Despite these efforts, black communities continue to face discrimination in service delivery. Daily reports of protests in impoverished, predominantly black communities emphasize the absence of a social compact in South Africa. This paper, primarily conceptual in nature and relying on secondary data, seeks to explore the nexus between the absence of a social compact, societal polarization, and its impact on service delivery in South African local government. It contends that addressing issues of poor service delivery, public protests and anti-government sentiment must start with acknowledging the absence of a social compact. This recognition should serve as the foundation for pursuing new paradigms for effective development and good governance practices at the local government level. The findings of this study suggest that the absence of a social compact is not only a result of human actions but also reflects structural issues. This absence exacerbates societal divisions, erodes trust in governance structures and hampers collaborative efforts crucial for effective service provision. Furthermore, societal polarization compounds challenges related to resource allocation and perpetuates disparities in service access, particularly impacting marginalized communities. In conclusion, the paper proposes policy recommendations aimed at fostering social cohesion, addressing structural inequalities, and promoting inclusive governance practices.

Keywords: *social compact, societal polarization, service delivery, local government, South Africa.*

Rezumat. Africa de Sud, o națiune marcată de disparități profunde, este profund înrădăcinată în moștenirile istorice dureroase ale trecutului său. Discursul asupra transformării socio-economice este în desfășurare de la intrarea la putere a Congresului Național African (ANC) în 1994, cu scopul de a promova un pact social și de a reconcilia societatea polarizată. În ciuda acestor eforturi, comunitățile negre continuă să se confrunte cu discriminare în

furnizarea de servicii. Rapoartele zilnice despre proteste în comunitățile sărace, predominant negre, subliniază absența unui pact social în Africa de Sud. Această lucrare, în primul rând de natură conceptuală și bazându-se pe date secundare, încearcă să exploreze legătura dintre absența unui pact social, polarizarea societală și impactul acesteia asupra furnizării de servicii în administrația locală din Africa de Sud. Acesta susține că abordarea problemelor legate de furnizarea de servicii slabe, protestele publice și sentimentul antiguvernamental trebuie să înceapă cu recunoașterea absenței unui pact social. Această recunoaștere ar trebui să servească drept fundație pentru urmărirea unor noi paradigme pentru o dezvoltare eficientă și bune practici de guvernare la nivel de administrație locală. Concluziile acestui studiu sugerează că absența unui pact social nu este doar rezultatul acțiunilor umane, ci reflectă și probleme structurale. Această absență exacerbează diviziunile societale, erodează încrederea în structurile de guvernare și împiedică eforturile de colaborare esențiale pentru furnizarea eficientă a serviciilor. În plus, polarizarea societală agravează provocările legate de alocarea resurselor și perpetuează disparitățile în ceea ce privește accesul la servicii, afectând în special comunitățile marginalizate. În concluzie, lucrarea propune recomandări de politici care vizează promovarea coeziunii sociale, abordarea inegalităților structurale și promovarea practicilor de guvernanță incluzivă.

Cuvinte cheie: *compact social, polarizare societală, furnizare de servicii, administrație locală, Africa de Sud.*

1. Introduction

The landscape of contemporary South African society reflects a complex legacy inherited from its apartheid era. With the advent of democracy, the crafting of a new Constitution sparked hope of dismantling entrenched inequalities. Post-transition, considerable efforts by the state and various social partners have been directed toward realizing the foundational principles of human dignity, non-racialism, non-sexism, universal adult suffrage and national prosperity [1]. To build a nation with a unified national identity, the citizens must embrace inclusivity, regardless of cultural, racial, or social background [2]. Even though many South Africans struggle to climb up the economic ladder, the potential for inclusive prosperity remains a crucial aspect. Such ambitions are documented in the National Development Plan (NDP) Vision 2030 and the Constitution of the Republic of South Africa, 1996, with the hope of reaching the Sustainable Development Goals (SDGs). Despite these aspirations, three decades into democracy, the nation still grapples with the absence of a cohesive social compact, essential for fostering good governance and social cohesion among its diverse populace. The National Economic Development and Labor Council (NEDLAC) mandates the involvement of various stakeholders, such as the government, labor unions, businesses, and communities, in tackling South Africa's socio-economic issues [3,4]. Internationally recognized as the "rainbow nation" [5], South Africa's reputation contrasts harshly with the stark reality faced by many of its citizens, where only a privileged few enjoy the nation's wealth. Despite increasing attention on social compacts and efforts to bridge societal divisions, historically marginalized communities continue to endure disparities in service delivery. In response to these challenges, the District Development Model has been introduced as a catalyst to expedite service delivery and address backlogs [6].

The trajectory of inequality is influenced by both benign and malign forces, with apartheid's legacy relegating black South Africans to disadvantaged positions [7]. Service delivery discrepancies across municipal jurisdictions further exacerbate these disparities [8].

Societal polarization persists in South Africa, hindering progress toward social cohesion. Meanwhile, economic sectors remain predominantly segregated, with whites dominating agriculture, trade, business, transport and logistics, medical services, media and Indians prominent in hardware businesses, often leading to disjointed cooperation among racial groups. The pursuit of a social compact thus emerges as a pivotal mission for enhancing global competitiveness and economic viability. The NDP 2030 underscores the importance of social compacts to address entrenched socio-historical divisions, including exclusion, poverty, and limited opportunities. President Cyril Ramaphosa has championed this cause, envisioning a comprehensive social compact involving all stakeholders to rebuild the economy and foster higher growth [9]. However, criticisms from former President Thabo Mbeki highlight challenges in meeting these aspirations within designated timeframes.

2. Literature Review

2.1. Social Compact and Governance

The relationship between a social compact and governance is interlinked and reliant on each other, unable to operate effectively in isolation [10]. The concept of a social compact implies a tacit agreement between the government and citizens about their roles and responsibilities in shaping society [11]. Governance is the structure that determines how a group is supervised and operates, including the strategies employed to uphold responsibility for the entity and its stakeholders [12]. The social compact defines the duties and obligations of various participants in society, specifying the anticipated contributions of government, civilians, non-governmental organizations, and businesses in advancing public welfare [13].

Social compact highlights the critical role of citizen engagement in governmental processes, advocating for their involvement in decision-making, holding authorities accountable and influencing the development of policies and programs [14]. Thus, social compact will ensure governmental accountability by promoting transparency, responsiveness, and integrity in managing public resources and delivering services at the local government level, thereby fostering good governance [15]. In South Africa, the social compact seeks to promote social justice by addressing inequalities, prejudice, and marginalization while protecting the needs and rights of all members of society [16]. It reinforces a commitment to upholding and advancing human rights, including civil, political, economic, social, and cultural rights, as outlined in national constitutions and international agreements [17].

The goal of the social compact and effective governance is to support economic progress and fairness by encouraging inclusive growth, creating jobs, reducing poverty and promoting sustainable development, all while addressing the underlying issues of poverty and inequality. The social compact emphasizes the significance of maintaining the rule of law, advocating for transparency, accountability, and effectiveness in governance procedures, and addressing corruption and impunity [18]. It encourages unity among various societal groups, fostering feelings of belonging, mutual esteem, and collaboration in governance [19]. Ethical leadership and the prudent management of public resources are essential components of the social compact, with government officials and leaders expected to exemplify high levels of integrity and professionalism to foster good governance [20]. The social compact incorporates strategies for conflict resolution and peacebuilding, promoting dialogue, reconciliation and social cohesion within diverse and fragmented communities [21]. It recognizes the evolving nature of societal needs and priorities, necessitating ongoing

evaluations, adaptations, and revisions of the governing agreement to maintain its relevance and effectiveness in addressing emerging governance challenges [18]. Consequently, the social compact within political leadership serves as a foundation for building consensus, encouraging collaboration, and advancing shared goals and values to develop a just, diverse, and progressive community through good governance [13].

2.2. Challenges and Consequences of Fractured Social Compact in South African Local Government

There is a widespread belief that local government does not have appetite to meet citizen's needs. This sentiment is particularly evident in the rural areas of South Africa, where persistent poverty and sluggish service delivery continue to afflict communities. Within the marginalized populations, individuals grappling with poverty and vulnerability encounter a myriad of challenges, necessitating a comprehensive and multidimensional approach to intervention [22]. The dearth of a cohesive social compact, characterized by a failure to foster consensus and collaboration among diverse societal stakeholders, exacerbates the existing societal polarization along political, ethnic, and socio-economic fault lines. This deficiency has profound ramifications for the efficacy of service delivery mechanisms within South African local governance structures. In a nation beleaguered by a plethora of issues, socio-economic inequality stands out prominently as a persistent challenge. It is undoubtedly true that service delivery protests can turn violent and, to some extent, lead to regime instability.

A poignant example of this dynamic can be observed in the unrest that unfolded in Phoenix, in Durban, where 38 fatalities resulted from clashes between members of the Black and Indian communities, rooted in the erosion of social cohesion [23, 24]. These incidents, alongside numerous other troubling occurrences in South Africa, underscore the imperative for fostering social diversity. However, a critical inquiry emerges regarding the extent to which societal unity is perceived as a collective responsibility or solely as the concern of the marginalized groups striving for equitable societal structures. The report on the July 2021 unrest by the South African Human Right Commission (SAHRC) underscores the prevalence of racial animosity as a catalyst for discord. The absence of a social compact further compound's societal polarization, reflecting a deficit in shared values, commitments, and mutual support and trust among governmental bodies, private enterprises, and civil society.

2.3. Service Delivery in South African Local Government

Understanding the concept and components of service delivery is crucial, as it is considered a key challenge in South Africa [25, 26]. Local government is tasked with providing vital services like water, sanitation, waste management, and roads by the constitution of South Africa [27, 28]. South African local government define public service delivery as sharing of basic resources and human needs to inhabitants [29]. Public service delivery includes guaranteeing that services are accessible to all South African citizens, particularly those in disadvantaged regions with a history of marginalization [28]. Providing efficient services involves engaging with the community in a meaningful way [30]. This occurs when local authorities engage citizens in decision-making, collect input on service delivery, and attend to the distinct requirements and interests of various populations. Service delivery is a concept that involves a contractual relationship between the government agency and the general public, where the agency is required to provide the service in the best possible way [31]. This is to make sure that services are provided to local residents in a timely, long-lasting, and impactful manner, treating them with the utmost respect and care. Service delivery functions

as a method to guarantee that local government remains open about their actions and responsible to the public [32]. This happens when local communities participate in meetings that discuss service delivery reports, including budgets, expenditures, performance indicators, and addressing citizen complaints and grievances.

Service delivery serves as a mechanism to dismantle the spatial planning remnants of the apartheid era in South Africa, which have resulted in significant disparities in service accessibility between urban and rural areas, and among various racial and socio-economic groups [33]. Consequently, local governments prioritize addressing these disparities through targeted interventions and inclusive development strategies.

Furthermore, public service delivery in South Africa aims to address unemployment and alleviate poverty [34]. This is achieved by employing local community members in projects, thus providing various income opportunities that help reduce poverty. Although these job opportunities are often temporary, they impart valuable skills and knowledge. Service delivery involves a government entity fulfilling its promises by providing goods and services to the community [35].

This is crucial as local governments are elected to represent and address the concerns and needs of their communities, thereby preventing unrest and dissatisfaction that can arise from unmet needs or unequal resource distribution. Additionally, service delivery in South Africa's local government enhances monitoring and evaluation [36].This improvement occurs when the general public and local governments continuously monitor progress, address obstacles, and gather feedback from stakeholders, thus promoting accountability, transparency and efficiency in service delivery processes.

2.4. Societal Polarization and its Implications on Service Delivery

Societal polarization not only increases the likelihood of violence within communities [25], however, violent protests can also exacerbate societal polarization, dividing people along party lines [8]. The adversary of polarization is politics.As observed by [7], the USA is no exception to societal polarization; at the highest levels of government, entrenched political differences in the capital have impeded legislative agreements, weakened established norms of behavior, and encouraged politicians to pursue their goals through means other than stalled governmental bodies, such as the legal system.These divisions extend beyond those in power, as widespread polarization is causing Americans to segregate into distinct and opposing political groups. The dynamics and challenges that haunt the USA are inextricably linked to the South African context in terms of societal division due political differences.

The rise of an "us versus them" mentality and the entrenchment of political identities in American socio-political life are evident in various aspects, from the growth of highly polarized media to the decreasing openness of Americans to marrying someone from a different political party [7]. Americans are becoming increasingly divided based on political party and ideology, even within their own neighborhoods [36].

These conundrums are also prevalent in South Africa. At times, services are rendered subjectively due to spouses engaged in different political parties.

This separation increases the likelihood of vilifying one another, ultimately leading to instabilities in service delivery. When individuals lack unity and cohesion, disagreements over certain services are more likely. Such disagreements hinder the effective provision of services, resulting in delays and inefficiencies in service delivery.

2.5. Tribalism and Ethnicity are Sources of Societal Polarization

Polarization involves more than simply having a divergent view from your neighbor on specific matters [37]. It occurs when individuals choose not to live beside neighbors with different political beliefs or opt not to enroll their children in racially diverse schools [37]. Tribalism is a significant driving force behind societal polarization. In the context of South Africa, tribalism and ethnophobia are pervasive issues that fracture black African communities and are seen as tactics historically used by colonizers to maintain control through division and violence within black societies [38]. Ethnic prejudice and tribalism have led to self-hatred across different races in South Africa, with different groups striving for dominance and recognition [38]. Individuals sometimes engage in ideological competition, considering the beliefs and traditions of other groups as less important and unnecessary compared to their own. Tribalism also exists in the workplace, where black people, whites, Indians, and coloreds associate themselves along racial lines [39]. This issue is closely linked to the persistent problem of racism that continues to haunt the country. An ethnically divided society can compromise service delivery in certain instances, as specific ethnic and tribal groups may demand preferential services over others. This division and favoritism can lead to ineffective and unequal provision of services, exacerbating societal disparities.

2.6. Helping Each Other is Foreign in the Communities

Helping others is believed to be a method through which individuals form, sustain, and enhance their social relationships. Assisting others enhances social engagement, diverts attention from personal issues, and boosts self-worth and abilities. Physical well-being and helping others result in greater social inclusion, enabling individuals to lead more active lives. However, it is inevitable to have enemies in any community, implying that no one is without adversaries. Because of this, the spirit of jealousy can pervade the lives of certain individuals. Jealousy and enmity are factors that hinder social cohesion, as some individuals may rejoice in the suffering of others instead of offering help. Controversial as it may be, this phenomenon is prevalent in some communities. This attitude leads to people hating each other, ultimately contributing to societal polarization.

2.7. Deception is our Friend in Societal Polarization; Trust is our Foe

Trust does not pertain to any specific social or political group. Instead, it is a general attitude towards others, specifically towards the average person in society [40]. Learning from [41] the failure of trust erodes moral behavior of individuals. It is cumbersome nowadays to trust because of deception. Gorge Crabbe indicates that "*Deceivers are the most dangerous members of society; they trifle with the best affections of our nature and violate the most sacred obligations*". Moreover, "Secrets with girls, like loaded guns with boys, are never valued till they make a noise" [42]. Crabbe highlights the difficulty of trusting a person. The quotes by Crabbe center on societal polarization, because individuals have become so attached to deceiving one another and have normalized it.

3. Materials and Methods

This paper used a literature-cantered approach to assess the nexus between the absence of a social compact, societal polarization and its implications on service delivery. This approach has been used to assess the possibilities and difficulties involved in the study concerning societal polarization. This approach was the foundational principle of the paper. Therefore, philosophers employed it long ago [43]. This kind of approach is qualitative

research that centers on the perspectives and viewpoints of various scholars, both subjective and objective. Nevertheless, this approach enabled the researchers to deeply engage with the current literature, pinpointing the deficiencies and shortcomings of the literature. Therefore, these voids were filled by pointing out that a lack of social compact, and societal polarization lead to ineffective provision of basic services.

3.1. Data collection

Because of the type of research being conducted, information was gathered using a desktop computer. Desktop research is another method for gathering data by reviewing existing literature. Therefore, information was gathered by reviewing journals, books, and reports to analyze and evaluate the topic being studied. This allowed the researchers to assess, examine, and debate various perspectives of scholars in order to accomplish the paper's objective.

3.2. Data analysis

Analyzing documents is a crucial aspect of conducting social research. Researchers analyze documentation in qualitative research to provide insights and interpretations on evaluation matters. Document analysis serves different academic needs. Document analysis is an effective way to gather data because documents are manageable and valuable resources. Using documents can assist in situating one's research within their specific subject or field by offering background information and thorough data coverage [43]. This analysis was utilized in this paper to clarify and explain the themes discussed in the paper. Furthermore, this enabled the researchers to delve deeper into the concepts, grasp perceptions, and clarify qualitative results.

4. Results and Discussion

The study emphasizes the critical need for policy interventions to address the absence of a social compact, societal polarization, and their implications on service delivery in South African local government. The recommendations proposed in this paper are rooted in the understanding that the challenges facing South Africa today are complex. The absence of a social compact has contributed to ongoing societal polarization, which in turn undermines efforts towards effective service delivery and socio-economic development. One of the key recommendations is to actively promote social cohesion through inclusive policies that bridge societal divides. Fostering social cohesion is seen as a fundamental step towards building a more unified and inclusive society. This can be achieved through community dialogues, cultural exchange programs and initiatives that encourage mutual understanding and cooperation among diverse communities. By promoting understanding and cooperation among different racial, ethnic and socio-economic groups, the government can reduce tensions and build a foundation for collaboration in addressing shared challenges. Addressing structural inequalities is crucial for achieving sustainable development. Decades of apartheid-era policies have left a legacy of inequalities that continue to impact access to services and opportunities for many South Africans, black people in particular. Targeted interventions are needed to ensure that historically disadvantaged communities receive the support they need to thrive. To address these, policies should focus on redistributing resources more equitably, particularly in historically marginalized communities. This may include targeted investment in infrastructure, education, healthcare, and job creation programs that benefit disadvantaged groups. Additionally, reforms in land and housing

policies are crucial to address historical injustices and promote economic empowerment among marginalized communities. Promoting inclusive governance practices is essential for building trust between citizens and government institutions. By enhancing transparency, accountability, and responsiveness, local governments can improve service delivery and ensure that resources are allocated fairly and effectively.

5. Conclusion

This paper strongly aligns with the Congolese proverb that says, "*A single bracelet does not jingle*," suggesting that unity is power. The paper holds a positive perspective that when people are united, they can eventually overcome all the scourges faced by the country. The South African government should lay the groundwork for new paradigms in development and governance that prioritize equity and effective service delivery for all South Africans. By addressing the underlying causes of poor service delivery and societal polarization, there should be establishment of local and practical policies that aim to address the current and continuous challenges. Policies that are flexible are intended to contribute to sustainable socio-economic transformation in the country. In conclusion, the paper proposes that research on the social compact in South Africa is essentially and should be conducted annually to fully understand the hindrances thereof. Furthermore, the findings of the research study will assist in providing guidelines for the development of several policies that are necessary to be structured and for the review of existing policies to ensure that they are aimed at fostering social cohesion, addressing structural inequalities, and promoting inclusive governance practices at the local government level. These recommendations are intended to guide policymakers and stakeholders in South Africa towards a more equitable and inclusive future. By prioritizing social cohesion, addressing structural inequalities and promoting inclusive governance practices, the country can move closer towards achieving sustainable socio-economic transformation and ensuring a better quality of life for all its citizens.

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MODELS FOR REAL-TIME TRAFFIC FLOW MANAGEABILITY AND DECISION-MAKING IN INTELLIGENT TRANSPORTATION SYSTEMS

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Abstract. This article explores models in Intelligent Transportation Systems for real-time traffic flow manageability, focusing on decision-making processes. It covers forecasting, planning, implementing, and controlling strategies to manage traffic flow and ease congestion. Traffic flow prediction models, like dynamic route guidance and traffic flow prediction, utilize historical data and real-time inputs for proactive decision-making. Traffic flow planning models, such as dynamic route guidance index and route efficiency factor, aid in route selection and signal timing optimization. In order to streamline the boundless complexity, the authors assume that it is effective to delineate the managerial capacity paradigm of intelligent transportation systems into the two separate scenarios of "stable and known situation" and "unstable and with large uncertainty situation". The article proposes a hypothesis to improve the decision-making process in traffic flow. The distinction between these two situations is essential for the smooth running of the business and requires a thorough understanding of the traffic flow in real time, making decisions in intelligent transport systems in order to direct the traffic. The article focuses on data-driven decisions for smoother traffic flow.

Keywords: *road movement, live choice determination, smart transportation networks, enhancing efficiency, instantaneous data, unpredictability.*

Rezumat. Articolul explorează modele în sistemele inteligente de transport pentru gestionarea fluxului de trafic în timp real, concentrându-se pe procesele de luare a deciziilor. Sunt analizate strategiile de prognoză, planificare, implementare și control pentru a optimiza fluxul de trafic și a reduce congestionarea. Modelele de predicție a fluxului de trafic, cum ar fi ghidarea dinamică a rutei și predicția fluxului de trafic, utilizează date istorice și intrări în timp real pentru luarea deciziilor proactive. Modelele de planificare a fluxului de trafic, cum ar fi indicele dinamic de ghidare a rutei și factorul de eficiență a rutei, ajută la selectarea rutei și la optimizarea sincronizării semnalului. Pentru a eficientiza complexitatea infinită, autorii presupun că este rațională delimitarea paradigmei capacității manageriale a sistemelor de transport inteligente în cele două scenarii separate "situație stabilă și

cunoscută" și "situație instabilă și cu incertitudine mare". Articolul propune o ipoteză pentru îmbunătățirea procesului decizional în fluxul de trafic. Distincția dintre cele două circumstanțe este esențială pentru raționalizarea traficului și solicită o comprehensiune profundă a fluxului de trafic în timp real, precum și luarea deciziilor în sistemele de transport inteligente în vederea dirijării traficului, decizii bazate pe date pentru un flux mai fluid al traficului.

Cuvinte-cheie: *circulație rutieră, determinarea alegerii momentane, rețele inteligente de transport, creșterea eficienței, date instantanee, imprevizibilitate.*

...the critical scarce factor in decision-making
is not information but attention.
What we attend to, by plan or by chance,
is a major determinant of our decisions [1].

1. Introduction

In this paper, we explore manageability within the context of real-time traffic flow control, with a focus on decision-making procedures. It acts as an extension of our prior articles [2-4].

The adoption of smart transportation technologies has transformed how urban traffic is managed, offering dynamic solutions to alleviate congestion, enhance safety, and optimize resource utilization. A key aspect of ITS success lies in its capability to oversee traffic flow instantly and make knowledgeable choices by considering changing environmental factors and user needs. However, the complexity of modern transportation networks poses significant challenges to achieving seamless manageability and decision-making. In response, this study endeavors to develop prediction and decision-making models that address these challenges and contribute to the evolution of ITS.

To formulate models for managing real-time traffic flow and decision-making in intelligent transportation systems, authors categorize situations into two groups: “situations are stable and known” and “unstable and with large uncertainty situations”.

In this current paper, we will incorporate several expressions from our preceding article: "knowledge in decision making process", "stable and known situation", “unknown in decision making process”, "unstable and with large uncertainty situation" [1, pp. 84-85].

Applied to real-time traffic flow manageability and decision-making in intelligent transportation systems, the authors will consider the following definitions in this article: "knowledge in decision-making procedure" denotes the level of compliance with the actual circumstances, validated by evidence (verified through repeatable trials, observation, and quantification) and logical justifications, aiding in the attainment of planner’s objectives (rational management of traffic flow). "Unknown in decision making process" pertains to the forthcoming unforeseeable hazard associated with achieving the planner's aim, which may or may not materialize, yet is exceedingly challenging to foresee in advance. “Decision making” can be viewed (figuratively) as a place to anticipate, experiment, and devise fresh understanding during the planning phase and make decisions regarding the line of reasoning and action with the intention to control the traffic flow. "Stable and known situation " signifies a foreseeable future condition, where the planner is cognizant of all impending occurrences, the complete array of risks, the ramifications of all outcomes, and there exist methodologies for sound probability assessments and computations, all constituting a scenario characterized by epistemic assurance and understanding. "Unstable and with large

uncertainty situation" delineates an unforeseeable future condition, where the planner lacks knowledge regarding forthcoming events and there exists no means to gauge or compute the likelihood of such events. The content of the aforementioned definitions has been reformulated and adjusted for the current paper based on those in the previous article [1, pp. 84-85].

2. Materials and Methods

The objectives of the study are to identify the dichotomous scenarios influencing the efficacy of Intelligent Transportation Systems and to identify models for real-time traffic flow manageability and decision-making in Intelligent Transportation Systems.

In our investigation, we will utilize conventional components of manageability: forecasting, planning, organizing, implementation, controlling, decision-making. We devised operational tasks with a twofold strategy, in a segmented structure, integrating components that enhance oversight (via equations – from the angle of “knowledge in decision making process” and “stable and known situation") and aspects that hinder oversight (via descriptors – structure from the viewpoint of "unknown in decision making process" and "unstable and with large uncertainty situation"). Authors employ a streamlined method to outlined equations (most familiar and basic) considering the vast array of approaches, methods, protocols, and equations for each segmented component.

A.1 Manageability as prognostication endeavor in Intelligent Transportation Systems from the standpoint of “knowledge in decision making process” and “stable and known situation"

Forecasting plays a pivotal role in the management of real-time traffic flow within Intelligent Transportation Systems (ITS), particularly in scenarios characterized by stability and familiarity. By utilizing advanced forecasting models, ITS can predict upcoming traffic scenarios using past data, live sensor information, and environmental influences. This enables dynamic decision-making processes aimed at enhancing traffic flow manageability and optimizing resource allocation. In this section, we enter into forecasting methodologies tailored to scenarios where future events are stable and known, offering insights into dynamic route guidance, traffic signal optimization, and proactive resource allocation within the realm of ITS. Through the application of predictive formulas and optimization techniques, ITS can proactively address traffic challenges, ensuring efficient and safe mobility for all road users. Below are several of the frequently employed equations.

A.1.1 Traffic Flow Prediction Models

These models use historical traffic data, real-time sensor information, and weather data to predict future traffic condition.

A.1.1.1 Dynamic Route Guidance. Navigation systems can recommend alternative routes based on predicted congestion.

$$R_{opt} = argmin(R_i)\left[\sum\left(C_{ij} + T_{ij}\right)\right], \quad (1)$$

where:

R_{opt} is optimal route;
R_i - available routes;
C_{ij} - travel cost on route i;
T_{ij} - estimated travel time on route i.

A.1.1.2 Traffic Flow Prediction:

$$TF_{pred} = f(HD, CD, CC), \quad (2)$$

where:

TF_{pred} is predicted traffic flow;
HD - historical traffic data;
CD - current traffic conditions;
CC - external factors affecting traffic flow.

A.1.1.3 Congestion Prediction:

$$CP_{pred} = argmin(CP_i)\ [\sum (D_{ij})], \quad (3)$$

where:

CP_{pred} is predicted congestion level;
CP_i - potential route options;
D_{ij} - degree of congestion on route i.

A.1.2 Traffic Signal Optimization. Traffic lights can be adjusted in real-time to optimize traffic flow.

A.1.2.1 Traffic Signal Optimization

$$TS_{opt} = argmin(TS_i)\ [\sum (D_{ij}] \quad (4)$$

where:

TS_{opt} is optimized traffic signal timing;
TS_i - different signal timing options;
D_{ij} - delay experienced by vehicles at signal i.

A.1.2.2 Queue Length Prediction:

$$QL_{pred} = f(TV, SPD, AC) \quad (5)$$

where:

QL_{pred} is predicted queue length;
TV - traffic volume;
SPD - vehicle speed;
AC - arrival rate of vehicles at intersection.

A.1.2.3 Optimal Cycle Length Calculation:

$$CL_{opt} = argmin(CL_i)\ [\sum (T_{ij}] \quad (6)$$

where:

CL_{opt} is optimal cycle length;
CL_i - different cycle length options;
T_{ij} - total delay experienced by vehicles during cycle i.

These algorithms are essential for predicting traffic patterns and fine-tuning traffic signal timings within Intelligent Transportation Systems.

A.1.3 Proactive Resource Allocation. Emergency services can be pre-deployed to areas with a high likelihood of accidents based on traffic patterns.

A.1.3.1 Proactive Resource Allocation:

$$PRA = f(TV, TQ, TT, WT) \quad (7)$$

where:

PRA is proactive resource allocation;
TV - traffic volume;
TQ - traffic queue length;
TT - travel time;
WT - waiting time at border crossings.

A.1.3.2 Resource Utilization Optimization:

$$RUO = argmax(RU_i) \left[\sum (C_{ij}) \right] \quad (8)$$

where:

RUO is optimized resource utilization;
RU_i - different resource allocation options;
C_{ij} - cost associated with resource allocation option i.

A.1.3.3 Border Crossing Time Prediction:

$$BCT_{pred} = f(TV, TT, WT), \quad (9)$$

where:

BCT_{pred} is predicted border crossing time;
TV - traffic volume;
TT - travel time;
WT - waiting time at border crossings.

These formulas are instrumental in forecasting traffic flow and optimizing resource allocation in Intelligent Transportation Systems with a proactive approach based on “knowledge in decision making process” and “stable and known situation".

A.2 Manageability as prognostication endeavor in Intelligent Transportation Systems from the standpoint of "unknown in decision making process" and "unstable and with large uncertainty situation"

Traffic congestion plagues modern cities, and managing its ever-changing nature is a constant challenge. Intelligent Transportation Systems (ITS) offer a promising solution, but real-time decision-making requires robust forecasting techniques that can handle the inherent uncertainties. This paper delves into forecasting for ITS, specifically focusing on situations with limited information ("unknown in decision making") and highly dynamic traffic flow ("unstable and with large uncertainty"). We explore how forecasting models can be adapted to navigate these complexities and contribute to improved traffic flow manageability.

The work [5] discusses the utilization of Intelligent Transportation Systems (ITS) for predicting traffic flow and speed, as well as classifying different traffic situations. It highlights the importance of understanding traffic patterns and making informed decisions to manage traffic effectively. The paper aims to explore the state-of-the-art methods employed in ITS for traffic prediction and classification, indicating a focus on forecasting future traffic conditions. Additionally, it mentions examining preprocessing techniques and evaluation metrics, which are crucial aspects of forecasting accuracy and performance assessment.

The paper [6] focuses on the development of a short-term traffic flow prediction model using deep learning techniques, specifically the long short-term memory (LSTM) network. It highlights the limitations of traditional prediction methods in accurately forecasting short-term traffic flow due to the complexity of influencing factors. The work proposes a solution by leveraging LSTM networks and variational modal decomposition to address the modal aliasing problem. The experimental results indicate that the proposed method achieves good prediction accuracy for short-term traffic flow.

The research [7] primarily focuses on the development and implementation of a k-nearest neighbor (KNN) model for short-term traffic flow prediction. It outlines the establishment of a prediction system based on KNN in three main aspects: the historical database, search mechanism and algorithm parameters, and prediction plan. The preprocessing of original data and standardization of effective data are discussed to improve prediction accuracy. The research highlights the development of a short-term traffic prediction model using KNN nonparametric regression in the Matlab platform, utilizing traffic flow data from Shanghai urban expressway sections. The comparison of different KNN models and the analysis of prediction reliability are also mentioned.

The study [8] mainly focuses on the development and implementation of a novel model, Attention Based Spatio-Temporal Graph Convolutional Network considering External Factors (ABSTGCN-EF), for multi-step traffic flow prediction. It acknowledges the importance of accurate multi-step traffic flow prediction in improving traffic network operational efficiency within intelligent transportation systems. The study highlights the complexities of traffic flow data and existing prediction methods, mainly achieved through a combination of Graph Convolutional Network (GCN) and recurrent neural network. The proposed model aims to address the challenges of multi-step prediction errors accumulation and the need for multiple sampling sequences, considering the spatio-temporal correlation of traffic flow and external factors like daytime, weekdays, and traffic accidents. The experimental results on public datasets demonstrate the effectiveness of the proposed ABSTGCN-EF model, achieving higher prediction performance compared to state-of-the-art baselines.

Traffic flow prediction models (TFPMs), despite significant advancements, operate within an inherently unstable and highly uncertain environment. This section details various elements that are potentially unknown during forecasting and can significantly affect the manageability of an organization relying on such models. These elements contribute to the inherent limitations of current prediction capabilities.

Condensing cited references as well as our perspective on prediction, we compile a concise inventory of elements that might elude detection during forecasting and could diminish the controllability of an entity:

A.2.1 *Unforeseen Changes in Traffic Patterns*. Construction projects, road closures, or detours can significantly alter established traffic patterns. These events often occur with limited prior warning, hindering the ability of TFPMs to adapt their predictions.

A.2.2 *Unexpected Incidents*. Accidents, vehicle breakdowns, or other unforeseen events can create bottlenecks and disrupt traffic flow. The stochastic nature of these incidents makes them challenging to incorporate into models.

A.2.3 *Sudden Shifts in Weather Conditions*. Adverse weather conditions like rain, snow, or fog can significantly affect road conditions and driver behavior. The dynamic nature of weather patterns presents a significant challenge for TFPMs.

A.2.4 *Historical Data Inaccuracy*. The accuracy of TFPMs relies heavily on the quality of historical traffic data. Errors or inconsistencies in historical data can lead to flawed predictions and hinder the ability of organizations to proactively manage traffic flow.

A.2.5 *Unaccounted for Driver Behavior*. TFPMs often struggle to capture the nuances of human behavior. Variations in driver route preferences, risk tolerance, and adherence to traffic regulations can significantly impact traffic flow in ways that are difficult to model.

A.2.6 *Emergence of New Transportation Technologies*. The introduction of autonomous vehicles, ride-sharing services, or other novel transportation technologies can disrupt established traffic patterns and render existing TFPMs obsolete.

A.2.7 *Unpredictable Events*. Events like protests, sporting events, or large gatherings can cause temporary spikes in traffic volume or disruptions in flow patterns. The unpredictable nature of these events makes them challenging to account for in TFPMs.

A.2.8 *Urban Development and Infrastructure Changes*. Changes in urban infrastructure, such as new road construction or modifications to existing ones, can significantly alter traffic flow patterns. The dynamic nature of urban development necessitates continuous model updates to maintain accuracy.

A.2.9 *Limited or Unreliable Sensor Data*. The accuracy of Traffic Flow Prediction Models (TFPMs) typically depends on access to real-time traffic information from sensors installed in roadways. Nonetheless, sensor failures, communication issues, or inadequate sensor distribution can greatly reduce the precision of these predictions.

A.2.10 *External Factor Omissions*. TFPMs may not account for the influence of external factors such as road maintenance activities, special events, or planned outages. These omissions can lead to inaccurate predictions and hinder the ability of organizations to manage traffic efficiently.

In conclusion, TFPMs offer valuable insights for traffic management, but their effectiveness is significantly compromised in situations characterized by instability and high uncertainty. Recognizing and addressing the limitations of TFPMs is crucial for organizations to maintain a robust and adaptable approach to traffic management in an ever-evolving transportation landscape.

B.1 Manageability as planning at strategizing endeavor in Intelligent Transportation Systems from the viewpoint of "knowledge in decision making process" and "stable and known situation"

Numerous distinct equations can be employed to assist manageability of Intelligent Transportation Systems that might be beneficial to assess the planning of traffic flow.

B.1.1 Traffic Flow Planning Models in Intelligent Transportation Systems from the perspective of Planning

B.1.1.1 Dynamic Route Guidance Index (DRGI):

$$DRGI = \sum(Congestion_i / Distance_i) \tag{10}$$

where:

$DRGI$ is dynamic Route Guidance Index;
$Congestion_i$ - level of congestion on route i;
$Distance_i$ - distance of route i.

B.1.1.2 Route Efficiency Factor (REF):

$$REF = \sum(Travel\ time_i / Distance_i) \quad (11)$$

where:

REF is Route Efficiency Factor;
$Travel\ time_i$ - travel time on route i;
$Distance_i$ - distance of route i.

B.1.1.3 Optimal Route Selection Criteria:

$$ORSC = argmin(\sum(Travel_Time_i)) \quad (12)$$

where:

$ORSC$ is Optimal Route Selection Criteria;
$Travel_Time_i$ - travel time route i.

B.1.1.4 Dynamic Route Adjustment Algorithm:

$$DRAA = min(\sum(Congestion_i)) \quad (13)$$

where:

$DRAA$ is Dynamic Route Adjustment Algorithm;
$Congestion_i$ - level of congestion on route i.

B.1.1.5 Route Optimization Heuristic:

$$ROH = argmin(\sum(Cong_i * Dist_i)) \quad (14)$$

where:

ROH is Route Optimization Heuristic;
$Cong_i$ - level of congestion on route i;
$Dist_i$ - distance of route i.

These algorithms assist in the planning stage of Intelligent Transportation Systems by dynamically directing vehicles along the most efficient routes according to real-time traffic conditions. By taking into account elements like congestion levels, travel times, and distances, planners can optimize route choices and improve overall traffic flow efficiency.

B.1.2 Traffic Signal Optimization in Intelligent Transportation Systems from the perspective of Planning

B.1.2.1 Signal Cycle Length Adjustment:

$$SCLA = (ITT) / (AVD) \quad (15)$$

where:

$SCLA$ is Signal Cycle Length Adjustment;
ITT - the desired time for vehicles to traverse the intersection (Ideal Travel Time);
AVD - the average delay experienced by vehicles at the intersection (Average Vehicle Delay).

B.1.2.2 Green Time Allocation Ratio:

$$GTAR = (OGT) / (TSCL) \quad (16)$$

where:

$GTAR$ is Green Time Allocation Ratio;

OGT - the ideal duration of green signal for each phase (Optimal Green Time);
$TSCL$ - the total duration of the signal cycle (Total Signal Cycle Length).

B.1.2.3 Queue Length Estimation:

$$QLE = (Arrival\ Rate) * (Service\ Time), \tag{17}$$

where:

QLE is Queue Length Estimation;
$Arrival\ Rate$ - the rate at which vehicles arrive at the intersection;
$Service\ Time$ - the average time taken to service each vehicle.

B.1.2.4 Optimal Signal Phase Sequence:

$$OSPS = argmin(\sum(Queue\ Length_i * Delay_i)), \tag{18}$$

where:

$OSPS$ is Optimal Signal Phase Sequence;
$Queue\ Length_i$ - queue length for phase i;
$Delay_i$ - delay experienced by vehicles in phase i.

B.1.2.5 Saturation Flow Rate Calculation:

$$SFRC = (NL) * (SH) / (TG), \tag{19}$$

where:

$SFRC$ is Saturation Flow Rate Calculation;
NL - the number of lanes at the intersection;
SH - the minimum time gap between consecutive vehicles for maximum flow;
TG - the actual time gap observed between vehicles.

These formulas aid in the planning phase of Intelligent Transportation Systems by optimizing traffic signal timings to minimize delays, reduce queue lengths, and maximize traffic flow efficiency at intersections.

B.1.3 Proactive Resource Allocation in Intelligent Transportation Systems from the perspective of Planning

B. 1.3.1 Proactive Resource Allocation Formula:

$$PRA = \sum(Demand_i - Capacity_i), \tag{20}$$

where:

PRA is Proactive Resource Allocation;
$Demand_i$ - demand for transportation resources in region i;
$Capacity_i$ - capacity of transportation resources in region i.

B.1.3.2 Optimal Resource Utilization Index:

$$ORUI = \sum(\frac{Utilization_i}{Capacity_i}), \tag{21}$$

where:

$ORUI$ is Optimal Resource Utilization Index;
$Utilization_i$ - actual utilization of transportation resources in region i;
$Capacity_i$ - capacity of transportation resources in region i.

B.1.3.3 Efficiency Improvement Factor:

$$EIF = \sum(Productivity_i / Resource_i), \quad (22)$$

where:

EIF is Efficiency Improvement Factor;
$Productivity_i$ - productivity of transportation resources in region i;
$Resource_i$ - total resources available in region i.

B.1.3.4 Resource Allocation Efficiency Ratio:

$$RAER = \sum(\frac{RA_i}{TR_i}), \quad (23)$$

where:

$RAER$ is Resource Allocation Efficiency Ratio;
RA_i - allocation of resources in region i (Resource Allocation i);
TR_i - total resources available across all regions (Total Resources i).

B.1.3.5 Optimal Allocation Strategy:

$$OAS = argmax(\sum(Benefit_i)), \quad (24)$$

where:

OAS is Optimal Allocation Strategy;
$Benefit_i$ - benefit derived from resource allocation in region i.

These formulas assist in proactive resource allocation for Intelligent Transportation Systems, ensuring efficient utilization of transportation resources and enhancing overall system performance. By optimizing resource allocation based on demand, capacity, utilization, and productivity, planners can effectively manage traffic flow and improve the reliability and effectiveness of transportation systems.

B.2 Manageability as planning endeavor in Intelligent Transportation Systems from the viewpoint of "unknown in decision making process" and "unstable and with large uncertainty situation"

The investigation [9] describes research aimed at determining expectations regarding Intelligent Transport Systems (ITS) applications for the management of freight transport enterprises. The study involves surveying 164 freight transport companies in southern Poland to identify the most important features of ITS applications perceived by the respondents. Subsequently, these features are categorized into four areas of support for management processes: vehicle management support, infrastructure management support, policy support, and general management support. The analysis involves elaborating on the expectations of representatives from all 164 freight transport companies towards 36 different ITS applications within these areas of support. The investigation focuses on the planning phase of understanding expectations and requirements for implementing ITS applications in freight transport enterprises.

The scientific work [10] discusses the challenges and barriers associated with implementing efficient and effective intermodal freight transport networks, such as rising fuel prices, drivers' shortages, legal developments, and congestion. It also highlights the role of Intelligent Communication Systems (ICS) in overcoming these barriers by providing real-time visibility, tracking, and efficient data collection. The scientific work then introduces the "ITS Italy 2020" project, which aims to foster the diffusion of Intelligent Transport Systems

(ITS) and presents a prototype solution for managing and monitoring freight transport along an intermodal network. This prototype solution integrates various systems and actors involved in the process, thus contributing to the successful design and implementation of an intermodal transport system.

The scientific study [11] discusses the need for cooperative intelligent public transport systems (C-ITS) in Smart Cities and proposes a solution that integrates the perspectives of travelers, public administration, vehicle manufacturers, and transport operators. The proposed solution includes defining capabilities maturity levels of the mobility ecosystem and a functional architecture for a collaborative decision-making system to implement C-ITS in future Smart Cities. The study digs into planning aspects by emphasizing various elements to enhance awareness and understanding of the Capability Maturity Model (CMM) for stakeholders. It focuses on collaborative assessment and improvement of capabilities among public and private companies, government regulation, conduct, and control to establish stable and mature processes for C-ITS institutionalization. Additionally, it discusses defining a functional architecture for C-ITS in future Smart Cities to support collaborative decision-making for public transport implementation.

The study [12] analyse the need for a solid framework and specific norms to be followed by Intelligent Transport Systems (ITS) applications, which suggests a planning process for the development and implementation of these systems in the European Union. Additionally, it mentions the coordination efforts of Member States through the NAPCORE project to harmonize their National Access Points (NAPs), which involves strategic planning and coordination of activities. Overall, study focuses on outlining planned activities and strategies for the development and implementation of NAPs, indicating a planning-oriented approach.

The study [13] investigates the operational planning of an environmentally friendly urban logistics (UL) service that leverages passenger bus networks for freight deliveries within cities. This approach aims to reduce the number of combustion engine vehicles operating in urban centers, thereby improving air quality, noise levels, and traffic congestion. The service involves clients dropping off freight at designated bus hubs outside the city center. Buses then transport the freight to designated stops within the city center, where a last-mile operator (LMO) completes the final delivery to the destination address. To optimize the operational planning of this entire logistics process, encompassing freight request reception to final delivery, this research proposes five Integer Linear Programming (ILP) models, each addressing a specific operational objective. The proposed models consider the perspectives of both the bus network operator and the LMO, with some focusing on the robustness of plans against potential disruptions. Additionally, the analysis examines five practical operational planning scenarios where two objectives are optimized. The analysis further demonstrates how these scenarios can be solved using the proposed ILP models.

Certain elements during planning, as described in the investigation cited above, as well as those reflected by the authors of the current article, may be ambiguous and restrict the manageability of traffic flow in the Face of Uncertainty within Intelligent Transportation Systems (ITS).

Effective traffic management in ITS relies heavily on robust planning methodologies. However, the presence of unknown factors can significantly hinder the decision-making processes within these plans. Here, we explore the impact of "unknown" elements on three

key ITS applications: Dynamic Route Guidance Index (DRGI), Proactive Resource Allocation (PRA), and Traffic Signal Optimization.

B.2.1. Dynamic Route Guidance Index (DRGI)

DRGI aims to provide real-time route recommendations to drivers based on an assessment of current and predicted traffic conditions. However, the level of congestion on different routes can be significantly impacted by unforeseen events. These events can include:

B.2.1.1 Accidents. Unforeseen accidents can create bottlenecks and significantly increase travel times on specific routes. The unpredictable nature of accidents makes it challenging to integrate them into congestion forecasts used by DRGI.

B.2.1.2 Weather Events. Rapid shifts in weather, such as snowfall, fog, or rainfall, can greatly influence the state of the roads and how drivers behave. The unpredictable nature of weather patterns makes it difficult for DRGI to forecast traffic congestion accurately.

B.2.1.3 Infrastructure Disruptions. Unplanned road closures or maintenance activities can disrupt traffic flow and render DRGI recommendations inaccurate.

These "unknown" elements can lead to suboptimal route recommendations, potentially increasing travel times and driver frustration.

B.2.2 Proactive Resource Allocation in Intelligent Transportation Systems (PRA)

PRA aims to optimize the allocation of resources like buses, public bicycles, or ride-sharing services in anticipation of future demand. However, the demand for transportation resources in different regions can be influenced by several unknown factors:

B.2.2.1 Spontaneous Events. Unforeseen events like concerts, sporting events, or protests can create temporary spikes in demand for transportation in specific areas. The unpredictable nature of such events makes it difficult for PRA to accurately forecast demand.

B.2.2.2 Shifting Travel Patterns. Changes in commuting patterns due to holidays, school schedules, or special events can lead to unexpected fluctuations in demand. These variations are often difficult to predict and can lead to resource allocation inefficiencies.

*B.2.2.3 Emerging Transportation Modes***.** The introduction of new transportation options like autonomous vehicles or ride-hailing services can disrupt established travel patterns, making historical data used by PRA models less reliable.

The presence of these uncertainties can lead to inefficient resource allocation, potentially resulting in insufficient resources in high-demand areas and underutilization in others.

B.2.3. Traffic Signal Optimization in Intelligent Transportation Systems

Traffic signal optimization algorithms seek to modify signal timings in real-time according to current traffic conditions to enhance the movement of vehicles. However, determining the optimal green time for each phase of the signal cycle can be hampered by unknown factors such as:

B.2.3.1 Pedestrian Activity. Unpredictable pedestrian activity at crosswalks can disrupt traffic flow and render optimized signal timings ineffective. The stochastic nature of pedestrian behavior makes it challenging to integrate into signal optimization models.

B.2.3.2 Public Transportation Schedule Deviations. Deviations from public transportation schedules, such as bus delays, can create unexpected fluctuations in traffic flow at specific

intersections. These unpredictable variations can disrupt the effectiveness of optimized signal timings.

B.2.3.3 Sensor Malfunctions. Traffic signal optimization algorithms depend significantly on live data gathered from sensors installed in the roads. Sensor malfunctions or communication disruptions can lead to inaccurate data and suboptimal signal timing decisions.

These "unknown" elements can lead to inefficient signal timing, potentially increasing congestion and wait times for drivers.

Unforeseen events and the inherent uncertainty associated with human behavior present significant challenges for planning and decision-making in ITS. By acknowledging these limitations and incorporating methods for handling uncertainty, ITS planners can develop more robust and adaptable strategies for managing traffic flow and resource allocation.

C.1 Manageability as structuring endeavor in Intelligent Transportation Systems from the viewpoint of "knowledge in decision making process" and "stable and known situation"

From the perspective of manageability, there are certain equations that can be utilized to compute structuring engagement in Intelligent Transportation Systems:

C.1.1 Dynamic Route Guidance in Intelligent Transportation Systems from the perspective of Organizing

C.1.1.1 Dynamic Route Guidance Algorithm. The Dynamic Route Guidance algorithm seeks to enhance traffic flow by continuously updating route suggestions in response to current traffic conditions. It can be represented as:

$$R_{\{t+1\}} = DynaRoute(R_t, T_{\{t+1\}}), \tag{25}$$

where:

$R_{\{t+1\}}$ is the updated set of recommended routes at time $t+1$;
R_t - the set of routes at time t;
$T_{\{t+1\}}$ - the observed traffic conditions at time $t+1$.

C.1.1.2 Route Selection Criteria. The algorithm considers various factors when selecting routes, including current traffic congestion, road conditions, historical traffic patterns, and user preferences. Each route is assigned a score based on these factors, and the algorithm selects the route with the highest score as the recommended route.

C.1.1.3 Traffic Condition Estimation. To update route recommendations in real-time, the algorithm relies on accurate estimation of traffic conditions. This can be achieved using data from traffic sensors, GPS devices, traffic cameras, and historical traffic data. The traffic condition estimation can be represented as:

$$T_{\{t+1\}} = EstimateTraffic(D_{\{t+1\}}), \tag{26}$$

where:

$T_{\{t+1\}}$ is the estimated traffic conditions at time $t+1$;
D_{t+1} - the observed traffic data at time $t+1$.

C.1.1.4 Dynamic Route Adjustment. Based on the estimated traffic conditions, the algorithm dynamically adjusts route recommendations to minimize travel time and alleviate

congestion. To ease congestion, strategies might include diverting vehicles to underutilized roads or proposing substitutes for individual car use, such as public transportation or ride-sharing services.

C.1.1.5 User Feedback Integration. The algorithm continuously incorporates user feedback to improve route recommendations over time. Users can provide feedback on route satisfaction, traffic conditions, and other factors, which the algorithm uses to refine its recommendations in future iterations.

C.1.1.6 Optimization Objective. This algorithm strives to create a well-oiled traffic system by minimizing congestion, expediting travel times, and boosting overall transportation effectiveness. It achieves this by organizing traffic in a way that minimizes congestion and maximizes the throughput of the transportation network.

These formulas enable transportation authorities to organize traffic effectively using Dynamic Route Guidance algorithms, leading to improved traffic flow and enhanced overall transportation system performance.

C.1.2 Traffic Signal Optimization in Intelligent Transportation Systems from the perspective of Organizing

C.1.2.1 Traffic Signal Timing Optimization. Traffic signal timing optimization aims to minimize delays and congestion at intersections by adjusting signal timings based on real-time traffic conditions. The optimization process can be represented as:

$$Optimize(T_t), \tag{27}$$

where: T_t is the set of traffic signal timings at time t.

C.1.2.2 Traffic Signal Timing Adjustment. To optimize traffic signal timings, the algorithm adjusts the durations of green, yellow, and red signal phases at each intersection dynamically. The adjustment process is based on observed traffic flow patterns, historical data, and predictive models of traffic behavior.

C.1.2.3 Traffic Flow Prediction. Prior to signal timing optimization, the algorithm predicts future traffic flow patterns using forecasting models. This can be represented as:

$$F_{\{t+1\}} = Forecast(T_{\{t\}}), \tag{28}$$

where:

$F_{\{t+1\}}$ is the forecasted traffic flow at time $t + 1$;

$T_{\{t\}}$ - the observed traffic flow at time t.

C.1.2.4 Performance Evaluation Metrics. The effectiveness of traffic signal optimization is evaluated using performance metrics such as intersection throughput, average delay per vehicle, and overall travel time. These metrics provide insights into the efficiency and effectiveness of signal timing adjustments.

C.1.2.5 Optimization Objective. The overarching objective of traffic signal optimization is to improve traffic flow, reduce congestion, and enhance overall transportation system efficiency. By optimizing signal timings based on real-time traffic conditions, the algorithm aims to minimize delays and improve the overall driving experience for commuters.

C.1.2.6 Adaptive Control Strategies. Ditching the rigid plan, traffic lights become dynamic. They analyze constant traffic flow data to adjust green light durations, making intersections run like well-oiled machines.

These formulas enable transportation authorities to effectively organize traffic flow through Traffic Signal Optimization, leading to reduced congestion, improved travel times, and enhanced overall transportation system performance.

C.1.3 Proactive Resource Allocation in Intelligent Transportation Systems from the perspective of Organizing

C.1.3.1 Dynamic Resource Allocation Algorithm. No more one-size-fits-all approach. Dynamic resource allocation makes the most of transportation resources like lanes and traffic signals by constantly adapting them to the current traffic situation. The algorithm dynamically adjusts resource allocations to optimize traffic flow and minimize congestion. Mathematically, this can be represented as:

$$Allocation_{\{t+1\}} = Organize(Forecast_{\{t\}}, Planning_{\{t\}}), \quad (29)$$

where:

$Allocation_{\{t+1\}}$ is the resource allocation plan at time $t + 1$;
$Forecast_{\{t\}}$ - the forecasted traffic conditions at time t;
$Planning_{\{t\}}$ - the planned resource allocations at time t.

C.1.3.2 Resource Utilization Metrics. To evaluate the effectiveness of resource allocation, various metrics can be used to assess resource utilization and performance. These metrics may include lane occupancy rates, route efficiency indices, and traffic signal utilization rates.

C.1.3.3 Optimization Objective. The primary objective of proactive resource allocation is to optimize the utilization of transportation resources to improve traffic flow and minimize congestion. By dynamically allocating resources based on forecasted and planned traffic conditions, the algorithm aims to enhance overall transportation system efficiency.

C.1.3.4 Adaptive Resource Allocation Strategies. Advanced resource allocation algorithms use flexible methods to adjust resource distribution in real-time, responding to fluctuating traffic conditions. By utilizing live data and feedback loops, these strategies aim to optimize resource usage and enhance traffic flow dynamically.

C.1.3.5 Performance Evaluation Criteria. The performance of proactive resource allocation algorithms can be evaluated based on criteria such as travel time reduction, congestion mitigation, and overall transportation system efficiency. These criteria provide insights into the effectiveness of resource allocation strategies in optimizing traffic flow.

By employing these formulas and strategies for proactive resource allocation, transportation authorities can effectively organize traffic flow, optimize resource utilization, and improve overall transportation system performance.

C.2 Manageability as structuring undertaking in in Intelligent Transportation Systems from the viewpoint of "unknown in decision making process" and "unstable and with large uncertainty situation"

The study [14] discusses the process of standardization in Intelligent Transport Systems (ITS) in the United States and Europe from 1991 to 2012. It examines how policies have influenced technical standardization, including policy priorities, government roles, intervention time, and cooperation. This involves organizing and structuring the standardization process, analyzing the influence of policies on various dimensions, and identifying patterns and impacts on technology research and development.

The investigation [15] primarily focuses on the development and application of a novel framework for traffic prediction and organizing, which involves incorporating surrounding spatial data from the road network into the analysis of existing sensor graphs. It describes the introduction of a heterogeneous graph that integrates surrounding spatial information from the road network into the analysis, highlighting the close association between traffic conditions and surrounding spatial information. The proposed framework, the heterogeneous attentive spatial-temporal network (HASTN), is introduced, which constructs a heterogeneous graph merging road networks with surrounding geographic features and employs attention mechanisms to learn traffic patterns. The work mentions the achievement of promising results on public datasets and a proposed dataset, indicating the forecasting capabilities of the proposed method and organizing effects on traffic flow. Additionally, it discusses the analysis of the impact of road traffic patterns on attention using spatial information.

Reference [16] primarily focuses on enhancing the precision of long-term traffic flow forecasting and management in urban settings, crucial for optimizing traffic flow and travel efficiency. The study examines the difficulties of modeling the interdependence of space and time in urban traffic data and underscores the shortcomings of current models in capturing meaningful spatial similarities and temporal influences on prediction accuracy. Introducing the multi-scale persistent spatiotemporal transformer (MSPSTT) model as a solution, it integrates temporal, periodic, and spatial attributes within an encoder-decoder framework. The model employs multi-head attention mechanisms to dynamically extract temporal, geographical, and semantic features, continually updating the spatiotemporal decoder to discern correlations across different time intervals for long-term prediction. Experimental findings underscore MSPSTT's superior performance compared to existing models.

The scientific investigation [17] developing multivariate machine learning-based prediction models and organizing methods for freeway traffic flow under non-recurrent events, specifically road crashes and rain. It outlines the construction of five different model architectures, including Multi-Layer Perceptron, Convolutional Neural Network Long Short-Term Memory, Convolutional Neural Network and Long Short-Term Memory, and Auto encoder and Long Short-Term Memory architectures networks, to predict traffic flow using a dataset consisting of five features: flow rate, speed, density, road incident, and rainfall. The evaluation of these models' performance is based on two standard metrics: Root Mean Square Error (RMSE) and Mean Absolute Error (MAE). Overall, work emphasizes the development and evaluation of forecasting models to predict freeway traffic flow during non-recurrent events, employing various machine learning techniques to leverage multivariate data inputs and organizing methods.

In reference [18], the research centers on creating and assessing an artificial neural network (ANN) model designed to predict and manage traffic flow at signal-controlled intersections. It highlights the growing adoption of machine learning techniques, particularly time series prediction, in forecasting traffic patterns. The study addresses the current lack of comprehensive research into modeling traffic flow specifically at signalized intersections. Using data from the South African road network, particularly from seven intersections linked to the busy N1 Allandale interchange, the research incorporates various traffic flow variables such as vehicle types, speeds, density, time, and volume. The ANN model is employed to accurately forecast traffic flow dynamics. Results indicate the ANN's robust performance across training, testing, and management phases, demonstrating its effectiveness in predicting and analyzing traffic conditions at signal-controlled intersections.

There is a possibility that unforeseen elements, as mentioned above, and reflections from the authors of the present article might emerge during the organization phase of traffic flow in Intelligent Transportation Systems:

C.2.1 Uncertainty in Traffic Conditions. Despite efforts to estimate traffic conditions accurately, unexpected events such as accidents, road closures, or adverse weather conditions may lead to unpredictable changes in traffic flow.

C.2.2 Dynamic Route Guidance Adjustment. Adapting route recommendations in real-time requires continuous monitoring of traffic conditions and rapid decision-making to minimize delays and congestion effectively.

C.2.3 Behavior of participants. Gaining insight into user actions and preferences is essential for providing effective route guidance. However, predicting how individuals will respond to route suggestions, especially in unpredictable traffic conditions, can be challenging.

C.2.4 Resource Availability. The availability of resources such as transportation lanes, routes, and traffic signals may fluctuate due to maintenance activities, emergencies, or unforeseen events, leading to uncertainty in resource allocation and utilization.

C.2.5 Real-time Data Accuracy. Depending on real-time data from sources like traffic sensors, GPS units, and traffic cameras to make decisions carries the risk of data inaccuracies or delays in transmission, which can impact the dependability of operational activities.

C.2.6 Adaptive Control Strategies Effectiveness. While adaptive control strategies aim to optimize traffic flow dynamically, their effectiveness in responding to rapidly changing traffic conditions may vary, leading to uncertainty in their impact on overall traffic management.

C.2.7 Forecasting Model Reliability. Forecasting future traffic conditions using predictive models is essential for proactive decision-making, but the accuracy and reliability of these models under dynamic and uncertain traffic environments may be limited.

C.2.8 Performance Evaluation Challenge. Evaluating the real-time effectiveness of traffic management activities presents challenges because of the intricate nature of traffic systems and the constantly changing flow of vehicles, which complicates precise measurement of management strategy effectiveness.

C.2.9 Feedback Integration Timeliness. Incorporating user feedback into organizing activities relies on timely data collection and analysis, but delays in feedback processing or response implementation may hinder the effectiveness of adaptive management approaches.

C.2.10 System Resilience and Adaptability. Ensuring the resilience and adaptability of organizing activities to cope with unforeseen disruptions or uncertainties in traffic conditions is essential for maintaining the manageability of transportation systems under challenging circumstances.

Despite efforts to estimate traffic conditions accurately, unexpected events such as accidents or adverse weather conditions may lead to unpredictable changes in traffic flow. Adapting route recommendations in real-time requires continuous monitoring and rapid decision-making to minimize delays effectively. Effectively guiding routes relies on understanding user behavior and preferences, yet forecasting individual decisions and responses can be problematic, especially in unpredictable traffic conditions.

D.1 Manageability as deployment endeavor within in Intelligent Transportation Systems from the viewpoint of "knowledge in decision making process" and "stable and known situation"

A wide variety of processes can be implemented within Intelligent Transportation Systems. Consequently, we present several formulas to calculate the specifics of these operational endeavors:

D.1.1 Dynamic Route Guidance in Intelligent Transportation System, considering the perspective of implementing:

*D.1.1.1 Dynamic Route Guidance Algorithm:*A dynamic route guidance algorithm helps drivers navigate through traffic by recommending the most efficient route in real-time. One common approach is to calculate the shortest path based on current traffic conditions, considering factors such as congestion levels, road closures, and travel time estimates.

$$ShortestPath = Dijkstra(Graph, StartNode, EndNode), \quad (30)$$

where:

$ShortestPath$ is the optimal route from the start node to the end node;
$Dijkstra$ - the Dijkstra's algorithm used to find the shortest path in the graph representation of the road network;
$Graph$ - the road network graph with nodes representing intersections and edges representing road segments;
$StartNode$ - the starting point of the journey;
$EndNode$ - the destination point.

D.1.1.2 Parameter Estimation. The parameters of the dynamic route guidance algorithm, such as traffic flow data, road network topology, and historical travel patterns, are estimated using machine learning techniques and real-time sensor data. These parameters are continuously updated to reflect changing traffic conditions and improve route recommendations.

D.1.1.3 Model Evaluation. After implementing the dynamic route guidance algorithm, its performance is evaluated based on metrics such as travel time savings, congestion reduction, and user satisfaction. These metrics help assess the effectiveness of the algorithm in optimizing traffic flow and guiding drivers to their destinations efficiently. Through the adoption of dynamic route guidance algorithms, transportation authorities can enhance traffic flow, mitigate congestion, and elevate the overall travel satisfaction of road users.

D.1.2.1 Traffic Signal Timing Optimization. Traffic signal timing optimization aims to minimize congestion and delays at intersections by adjusting the timing of traffic signals based on real-time traffic data and predefined optimization objectives.

$$GreenTime = f(TrafficVolume, TrafficSpeed, CycleTime), \quad (31)$$

where:

$GreenTime$ is the duration of the green signal phase;
$TrafficVolume$ - the volume of vehicles approaching the intersection;
$TrafficSpeed$ - the average speed of vehicles in the vicinity of the intersection;
$CycleTime$ - the total duration of the traffic signal cycle.

D.1.2.2 Optimization Objective Function. An objective function is defined to quantify the performance of traffic signal timing plans. It typically incorporates factors such as intersection delay, queue length, and vehicle throughput to balance competing objectives and find an optimal signal timing configuration.

$$Objective = w_1 * Delay + w_2 * QueueLength + w_3 * Throughput, \quad (32)$$

where:

$Objective$ is an optimal signal timing configuration;
$Delay$ - the total delay experienced by vehicles at the intersection;
$QueueLength$ - the length of vehicle queues at the intersection;
$Throughput$ - the number of vehicles passing through the intersection during a given time period;
w_1, w_2, w_3 - weighting factors that determine the relative importance of each objective.

D.1.2.2 Parameter Adjustment Algorithm. A parameter adjustment algorithm is used to iteratively refine the traffic signal timing parameters to optimize the objective function. Techniques such as genetic algorithms, simulated annealing, or reinforcement learning may be employed to search for the optimal parameter values.

$$NewParameter = CurrentParameter + \Delta Parameter, \quad (33)$$

where:

$NewParameter$ is the updated value of the signal timing parameter;
$CurrentParameter$ - the current value of the parameter;
$\Delta Parameter$ - the change in parameter value determined by the optimization algorithm.

Through the adoption of advanced traffic signal optimization techniques, transportation authorities can enhance the efficiency of traffic flow, decrease travel durations, and improve the overall operational performance of road networks.

D.1.3.1 Dynamic Resource Allocation Algorithm. Dynamic resource allocation adjusts the distribution of resources like traffic lanes, signal timings, and transit services in response to current traffic conditions and demand fluctuations in real-time. An algorithm is used to determine the optimal allocation strategy.

$$Allocation = f(TV, CL, RA), \quad (34)$$

where:

$Allocation$ is the allocation of resources (e.g., lanes, signal timings);
TV - the volume of traffic on the road network;
CL - the level of congestion or traffic flow conditions;
RA - the availability of resources for allocation.

D.1.3.2 Optimal Lane Assignment. Optimal lane assignment aims to assign vehicles to lanes in a way that minimizes congestion and maximizes throughput. An algorithm takes into account variables like lane capacity, speed of vehicle, and the level of congestion specific to each lane to decide in real-time which lanes vehicles should use.

$$LaneAssignment = f(VS, LC, CL), \quad (35)$$

where:

LaneAssignment is the assignment of vehicles to lanes;
VS - the speed of vehicles;
LC - the maximum capacity of each lane;
CL - the level of congestion on each lane.

D.1.3.3 Dynamic Signal Timing Adjustment. Adapting traffic signal timings dynamically involves modifying them in response to current traffic conditions. An algorithm calculates the best signal timings considering factors such as traffic volume, queues of vehicles, and delays at intersections.

$$SignalTiming = f(TV, VQ, ID), \tag{36}$$

where:

SignalTiming is the timing of traffic signals;
TV - the volume of traffic approaching the intersection;
VQ - the length of vehicle queues at the intersection;
ID - the delay experienced by vehicles at the intersection.

By implementing proactive resource allocation strategies, transportation authorities can optimize the use of available resources, improve traffic flow, and enhance overall transportation system performance.

These formulas represent algorithms used to implement proactive resource allocation strategies in an Intelligent Transportation System. They consider parameters such as traffic volume, congestion level, resource availability, vehicle speed, lane capacity, vehicle queues, and intersection delay to optimize the allocation of resources, lane assignment, and signal timing for improved traffic flow and system performance.

D.2 Manageability as executing operation within Intelligent Transportation Systems considering "unknown in decision making process" and "unstable and with large uncertainty situation"

In the study [19] it is discussed the development and evaluation of a model Spatiotemporal Multi-Head Graph Attention Network (ST-MGAT) for predicting traffic flow. It outlines the methodology used for traffic flow prediction and implementation, describes the structure of the proposed model, presents experiments designed to validate the model's performance, and reports the results obtained from these experiments. Mostly the study focuses on forecasting future traffic flow patterns using a novel approach, making it most relevant to the implementation in the Intelligent Transportation Systems.

The investigation [20] provided primarily focuses on the "implementing" category. It discusses the implementation of intelligent transportation systems (ITS) in both developed and developing countries, particularly in sub-Saharan countries. The paper outlines the differences in transportation scenarios between developed and sub-Saharan countries and proposes ideas for deploying ITS on dirt roads, which involves the practical implementation of such systems in real-world settings.

Reference [21] explores the development and application of a method for short-term traffic flow prediction in urban intelligent transportation systems (ITS) to tackle congestion issues. It introduces an ensemble prediction strategy combining optimized variational mode decomposition (OVMD) with a hybrid long short-term memory network (LSTM). The approach aims to enhance prediction accuracy by optimizing VMD parameters using an enhanced bat algorithm, decomposing traffic flow time series into multiple intrinsic mode functions (IMFs) via OVMD, and refining an optimized L-BILSTM model through a fusion of standard LSTM and bidirectional LSTM. The study empirically validates the proposed prediction model using traffic data from Changsha City, assessing how OVMD impacts training set data and overall prediction outcomes.

The search work [22] develops application of an algorithm for short-term predictions and implementation of vehicle flow and speed on a road segment. It introduces a physics-aware recurrent neural network (RNN) algorithm that embeds a discretization of a macroscopic traffic flow model, specifically the Traffic Reaction Model, into the architecture of the network. The algorithm utilizes past measurements of traffic flow and speed to estimate and predict space-time dependent traffic parameters, which are constrained by the macroscopic traffic flow model. These parameters are obtained using a succession of LSTM recurrent neural networks. The work emphasizes the importance of incorporating physics-based models into neural network architectures for accurate traffic prediction and testing the algorithm on raw flow measurements obtained from loop detectors and how to implement it.

D.2.1 Uncertain factors may emerge during the execution phase within Intelligent Transportation Systems. Here are the elements that could potentially be unknown during implementation based on works mentioned above and may affect the manageability of Traffic Flow Implementation Models:

D.2.1.1 Data Accuracy. Despite efforts to use historical traffic data and real-time sensor information, inaccuracies or delays in data collection may occur, affecting the reliability of traffic flow predictions.

D.2.1.2 Weather Variability. Weather conditions play a crucial role in traffic flow dynamics, yet accurately forecasting weather patterns and their impact on traffic can pose challenges, particularly in areas where weather patterns are unpredictable.

D.2.1.3 Traffic Behavior Changes. Unexpected changes in driver behavior, such as accidents, road closures, or sudden shifts in travel patterns, can influence traffic flow dynamics and undermine the effectiveness of prediction models.

D.2.1.4 Infrastructure Changes. Construction projects, road closures, or changes in traffic management policies may occur unexpectedly, leading to disruptions in traffic flow that are not accounted for in prediction models.

D.2.1.5 System Integration Issues. Integrating prediction models with existing traffic management systems or infrastructure may encounter technical challenges or compatibility issues, affecting the implementation and effectiveness of the models.

D.2.1.6 Stakeholder Coordination. Effective collaboration among diverse stakeholders—including transportation agencies, local authorities, and technology providers—is essential for successful implementation. However, challenges such as varying priorities, communication barriers, or conflicting interests can impede seamless coordination and hinder the implementation process.

D.2.1.7 Resource Allocation Constraints. Limited resources, such as funding, manpower, or technological capabilities, may constrain the implementation of traffic flow prediction models, impacting their scalability and effectiveness in real-world settings.

D.2.1.8 Regulatory Compliance. Adhering to regulatory requirements and standards, such as data privacy regulations or traffic safety guidelines, is essential for implementing prediction models responsibly. Failure to comply with these regulations may lead to legal liabilities or public trust issues.

D.2.1.9 Public Acceptance and Trust. Public acceptance of and trust in prediction models are crucial for their successful implementation. Addressing concerns about data privacy, algorithm transparency, and fairness is essential to gain public confidence and support.

D.2.1.10 Continuous Monitoring and Evaluation. Implementing traffic flow prediction models requires ongoing monitoring and evaluation to assess their performance, identify potential issues or limitations, and make necessary adjustments or improvements over time.

These elements highlight the complexities and uncertainties involved in implementing traffic flow prediction models in Intelligent Transportation Systems, emphasizing the importance of effective planning and decision-making processes to ensure their successful deployment and manageability.

E.1 Manageability as maintaining order and direction to ensure operational effectiveness and stability of Intelligent Transportation Systems viewed through the lens of "knowledge in decision making process" and "stable and known situation"

Numerous equations exist for computing regulatory functions within Intelligent Transportation Systems.

E.1.1 Traffic Flow Controlling Models with a focus on Dynamic Route Guidance.

E.1.1.1 Dynamic Route Guidance Algorithm:

$$V_{ij} = V_{ij} + \alpha * (V_{target} - V_{ij}), \tag{37}$$

where:

V_{ij} is current traffic flow on route between nodes i and j;

V_{target} - target traffic flow on route between nodes i and j;

α - control parameter adjusting the rate of change.

E.1.1.2 Congestion Mitigation Model:

$$V_{ij} = V_{ij} + \beta * (V_{max} - V_{ij}) * (1 - e^{-\gamma * D_{ij}})) \tag{38}$$

where:

V_{ij} is updated traffic flow on route between nodes i and j;

V_{max} - maximum traffic flow capacity of route between nodes i and j;

D_{ij} - distance between nodes i and j;

β - control parameter adjusting the rate of congestion alleviation;

γ - control parameter adjusting the influence of distance on congestion mitigation.

E.1.1.3 Route Selection Probability Model:

$$P_i = e^{-(\lambda * (C_i - C_{min}))} / \Sigma(e^{-(\lambda * (C_i - C_{min}))}) \tag{39}$$

where:

P_i is probability of selecting route i;

C_i - cost of route i (e.g., travel time);

C_{min} - minimum cost among all routes;

λ - control parameter adjusting the sensitivity to cost differences.

E.1.1.4 Adaptive Traffic Signal Control Model:

$$G_{i(t+1)} = G_{i(t)} + \eta * (Q_{i(t)} - Q_{i(t-1)}) \tag{40}$$

where:

$G_{i(t+1)}$ is green time for signal i in the next time period;

$G_{i(t)}$ - green time for signal i in the current time period;

$Q_{i(t)}$ - traffic queue length at signal i in the current time period;

$Q_{i(t-1)}$ - traffic queue length at signal i in the previous time period;

η - learning rate.

These formulas support the implementation of Traffic Flow Controlling Models with a focus on Dynamic Route Guidance in Intelligent Transportation Systems.

E.1.2 **Traffic Flow Controlling Models with a focus on Traffic Signal Optimization**

E.1.2.1 Traffic Signal Timing Adjustment Model:

$$T_i = T_i + \Delta T_i \tag{41}$$

where:

T_i is current timing plan for traffic signal i

ΔT_i - adjustment to the timing plan for traffic signal i.

E.1.2.2 Traffic Signal Cycle Length Optimization Model:

$$C_{opt} = argmin(CL) \tag{42}$$

where:

C_{opt} is optimized cycle length for traffic signals;

CL - cycle length for traffic signals;

argmin - argument that minimizes the cycle length.

E.1.2.3 Green Split Ratio Adjustment Model:

$$GS_i = GS_i + \Delta GS_i \tag{43}$$

where:

GS_i is current green split ratio for phase i;

ΔGS_i - adjustment to the green split ratio for phase i.

E.1.2.4 Traffic Signal Coordination Model:

$$\Delta Offset = f(T, C) \tag{44}$$

where:

$\Delta Offset$ is adjustment to the offset between traffic signals;

T - traffic flow characteristics (e.g., volume, speed) at each intersection;

C - coordination parameters (e.g., cycle length, green split ratios).

E.1.3 **Traffic Flow Controlling Models with a focus on Proactive Resource Allocation**

E.1.3.1 Proactive Resource Allocation:

$$R = f(T, D, P, S) \tag{45}$$

where:

R is resource allocation for traffic flow control;

T - traffic flow characteristics (e.g., volume, speed, density) at different locations;
D - demand patterns and forecasts for various routes or areas;
P - prioritized objectives and performance metrics (e.g., minimizing delays, maximizing throughput);
S - available resources and their capacities (e.g., number of traffic signals, lane configurations).

E.1.3.2 Explanation. The formula represents the proactive allocation of resources (R) for traffic flow control based on several factors:

Traffic Flow Characteristics (T). This involves up-to-the-minute information on traffic flow volume, vehicle speeds, and congestion levels at various points across the transportation network. These details are instrumental in evaluating present traffic conditions and pinpointing areas of congestion.

Demand Patterns (D). Information about historical traffic patterns, anticipated changes in demand, and forecasts for future traffic conditions. This allows for proactive planning to address potential congestion or disruptions.

Prioritized Objectives (P). Defined goals and performance metrics for traffic management, such as minimizing travel time, reducing congestion, improving safety, or optimizing resource utilization. These objectives guide the resource allocation strategy.

Available Resources (S). Inventory of available resources for traffic control, including traffic signals, surveillance cameras, variable message signs, dynamic lane control systems, etc. Understanding the capabilities and capacities of these resources enables effective allocation to meet the identified objectives.

E.1.3.3 Function f. The function f represents the relationship between the input variables (*T*, *D*, *P*, *S*) and the allocation of resources (*R*).

It involves algorithms, optimization techniques, or decision-making processes to determine the optimal allocation strategy based on the current traffic conditions, anticipated demand, management objectives, and resource constraints.

The function f may utilize techniques such as machine learning, optimization algorithms, or simulation models to dynamically adjust resource allocations in response to changing traffic dynamics and operational requirements.

E.1.3.4 Objective. The objective of proactive resource allocation is to efficiently manage traffic flow, optimize the utilization of available resources, and achieve the specified performance goals.

By proactively allocating resources based on real-time and forecasted data, transportation agencies can effectively mitigate congestion, improve traffic flow, enhance safety, and provide better travel experiences for road users.

This model enables proactive traffic flow management through real-time resource allocation, adapting to current traffic conditions, projected demand, operational goals, and available resources. This approach enhances the efficiency and effectiveness of traffic management operations within an Intelligent Transportation System (ITS) framework.

E.2 Manageability as overseeing function in Intelligent Transportation Systems considering "unknown in decision making process" and "unstable and with large uncertainty situation"

The study [23] suggests a method for controlling vehicle trajectories during lane changes using a combination of extended Kalman filter (EKF) and robust tube-based model predictive control (RTMPC) techniques to enhance resistance to disturbances. A polynomial function based on time is used to plot trajectories and determine a preferred reference path. The planned trajectory is then fed into the model predictive controller (MPC) within the RTMPC framework to optimize control of the nominal system. The EKF gathers current state measurements and previous state estimates, filtering them to yield optimal estimates of the current state. These estimates, along with the nominal system state, inform the auxiliary control law within RTMPC for controlling the actual system.

The research [24] introduces a hierarchical control framework that utilizes vehicle trajectory data to address network traffic congestion at bottlenecks. Initially, the bottleneck-related sub-network (BRS) is identified by tracing vehicle trajectories upstream and downstream of the bottleneck. Subsequently, a hierarchical control framework is proposed for optimizing BRS. The outer layer, known as the gating control layer, employs a multimemory deep Q-network approach to regulate multigated intersections within BRS, optimizing network traffic distribution. Meanwhile, the inner layer, referred to as the coordinated control layer, coordinates local intersection controllers by adjusting dynamic input and output streams of the bottleneck, guided by the outer layer controller. This coordination aids in balancing traffic pressure within BRS and prevents congestion from spreading throughout the network. Both simulation and field experiments validate the efficacy of the hierarchical framework, demonstrating reduced queue length and travel time, effectively alleviating network traffic congestion.

The study [25] proposes a unified strategy for the cooperative optimization of pedestrian control patterns and signal timing plans to improve the efficiency and safety of pedestrian–vehicle mixed traffic flow. The existing control patterns, such as EPPs, LPIs, and two-way crossing (TWC), are unified. The safety and efficiency costs are monetized, and the minimization of average costs per traffic participant is taken as the optimization objective. Additionally, decision variables for diagonal crossing at intersections and pedestrian–vehicle priority are introduced to achieve cooperative optimization of the pedestrian control patterns and signal timing plans. The proposed model parameters were calibrated and validated using a real-world case study, and the applicable boundaries of different pedestrian control patterns under different pedestrian and vehicle flow scenarios were identified based on cost difference analysis. The results indicate that the vehicle turn ratio, average vehicle carrying rate, and unit cost ratio dynamically change the applicable boundaries. On average, the proposed method reduced the cost by 2.62% compared with separately optimized EPPs, LPIs, and TWC across various scenarios.

The investigation [26] introduces two straightforward adaptable control strategies that merely require sample delay and the count of stops, aiming to alleviate oversaturation issues. The simplicity arises from the necessity of managing under any trajectory penetration rate. These two strategies vary in the feasibility of implementing the control infrastructure. The initial strategy aims to minimize oversaturation by deviating from a predetermined reference signal plan, which can either be an existing one or estimated from aggregated trajectory data. The alternative approach first establishes a series of green split plans,

subsequently chosen by a control mechanism. This latter strategy is designed for use in systems where signal plans are confined to a predetermined discrete set. In the work is proposed selection logic for plan choices, or alternatively, the original selection policy can also be applied. Both strategies are field-tested, demonstrating significant reductions in delay, oversaturation, and spill over rates.

According to the works mentioned above and the ideas of the authors pondering the monitoring and control processes within Intelligent Transportation Systems may not account for all potential factors. These factors could include:

E.2.1 Real-Time Traffic Conditions. Unpredicted changes in traffic volume, congestion levels, or incidents can occur, affecting the effectiveness of resource allocation decisions.

E.2.2 Resource Availability. The availability of resources such as lanes, routes, and traffic signals may fluctuate due to unexpected events like maintenance activities or emergencies, affecting proactive resource allocation plans.

E.2.3 Weather Conditions. Sudden weather changes, such as rain, snow, or fog, can influence traffic flow and resource utilization, posing challenges for proactive allocation strategies.

E.2.4 Incident Response Time. The duration required to detect and react to incidents, such as accidents or road closures, can vary and might interfere with planned resource allocation strategies.

E.2.5 User Behavior: Unpredictable behavior among road users, such as sudden changes in travel patterns or preferences, can affect the effectiveness of resource allocation strategies.

E.2.6 Infrastructure Changes. Unexpected changes in road infrastructure, such as construction work or road closures, may require adjustments in resource allocation plans to accommodate altered traffic patterns.

E.2.7 Emergency Situations. Emergencies like natural disasters or security incidents can lead to sudden changes in traffic demand and require rapid adjustments in resource allocation to ensure efficient traffic flow.

E.2.8 Data Accuracy. Inaccuracies or delays in obtaining real-time traffic data from sensors or other sources can hinder the effectiveness of proactive resource allocation models.

E.2.9 Technological Failures. Malfunctions in Intelligent Transportation Systems components, such as traffic sensors or control systems, can disrupt the execution of proactive resource allocation strategies.

E.2.10 Regulatory Changes. Changes in traffic regulations or policies may impact traffic behavior and necessitate adaptations in resource allocation plans to maintain manageability and efficiency in transportation systems.

The factors identified above highlight the need for robust and adaptable resource allocation models within Intelligent Transportation Systems. By incorporating methods to handle uncertainty, these systems can become more responsive to real-time conditions and improve overall traffic management.

F.1 Manageability as optimizing decision-making processes within Intelligent Transportation Systems from the view of "knowledge in decision making process" and "stable and known situation"

This section explores various traffic flow decision-making models used in Intelligent Transportation Systems (ITS) with a focus on Dynamic Route Guidance (DRG), Traffic Signal Optimization, and Proactive Resource Allocation. These models incorporate both historical

data and real-time traffic information for optimal decision-making and improved traffic management.

F.1.1 Traffic Flow Decision Making Model

F.1.1.1 Traffic Flow Decision Making Model: Dynamic Route Guidance (DRG)

$$DRG = f(T, R, D)\ , \tag{46}$$

where:

DRG - decision-making related to Dynamic Route Guidance *DFG*;

T - traffic conditions, including factors such as congestion levels, traffic speed, and road closures;

R - route options available to the vehicle or driver;

D - decision parameters, which may include preferences such as shortest route, fastest route, or route with least congestion.

F.1.1.1.1 Explanation. The formula calculates the decision-making process related to dynamic route guidance based on various factors:

Traffic Conditions (T). Real-time information about traffic conditions, including congestion levels, traffic speed, accidents, and road closures, obtained from sensors, cameras, or traffic management systems.

Route Options (R). The available routes that the vehicle or driver can choose from, which may vary based on road network topology and current traffic conditions.

Decision Parameters (D). Preferences or criteria used to make routing decisions, such as minimizing travel time, avoiding toll roads, or prioritizing certain roads based on traffic conditions.

F.1.1.1.2 Function f. The function f represents the decision-making process that evaluates traffic conditions, available route options, and decision parameters to determine the optimal route guidance for vehicles. DRG systems use algorithms that analyze real-time traffic data and user preferences to provide personalized route recommendations to drivers, aiming to minimize travel time and improve overall traffic flow.

F.1.1.1.3 Benefits. DRG systems help drivers make informed decisions by providing real-time route recommendations based on current traffic conditions.

Integrating decision-making models into transportation systems can streamline traffic flow, alleviate congestion, and improve the operational efficiency of road networks.

F.1.1.2 Traffic Flow Decision Making Model: Dynamic Route Guidance

$$P(R_i/T)\ =\ (P(T/R_i) \times P(R_i))/P(T) \tag{47}$$

where:

$P(R_i/T)$ is probability of route R_i given the observed traffic conditions T.

P(T/Ri) - likelihood of observing the traffic conditions T given the route R_i.

P(R_i*)*- prior probability of selecting route R_i without considering traffic conditions.

$P(T)$ - total probability of observing the traffic conditions *T*.

F.1.1.2.1 Explanation. The formula calculates the probability of selecting each route R_i given the observed traffic conditions T using Bayes' theorem.

Likelihood P(T/Ri). This term represents the probability of observing the specific traffic conditions T given the selected route Ri. It accounts for how likely it is to encounter certain traffic conditions along each route.

Prior Probability (P(R_i). This term represents the probability of selecting each route R_i without considering traffic conditions. It reflects any biases or preferences towards certain routes.

Total Probability $P(T)$. This term represents the total probability of observing the traffic conditions T, considering all possible routes. It acts as a normalization factor.

F.1.1.2.2 Bayes' Theorem. Bayes' theorem provides a way to update our beliefs (prior probabilities) about the occurrence of an event (selecting a route) based on new evidence (observed traffic conditions). By applying Bayes' theorem in the context of dynamic route guidance, we can estimate the likelihood of each route given the current traffic conditions, helping in decision-making.

F.1.1.2.3 Application. The Bayes probabilistic model can enhance Dynamic Route Guidance systems by dynamically adapting route suggestions according to current traffic data. By continually updating route probabilities based on real-time traffic conditions, the system can direct drivers to optimal routes, taking into account variables like congestion levels, road closures, and travel duration.

F.1.1.2.4 Benefits. Utilizing Bayes' theorem enables Dynamic Route Guidance systems to make informed decisions by incorporating both prior knowledge and current observations. This approach enhances the adaptability and effectiveness of route guidance systems in response to changing traffic conditions, leading to improved traffic flow and reduced travel time for drivers.

F.1.2.1 Traffic Flow Decision Making Model: Traffic Signal Optimization

$$P(Opt|T) = (P(T|Opt) \times P(Opt))/P(T), \tag{48}$$

where:

$P(Opt/T)$ is probability of optimizing traffic signals given the observed traffic conditions T;

$P(T/Opt)$ - likelihood of observing the traffic conditions T given the optimization of traffic signals;

$P(Opt)$ - prior probability of optimizing traffic signals without considering traffic conditions;

$P(T)$ - total probability of observing the traffic conditions T.

F.1.2.1.1 Explanation: The formula calculates the probability of optimizing traffic signals given the observed traffic conditions T using Bayes' theorem.

Likelihood ($P(T/Optimization)$). This term represents the probability of observing the specific traffic conditions T given the optimization of traffic signals. It accounts for how likely it is to encounter certain traffic conditions when traffic signals are optimized.

Prior Probability ($P(Optimization)$). This term represents the prior probability of optimizing traffic signals without considering traffic conditions. It reflects any biases or preferences towards traffic signal optimization.

Total Probability ($P(T)$). This term represents the total probability of observing the traffic conditions T, considering all possible scenarios. It acts as a normalization factor.

F.1.2.1.2 Bayes' Theorem. Bayes' theorem provides a way to update our beliefs (prior probabilities) about the occurrence of an event (optimizing traffic signals) based on new evidence (observed traffic conditions). By applying Bayes' theorem in the context of traffic signal optimization, we can estimate the likelihood of optimizing traffic signals given the current traffic conditions, aiding decision-making.

F.1.2.1.3 Application. The Bayes probabilistic model can be integrated into Traffic Signal Optimization systems to dynamically fine-tune signal timings based on real-time traffic data. By consistently updating the probability of optimizing traffic signals through observed traffic conditions, the system can intelligently adjust to enhance traffic flow efficiency and alleviate congestion at intersections.

F.1.2.1.4 Benefits. Utilizing Bayes' theorem enables Traffic Signal Optimization systems to make data-driven decisions by considering both prior knowledge and current observations. This method improves the efficiency of traffic signal timing strategies, resulting in smoother traffic flow, decreased wait times, and enhanced overall management of traffic.

F.1.3.1 Traffic Flow Decision Making Model: Proactive Resource Allocation

$$P(Allocation \mid D) = (P(D \mid Allocation) * P(Allocation)) / P(D), \quad (49)$$

where:

$P(Allocation/D)$ is probability of allocating resources given the observed data D;

$P(D/Allocation)$ - likelihood of observing the data D given the resource allocation;

$P(Allocation)$ - prior probability of resource allocation without considering the observed data;

$P(D)$ - total probability of observing the data D.

F.1.3.1.1 Explanation. The formula calculates the probability of allocating resources given the observed data *D* using Bayes' theorem.

$Likelihood\ (P(D/Allocation))$. This term represents the probability of observing the specific data D given the allocation of resources. It accounts for how likely it is to encounter certain data when resources are allocated.

$Prior\ Probability\ (P(Allocation))$. This term represents the prior probability of allocating resources without considering the observed data. It reflects any biases or preferences towards resource allocation.

$Total\ Probability\ (P(D))$. This term represents the total probability of observing the data *D*, considering all possible scenarios. It acts as a normalization factor.

*F.1.3.1.2 Bayes' Theorem***.** Bayes' theorem provides a way to update our beliefs (prior probabilities) about the occurrence of an event (allocating resources) based on new evidence (observed data). By applying Bayes' theorem in the context of proactive resource allocation, we can estimate the likelihood of allocating resources given the current data, aiding decision-making.

F.1.3.1.3 Application. The Bayes probabilistic model can be implemented in Intelligent Transportation Systems for proactive resource allocation, such as dispatching emergency services, adjusting traffic signal timings, or deploying maintenance crews. By dynamically adjusting resource allocation based on real-time data updates, the system can make well-

informed decisions to maximize resource efficiency and enhance overall transportation effectiveness.

F.1.3.1.4 Benefits. Utilizing Bayes' theorem enables Intelligent Transportation Systems to make data-driven decisions about resource allocation by considering both prior knowledge and current observations. This approach enhances the effectiveness of resource allocation strategies, leading to improved response times, reduced congestion, and enhanced safety on roadways.

By incorporating Bayes' theorem into decision-making models for traffic flow, Intelligent Transportation Systems can leverage both historical data and real-time information to dynamically optimize traffic flow, signal timing, and resource allocation, ultimately leading to a more efficient and adaptable transportation network.

F.2 Manageability as optimizing decision-making processes within Intelligent Transportation Systems from the view of "unknown in decision making process" and "unstable and with large uncertainty situation"

In pursuit of enhancing interaction amid intelligent autos and human operators, the investigation [27] advocates for the MCLG (multi-head scrutiny + convolutional communal pooling + long-term transient recollection + Gaussian amalgam model) trajectory anticipation and lane alteration decision model, featuring a lane modification intent determination module. This model encompasses a lane modification decision component accountable for discerning three lane alteration intents: leftward lane change, rightward lane change, and vehicle trailing. Subsequently, a multi-head scrutiny apparatus processes intricate vehicular interaction data to boost modeling precision and intellect. Moreover, uncertainty in trajectory anticipation is addressed via multimodal trajectory anticipation and Gaussian amalgam model, with diversity and uncertainty amalgamated by fusing trajectory anticipation from varied modalities through probabilistic compositive sampling configurations. Evaluation outcomes reveal that the MCLG model, grounded on the multi-head scrutiny module, surpasses extant techniques in trajectory anticipation. The decision module, incorporating interactive data, displays superior predictability and precision. Furthermore, the MCLG model, contemplating the lane-modifying decision module, substantially amplifies trajectory anticipation precision, furnishing robust decision-making endorsement for self-directed driving systems.

Overtaking maneuvers pose significant risks for road vehicles, particularly on two-way roads. The paper [28] introduces a novel approach to overtaking in two-way road scenarios using principles derived from the Mixed Observable Markov Decision Process (MOMDP). This innovative formulation enables the determination of optimal strategies while accounting for inherent uncertainties in the overtaking problem. Despite the computational challenges associated with Markov-based decision processes, advancements in solver efficiency and computational technology demonstrate the viability of these approaches for addressing overtaking scenarios. Through simulations, the proposed MOMDP method is evaluated against stochastic-variant Markov Decision Process (MDP) and traditional time to collision (TTC) methodologies, displaying superior performance by reducing collision risks and overtaking durations.

Optimizing an intra-city express delivery network by reducing its levels from three to two holds significant appeal for suppliers and customers aiming to cut costs and enhance service efficiency. While one potential solution involves identifying key nodes within the

existing three-tier network and upgrading them to serve as transshipment hubs in the simplified two-tier system, conventional optimization approaches often overlook the integration of empirical business data, composite metrics, and objective evaluation criteria. To address this gap, study [29] proposes an integrated approach that combines empirical data analysis, multi-criteria decision-making techniques, and mathematical optimization modeling, drawing insights from real-world applications at the SF Express Chengdu branch. By leveraging multiple centrality assessments from complex network theory and employing fuzzy Technique for Order Preference by Similarity to an Ideal Solution, authors of the study evaluate the suitability of candidate service points as potential transshipment facilities from both internal and external perspectives. Subsequently, they identify 16 optimal transshipment facility locations using a combination of these assessments, followed by the development of a multi-objective integer-programming model to determine the optimal number and coverage of service points for each transshipment facility. Multi-methodological approach demonstrates that the optimized two-tier network offers economic feasibility and practical applicability, resulting in an 18.41% reduction in total costs and a 6-hour decrease in average delivery time. This research holds practical significance and serves as a valuable reference for streamlining ground express service networks in large urban centers.

Integrated into the surface transportation system are connected and automated vehicles (CAVs), which rely on a wealth of information for safe operation, including both static data such as high-resolution navigation maps and real-time sensor inputs. These navigation maps, equipped with historical driving data, collaborate with sensors to assist CAVs in proactive maneuver planning, offering insights into driving behaviors at specific locations along routes. Pre-installing records of historical driving decisions can preemptively alert CAVs and drivers alerted to potential hazards, enhancing informed decision-making. The study [30] investigates the role of location-based driving volatility, measured by the frequency of extreme maneuvers at specific points in the road network, as a means of bolstering safety in CAV navigation. Through modeling and visualization of real-world data obtained from a connected vehicle safety program in Ann Arbor, Michigan, authors of the study demonstrate the significance of location-based volatility in predicting safety outcomes, suggesting its utility as a valuable addition to CAV navigation maps.

Unforeseen factors described in the above works within the decision-making process of Intelligent Transportation Systems (ITS) can negatively affect manageability if they remain undetected. Here they are:

F.2.1 Real-time sensor accuracy. The accuracy of sensor data, including traffic flow, weather conditions, and vehicle speed, may be unknown, influencing the reliability of predictions.

F.2.2 Weather unpredictability. Sudden weather changes, such as storms or heavy rainfall, can affect traffic conditions unpredictably, leading to uncertainty in traffic flow predictions.

F.2.3 Sensor malfunction: Malfunctioning sensors or data transmission errors can result in missing or erroneous data, affecting the quality of traffic flow predictions.

F.2.4 Road construction activities. Unforeseen road construction projects or closures may disrupt traffic patterns, introducing uncertainty into traffic flow predictions.

F.2.5 Vehicle breakdowns. Unexpected vehicle breakdowns or accidents can cause sudden changes in traffic flow, which may not be accounted for in prediction models.

F.2.6 Human behavior. Unpredictable driver behavior, such as sudden lane changes or reckless driving, can impact traffic flow and introduce uncertainty into prediction models.

F.2.7 Emergencies. Unexpected emergencies, like accidents or medical incidents, have the potential to disturb traffic patterns and cause unforeseen delays.

F.2.8 Traffic incidents. Unexpected traffic incidents, such as car crashes or spills of hazardous materials, can severely disrupt traffic flow and impact the precision of traffic predictions.

F.2.9 External events. Events like sports games, concerts, or protests can lead to unexpected increases in traffic volume, influencing traffic flow predictions.

F.2.10 System errors. Errors in prediction algorithms or model assumptions may result in inaccurate traffic flow predictions, especially in unstable or uncertain situation

These formulas can help organizations gain better visibility into their forecasting, planning, organizing, implementing, controlling and decision-making processes and identify areas for improvement. However, it is important to note that these formulas should be used in conjunction with other management tools and techniques to gain a complete understanding of manageability in the organization as mentioned above the factors that reduce the power, validity and application of formulas.

3. Results and Discussion

The exploration of traffic flow decision-making models within Intelligent Transportation Systems (ITS) demonstrates the efficacy of incorporating historical data and real-time information for optimal decision-making and traffic management. Models such as Dynamic Route Guidance, Traffic Signal Optimization, and Proactive Resource Allocation leverage these inputs to enhance efficiency and adaptability in traffic management. By applying Bayes' theorem, these models can adapt recommendations and allocations in real-time using observed data, resulting in smoother traffic flow, decreased congestion, and enhanced safety. However, challenges arise when variables influencing decision-making are uncertain or fluctuating. Factors like real-time sensor precision, unpredictable weather conditions, and human behavior introduce variability into prediction models, affecting their reliability. Addressing these challenges is essential to ensure the dependability and efficiency of Intelligent Transportation Systems in dynamic and uncertain conditions.

Leveraging the classification scheme established within our research framework, we will conduct a secondary data analysis to evaluate the alignment between our hypothesis and findings reported in prior study by [31], for Intelligent Transportation Systems.

In order to devise Traffic Flow Prediction Models based on the furnished dataset information, diverse methodologies can be employed, including time series analysis, machine learning algorithms, and deep learning models. We will employ our hypothesis about applicability of Bayes' theorem to analyze route selection, as proposed in the section "F.1.1.2 Traffic Flow Decision Making Model: Dynamic Route Guidance", formula [47]. The probability of selecting Route RF at P/Castellana station, considering traffic conditions (T) and decision parameters (D), will be computed using Bayes' theorem.

Bayes' theorem calculates the conditional probability of an event (selecting Route *RF*) given another event (specific traffic conditions) and prior knowledge. The formula is:

$$P(RF/T,D) = [P(T/RF,D) \times (RF/D)]/P(T/D) \quad (50)$$

where:

$P(RF/T,D)$ is probability of selecting Route RF given traffic conditions T and decision parameters D;

$P(T/RF,D)$ - likelihood of observing traffic conditions T given Route RF and decision parameters D;

$P(RF/D)$ - prior probability of selecting Route RF given decision parameters D;

$P(T/D)$ - total probability of observing traffic conditions T given decision parameters D.

Using average values from Tables 2 to 6 for P/Castellana station [31], yields:

P(T/RF,D) = 0.807 (Mean Max 12 h) - probability of traffic conditions *T* given Route *RF* and decision parameters *D* (from Table 2).

P(RF/D) = 0.775 (Mean Max 12 h) - prior probability of selecting Route *RF* given decision parameters *D* (from Table 2).

P(T/D) = 0.829 (Mean Max 12 h) - total probability of observing traffic conditions *T* given decision parameters *D* (assumed value).

The values are substituted into the formula:

$$P(RF/T,D) \approx (0.807 \times 0.775)/0.829 \approx 0.759 \quad (51)$$

Based on Bayes' theorem, the calculated probability of selecting Route RF given specific traffic conditions and decision parameters is approximately 75.9%. However, this value differs from the actual probability provided by the data (approximately 65.58%).

The authors recognize the presence of a potential difference between the calculated and observed probability values. This divergence may be attributed to a number of factors, including:

Limited Scope of the Comparison. The data used for comparison may not fully encompass the range of conditions considered by the researchers conducting the study or the model developers.

Model Simplifications. The computational model employed might have necessarily simplified certain aspects of route selection, potentially influencing the final probability calculations.

Evaluation of Results. The authors acknowledge the potential disparity in probability values, attributing it to factors undisclosed in comparison to the researchers conducting the study. Nevertheless, we deem the obtained results as acceptable, corroborating our hypothesis.

Leveraging the data presented in current section and in Tables 1-6 [18], the following conclusions can be drawn regarding our hypothesis:

Conclusion 1. Under conditions of high manageability (stable and known situations), the application of formulas for decision-making in Intelligent Transportation Systems (ITS) is well-justified.

Conclusion 2. Under conditions of low manageability (unstable and highly uncertain situations), Intelligent Transportation Systems employing judgment-based strategies are likely to be better equipped to navigate challenges and uncertainties.

Our hypothesis regarding manageability in two distinct states ("stable and known situation" and "unstable and highly uncertain situation") finds substantial support from the analyzed data and existing research. However, limitations exist within highly uncertain situations. Further research is needed to develop more specific hypotheses tailored to these

conditions and to validate or reject them through rigorous testing. We believe this study provides a foundation for further investigation and exploration within this domain.

4. Conclusions

The presented study aimed to identify the dichotomous scenarios influencing Intelligent Transportation Systems efficacy and identify models for real-time traffic flow manageability and decision-making in Intelligent Transportation Systems. The proposed models highlights two key determinants impacting an Intelligent Transportation System's manageability:

I. Definite Knowledge, Stable Situations: When decision-making relies on well-defined algorithms and occurs within predictable contexts, manageability is maximized.

II. Uncertain Knowledge, Unstable Situations: Conversely, when decision-making is characterized by ambiguity and unfolds under unpredictable circumstances, manageability is reduced.

However, it is crucial to acknowledge the inherent limitations of real-world decision-making environments, especially within Intelligent Transportation Systems. While algorithms can be powerful tools, they are incapable of capturing the numerous complexities inherent to real-world scenarios, such as temporal constraints, resource scarcity, and ethical dilemmas.

The proposed models functions as a conceptual framework for managers, facilitating their navigation managing Intelligent Transportation Systems. Managers within Intelligent Transportation Systems are encouraged to:

1. Evaluate the Situation: Ascertain the level of predictability within the scenario.
2. Adapt the Model: Modify, combine, or develop new models to address specific requirements.
3. Utilize Experience and Judgment: Leverage their expertise and ethical compass to scrutinize, judge, and formulate optimal courses of action.

The interplay between the models and the prevailing environment is dynamic, necessitating continuous reassessment and recalibration. Success hinges on achieving a harmonious balance between the model's guidance and the unique demands of each situation.

The interplay between the model and actual decision-making is complex, influenced by a multitude of variables. While the model aids in identifying manageable scenarios, certain situations fall outside its scope. This emphasizes the need for further scholarly exploration to unravel the intricacies of decision-making in multifaceted environments.

While unforeseen difficulties may arise, collaborative efforts guided by ethical considerations and resolute action from both traffic managers and traffic participants can potentially lead to the achievement of desired outcomes within Intelligent Transportation Systems and be extant.

Conflicts of Interest. The authors declare no conflict of interest.

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SUSTAINABLE DEVELOPMENT OF RURAL AREAS IN THE REPUBLIC OF MOLDOVA THROUGH INCREASING THE EFFICIENCY OF THE LAND RESOURCE USE IN THE AGRICULTURAL SECTOR

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Abstract. The evaluation of the agricultural land in the Republic of Moldova represents the main factor in the sustainable rural space development and it emphasizes economic criteria for the efficiency of land resources. The hedonic price in the sales-purchase transactions of parcels in agricultural land may be the scientific innovation and originality of the geographically weighted regression methodology with the spatial approach in the used econometric model. The price of agricultural land used parcels in Maiovca village, Ocnița district were evaluated by using the data from transactions registered in 2022 and the results of the geographically weighted regression stands up the suitable conclusions of the licensed assessors in the field. The autocorrelation coefficient value evaluated by SAR is ρ = 0.072 according to Cobb Douglas model confirms the high quality of the regression techniques carried out and the used spatial methodology can be implemented in cadastral practice for the taxation in the agrarian sector. The geographically weighted regression utility proposed in this methodology has advantage in research area because of the similar evaluation techniques carried out in the countries of the European Union that are adjacent to the Republic of Moldova.

Keywords: *agricultural land, cadastral code, transactions evaluation, spatial econometric model, adjacency matrix.*

Rezumat. Evaluarea terenurilor agricole în Republica Moldova stă la baza componentei economice a dezvoltării durabile a spațiului rural, determinând eficiența utilizării resurselor funciare. Prețul hedonic în tranzacțiile de vânzare-cumpărare a parcelelor reprezintă noutatea științifică în metodologia regresiei geografic ponderate cu abordarea spațială în modelul econometric realizat. S-au calculat prețurile parcelelor pentru comuna Maiovca din raionul Ocnița în baza tranzacțiilor înregistrate pentru anul 2022. Rezultatele regresiei geografic ponderate confirmă concluziile corespunzătoare a evaluatorilor licențiați din teren. Valoarea coeficientului de autocorelație evaluat ρ = 0,072 conform modelului Cobb Douglas confirmă calitatea tehnicilor de calcul realizate și metodologia spațială propusă poate fi implementată

în practica cadastrală cu scopul impozitării în sectorul agrar. Utilitatea regresiei geografic ponderate în calitate de metodologie propusă este evidentă sub aspectul tehnicilor similare de evaluare realizate în țările Uniunii Europene adiacente Republicii Moldova.

Cuvinte cheie: *terenuri agricole, cod cadastral, evaluarea tranzacției, model econometric spațial, matrice de adiacență.*

1. Introducere

Referitor la anul 2023 se poate afirma că fiind dotată cu cernoziomuri agricole bogate și un climat temperat, Republica Moldova, de-a lungul istoriei sale, s-a bazat în mare măsură pe agricultură și ea dispune de 2493 mii ha de teren agricol. Suprafața totală disponibilă de 3384,9 mii ha este împărțită aproximativ în 91% mediu rural și 9% mediu urban. Utilizarea terenurilor agricole cuprinde aproximativ 73,6% din suprafața totală a terenurilor Republicii Moldova. Conform datelor statistice oficiale 74,9% din terenurile agricole sunt arabile și doar 10,8% din acestea sunt acoperite cu plantații multianuale [1]. Pădurile acoperă aproximativ 13,8% din suprafața totală a terenurilor. Conform codului cadastral autohton, suprafața resurselor funciare poate fi structurată în modul următor:

- 75% din teritoriu este acoperit de cernoziomuri.
- 28,8% din populație este ocupată în sectorul agrar, care produce 15% din PIB-ul țării.
- 55,1% din populație locuiește în sate.
- 69% din terenuri sunt în proprietate privată.

Tabelul 1

Informația primară referitor la suprafața terenurilor agricole și numărul tranzacțiilor de cumpărare-vânzare în perioada anilor 1999-2022

Anii	Numărul tranzacțiilor vânzare-cumpărare, unități	Suprafața terenurilor vândute-cumpărate, ha		Prețul de piață (vânzare-cumpărare)		Ponderea suprafe ețelor vândute - cumpărate, %	Suma totală a tranzacțiilor de vânzare-cumpărare	
		Total	În calcul la o tranzacție	Lei MD/ha	Dolari SUA/ha		Milioane lei, MD	Mii dolari, SUA
1999	1931	1454,0	0,75	3323	315,75	0,08	4,83	459,1
2000	9753	7338,0	0,75	3687	296,54	0,40	27,05	2176,0
2005	47382	21825,0	0,46	4778	379,21	1,18	104,28	8276,3
2015	30805	18379,9	0,60	17757,2	943,72	0,99	326,36	17345,5
2016	30514	18201,0	0,59	22556,5	1132,14	0,98	410,55	20606,1
2017	30224	18082,0	0,60	27356	1479,50	0,98	494,65	26752,3
2019	28550	17215,8	0,60	23542,6	1286,50	0,93	405,31	22148,1
2020	27480	16392,1	0,66	19422,8	1121,41	0,88	318,38	18382,3
2021	24362	14490,5	0,59	27434,8	1551,74	0,78	400,16	22633,4
2022	17829	11787,5	0,66	43946,7	2326,45	0,63	518,02	27423,3

Sursa: Elaborat de autor în baza datelor primare colectate.

În Republica Moldova, contribuția sectorului agricol la PIB a înregistrat o scădere abruptă în ultimii 20 ani, trecând de la 30-35% în anul 2000 la 12-13% în ultima perioadă. Paralel, ponderea ocupării forței de muncă în agricultură a scăzut de la 40-45% la 30-35% în anul 2023. Această tendință de scădere este mult mai accentuată în comparație cu alte țări

din regiune (cum ar fi Georgia, Belarus și Azerbaidjan). Migrația populației a dus la un real deficit de forță de muncă în mediul rural și procentul populației rurale în totalul populației a rămas în jur de 40-45% în comparație cu 55-60% în anul 2000. În ceea ce privește veniturile, sectorul agricol înregistrează cele mai mici venituri medii lunare comparativ cu alte sectoare ale economiei, evoluând de la 500-600 lei în 2004 la 1200-1800 lei în 2011. Referitor la anul 2023 cele mai mici valori ale câștigului salarial mediu lunar au fost înregistate în activitățile de agricultură, silvicultură și pescuit cu valoarea aproximativ 7000 lei. Sectorul agrar în Republica Moldova se evidențiază prin unul dintre cele mai mari nivele de utilizare a terenurilor agricole, terenurile arabile reprezentând 55,1% din totalul acestora. Însă sub aspectul eficienței economice fondul funciar cu destinație agricolă este fragmentat în mare măsură ca urmare a reformei funciare din 1998. În comparație cu țările din Uniunea Europeană (UE), Republica Moldova are în general o productivitate agricolă mai redusă, fiind influențată de mai mulți factori, cum ar fi infrastructura agricolă învechită în anumite zone, utilizarea limitată a tehnologiilor moderne, fragmentarea terenurilor agricole, accesul limitat la finanțare pentru investiții agricole și fluctuațiile climatice [2].

Ponderea sectorului agrar în totalul investițiilor în mijloace fixe a rămas redusă în ultimii 10 ani, activitatea agricultură, silvicultură și pescuit constituind 7,7% în anul 2020, 9,3% în anul 2021 și 12,5 % în anul 2022, observându-se tendința de creștere a acestui indicator. Totuși, deficitul de finanțare pentru agricultură rămâne semnificativ (60-70%), iar balanța comercială înregistrează o tendință negativă, pe fondul unei creșteri semnificative a importurilor de produse agroalimentare comparativ cu exporturile. În ceea ce privește exportul, Republica Moldova domină în principal în sectorul băuturilor alcoolice, deși ponderea acestora în exporturi a scăzut de la 45% în 2000 la 22-23% în 2012. Alte produse importante în export sunt fructele, nucile, semințele și fructele oleaginoase. De asemenea, Republica Moldova se remarcă ca fiind singura țară în lume cu aproximativ 80% din teritoriul său acoperit de soluri cernoziomice. Structura terenurilor agricole după bonitate (grad/ha) este următoarea: diapazonul 81-100 reprezintă 26%; diapazonul 71- 80 reprezintă 20%; diapazonul 61-70 reprezintă 15%; diapazonul 51-60 reprezintă 15%; diapazonul 41-50 reprezintă 11%; diapazonul 21-40 reprezintă 6%; și diapazonul 0-20 reprezintă 7%. În rezultatul realizării reformei funciare în Republica Moldova structura fondului funciar include după destinație următoarele componente:

- cu destinație agricolă – 59%;
- silvic – 13%;
- de rezervă – 14%;
- ape – 3%;
- industrie și transport – 2%;
- localități – 9% [3].

Piața funciară a Republicii Moldova este relativ tânără. Pe parcursul perioadei de 20 ani de funcționare, ea a trecut prin schimbări radicale în ce privește structura tranzacțiilor, argumentarea științifică a calculării prețului de piață, operativitatea efectuării tranzacțiilor etc. În baza datelor cadastrale sistematizate se înregistrează o tendință dinamică de creștere a prețului de piață a terenurilor agricole în Republica Moldova. Piața funciară agricolă constituie un factor important în formarea și dezvoltarea celor mai competitive forme organizatorico-juridice de utilizare a trenurilor, prin formarea unor suprafețe optimale. În ultimul deceniu în Republica Moldova tot mai activ merge procesul de formare a pieței terenurilor, și în particular a pieței terenurilor cu destinație agricolă. În mediul de afaceri din

țară crește înțelegerea, că pământul nu e doar un factor de producere de bază, ci și un activ prețios, care poate genera venituri comparabile cu investițiile în instrumentele financiare. Este evident, că investițiile în terenuri agricole sunt expuse și unor riscuri majore, ca consecință a pieței funciare slab dezvoltate, lipsa informației transparente și obiective privind valoarea terenurilor [4].

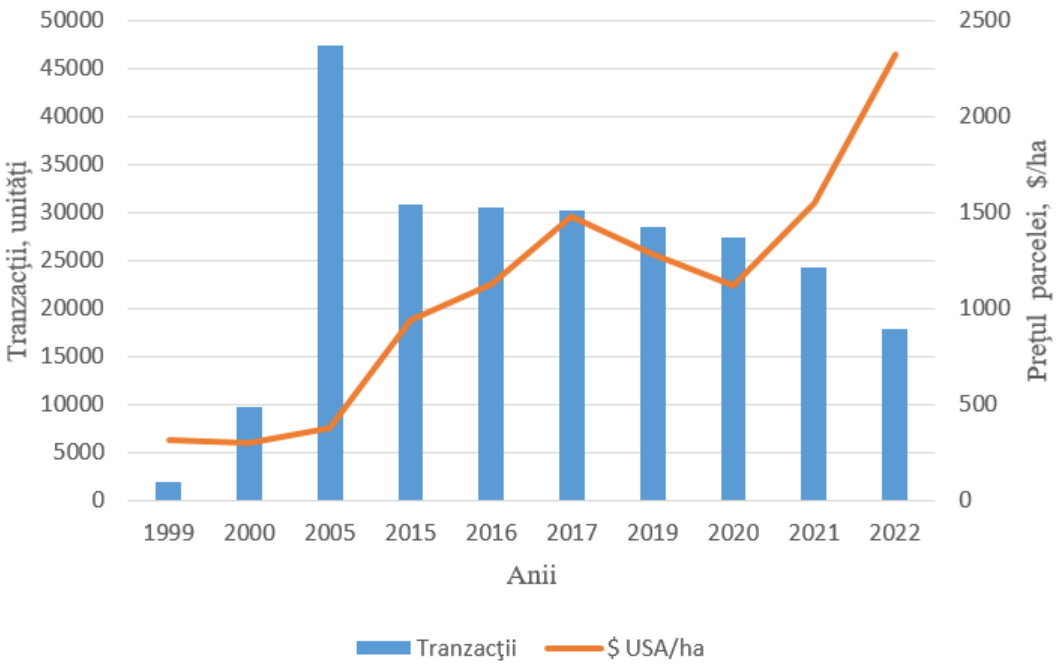

Figura 1. Prețul terenurilor agricole în tranzacțiile vânzare-cumpărare, dolari SUA per 1 ha.
Sursa: Elaborat de autor în baza datelor primare colectate.

În astfel de condiții, un rol foarte important revine evaluării adecvate a terenurilor cu destinație agricolă. Cu atât mai importantă a devenit evaluarea terenurilor pentru determinarea impozitului funciar, ca sursă importantă de formare a bugetelor locale. Analizând situația din țară, se poate de afirmat, că piața terenurilor agricole se află la un nivel de dezvoltare destul de slab. Această piață se caracterizează prin lipsa unei baze unice privind prețurile actuale de tranzacții cu terenurile agricole. Fiecare companie își creează baza proprie de date. Crearea unei baze de date cu prețurile reale de tranzacționare din contratele de vânzare-cumpărare ar prezenta un pas pozitiv în dezvoltarea pieței funciare. Însă, la moment avem diferențe semnificative între prețurile indicate în contracte și prețurile reale [5].

În rezultatul analizei pieței funciare, datele primare referitor la numărul tranzacțiilor de vânzare-cumpărare și prețul de piață (în lei și dolari SUA) sunt prezentate în Tabelul 1. În contextul pieței terenurilor agricole, vânzările directe reprezintă doar o treime din totalul tranzacțiilor. Celelalte două treimi constau în moșteniri, dăruri, schimburi, arendă pe termen lung și includerea în capitalul întreprinderilor. Anual, aproximativ 17,0 mii hectare sunt vândute, constituind 1,0 % din totalul terenurilor agricole private (1701,86 mii ha), restul de 2,0 % fiind atribuit altor tipuri de tranzacții. Este semnificativ faptul că, conform Agenției Servicii Publice, odată la 30-35 de ani (media fiind 33 de ani), terenurile agricole schimbă proprietarul, reflectând longevitatea unei generații de fermieri activi. Aceste informații subliniază importanța diversității tranzacțiilor în piața terenurilor agricole și implicarea ciclică a schimbării proprietății în dinamica economică a sectorului.

Subiectiv, abordarea pieței funciare impune modalitatea de schimb a terenurilor prin decizia proprietarului. După cum a fost deja menționat se poate afirma că aproximativ o treime

din aceste tranzacții duc la vânzarea terenurilor, suplimentar o altă treime decizia de schimbare a proprietarului se rezumă la moștenire sau dăruire, iar restanța în volum de o treime presupune modalități de tranzacționare alternative.

În conformitate cu Tabelul 1 este evident trendul ascendent în numărul de tranzacții vânzare-cumpărare și prețul de piață în valută națională este în creștere. Diferențele mari referitor la prețul unitar la hectar pentru diferite perioade de timp sunt cauzate de factorii tehnologici a parcelelor (distanța până la primăria comunei aferente, distanța până la drum cu acoperiș rigid, expoziția geografică preponderent sudică, altitudinea pe pantă și bonitatea), precum și de factorii economici (rata dobânzii Băncii Naționale a Republicii Moldova, inflația și cursul valutar). Se poate afirma din datele tabelului 1 că valoarea medie de piață a unui hectar de teren agricol în perioada de studiu a crescut de la 3,4 mii lei pe un hectar în anul 1999 până la 19,7 mii lei în anul 2021. Prezentarea grafică a trendului ascendent în evaluarea dinamică a terenurilor agricole este expusă în Figura 1 cu numărul de tranzacții realizate în partea stângă, iar în partea dreaptă a imaginii scara referitor la prețul parcelei în dolari SUA [6].

Pe parcursul anilor, de asemenea, și nivelul calității informației este diferit. Dacă în anul 1999 au fost înregistrate în total doar 1933 de tranzacții pe o suprafață de 232 hectare, atunci calculele estimării valorii pentru anul 2016 sunt bazate pe 367 mii de tranzacții cu o suprafață totală de 135 mii hectare. Evident că și nivelul de veridicitate a informației selectate în anul 2016 este mai ridicat. Printre factorii generali care au influențat nemijlocit asupra prețului de vânzare-cumpărare a terenurilor agricole sunt:

- ridicarea nivelului de maturitate a pieței;
- raportul dintre cerere și ofertă;
- politica investițională;
- politica subvențională.

Totodată, analiza grafică a valorii medii a terenurilor agricole ne arată, că pe parcursul studiului valoarea terenului a suferit diferite etape de dezvoltare: creștere, stagnare și chiar cădere. Este rezonabilă întrebarea: sub acțiunea căror factori valoarea medie de piață a terenurilor agricole se află în cădere. Unul din cei mai previzibili factori care devalorizează terenul agricol este inflația înaltă al valutei naționale. Anual doar din motivul inflației valoarea terenului cade aproximativ cu 10 la sută. Rata înaltă a inflației influențează negativ asupra valorii terenurilor agricole [7].

2. Materiale și Metode

Modelul de evaluare a terenurilor cu destinație agricolă ca orice model economic reflectă anumite relații cadastrale fundamentale, însă, nu poate cuprinde realitatea economică în întreaga sa complexitate. Modelul de evaluare a terenurilor cu destinație agricolă oferă o imagine schematizată a trăsăturilor esențiale, considerate de cercetători, de aici și importanța majoră a teoriei economice pentru reușita modelării.

Database Navigator reprezintă o interfață și mediu de programare care definește structura și conținutul bazelor de date, conform Figurii 2 [8]. Pentru a deschide baza de date *LC_cadastr.dbf* în mediul Windows aplicăm meniul *View*, prin care se deschide structura bazei de date cadastrale și ferestrele aferente tipurilor de variabile endogene și exogene. Structural baza de date este prezentată în format de arbore a obiectelor înserate ca noțiuni aparte și conțin următoarele elemente:

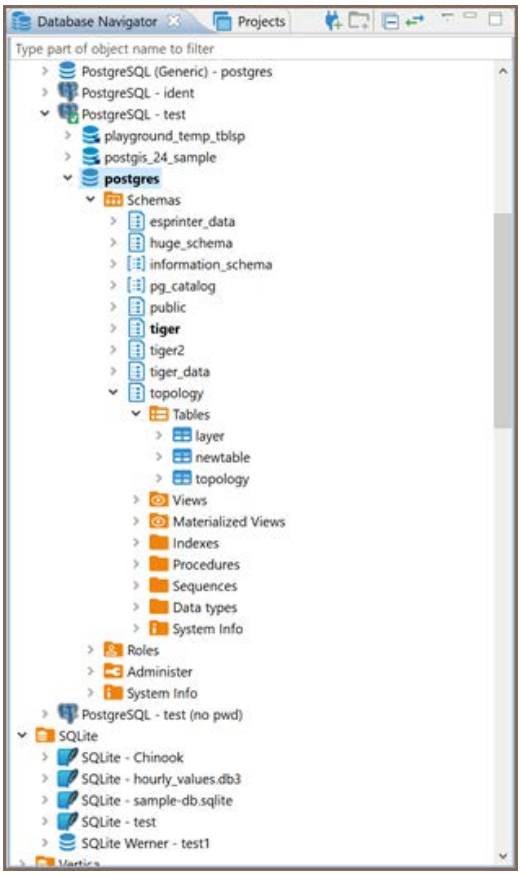

Figura 2. Interfața Database Navigator a bazei de date DBeaver cu indicarea meniului și a structurii mapelor cu evidențierea obiectelor înserate**.**

- mape cu fișierele referitor la scripturile SQL de prelucrare primară a datelor cadastrale, variabilele endogene și exogene;
- interogările în cadrul tabelelor DBeaver și alte etichete a bazelor de date;
- obiectele DBeaver incluse în Application Window Overview – tabele, limitări, indecși, secvențe, triggeri.

Înțelegerea științifică a teoriei economice permite selectarea variabilelor esențiale, stabilirea relațiilor de interdependență. În procesul modelării econometrice este necesară formalizarea legăturilor dintre categoriile economice definite mai întâi ca variabile de model. În așa fel se alcătuiește modelul calitativ al fenomenului procesului, model care se fixează sub formă de diagrame de fluxuri. Interdependențele dintre fenomene se descriu sub forma unor ecuații, iar parametrii variabilelor caracterizează structura legăturii dintre variabile. Conceptual, elaborarea metodologiei de realizare a modelelor econometrice de evaluare a terenurilor cu destinație agricolă impun necesitatea definirii factorilor endogeni (care influențează prețul de piață a parcelelor) și a factorilor exogeni (cauzali, care caracterizează proprietățile fizico-chimice sau tehnologice a parcelelor aflate în gestiunea proprietarilor). Factorii determinanți ai prețului terenurilor agricole pe piața funciară din Republica Moldova pot fi caracterizați sub aspectul informației cadastrale primare din baza de date a *LC_cadastr.dbf* . Instrumentarul de bază în realizarea colectării parametrilor tehnologici a unităților cadastrale reprezintă aplicația DBeaver care este o bază de date universală open-source și care suportă un set larg de date primare în formatul SQL, NoSQL și altele. De asemenea, ea permite utilizarea mediului de programare tradițional cu o interfață comodă

pentru lucrul curent cu baza de date, redactarea și modificarea cu analiza economică de referință.

Utilizarea instrumentarului bazei de date presupune definirea accesului la informația structural aranjată conform formatului implicit cu limitarea posibilității divulgării datelor personale cadastrale [9]. Metodologic evaluarea terenurilor agricole în Republica Moldova are la bază conceptul prețurilor hedonice pe piața funciară și aplicația utilizată spatial autoregressive model (SAR) reprezintă instrumentarul de bază în definirea algoritmului de calcul. Argumentarea abordării dependenței autocorelative a prețurilor se bazează pe nonstaționaritatea spațială și este o condiție fundamentală în criteriile de elaborare a modelului econometric cu opțiunea de ponderabilitate geografică.

$$\begin{gathered} y = \rho * W * y + X * \beta + \varepsilon \\ y = (I_n - \rho * W)^{-1} * X * \beta + (I_n - \rho * W)^{-1} * \varepsilon \\ \varepsilon \sim N(0, \sigma^2 * I_n), \end{gathered} \tag{1}$$

unde:

β – parametrii ecuației de regresie spațială;

X – variabilele exogene incluse în model (suprafața parcelelor, bonitatea, perimetrul, distanța până la sat, distanța până la drum, înclinația, expoziția și altitudinea);

y – prețul tranzacțiilor de cumpărare-vânzare a terenurilor agricole;

ρ – componenta spațială în ecuația de regresie;

W – matricea de adiacență s parcelelor;

I_n – matricea unitară n dimensională;

σ – abaterea medie pătrată a reziduurilor în cadrul distribuției normale (Gauss) cu media aritmetică egală cu zero și dispersia σ^2;

ε – componenta aleatoare a modelului regresional (reziduurile).

Obiectivul principal în cadrul utilizării regresiei geografic ponderate constă în identificarea tipului relațiilor care există între variabilele exogene și endogene [10]. Aceasta poate fi realizată prin calcularea statisticilor sau estimarea parametrilor β pentru valori calculate la diferite parcele cu o spațiere diferită și zonă valorică specifică. Implicit se presupune că statisticile evaluate a parametrilor sunt constante în spațiu, deși presupunerea utilizată este în mare măsură discutabilă și componenta hedonică a modelului impune valori contradictorii. Rezonabil putem presupune că în ecuația 1 există relații autocorelative de nivel lag AR(1), AR(2)... ce au o componentă spațială intrinsecă și care generează probleme nesoluționate referitor la specificarea modelului econometric
cu consecințe grave pentru componenta aleatoare ε (reziduurile conform testului Jarque-Bera nu suportă o distribuție normală cu media aritmetică zero și dispersia staționară σ^2).

Tabelul 2

Analiza pieței funciare pentru anul 2018 conform regiunilor administrative a Republicii Moldova

Regiuni		Numărul de tranzacții	Suprafața totală a terenurilor, ha	Prețul mediu ponderat pentru 1 ha, lei	Suma totală a plăților de vânzare-cumpărare, mii lei
Regiunea de Nord		10775	7146	21196	151472605
1.	mun. Bălți	122	78	47530	3708200
2.	Briceni	480	307	14861	4555679

Continuare Tabelul 2

3.	Dondușeni	493	368	27350	10063297
4.	Drochia	559	526	20235	10650594
5.	Edineț	1158	829	18652	15456055
6.	Fălești	509	269	23974	6441472
7.	Florești	220	203	20412	4153682
8.	Glodeni	1040	573	24830	14223581
9.	Ocnița	833	664	25610	16999092
10.	Râșcani	1405	915	22991	21033380
11.	Sângerei	1365	592	28081	16618673
12.	Soroca	2591	1823	15121	27568900
Regiunea de Centru		10049	5247	20928	109813003
13.	mun. Chișinău	307	165	101484	16711151
14.	Anenii Noi	807	777	14094	10947087
15.	Călărași	701	206	18125	3742578
16.	Criuleni	113	129	25192	3244191
17.	Dubăsari	470	253	21287	5379718
18.	Hâncești	832	339	14861	5040827
19.	Ialoveni	1265	549	33130	18186366
20.	Nisporeni	893	362	15474	5599744
21.	Orhei	1750	733	14597	10706173
22.	Rezina	254	225	21739	4882081
23.	Strășeni	666	271	15807	4290606
24.	Șoldănești	1064	618	14118	8729603
25.	Telenești	254	147	23129	3395041
26.	Ungheni	673	473	18927	8957836
Regiunea de Sud		5504	3513	14654	51486132
27.	Basarabeasca	286	194	21097	4083216
28.	Cahul	699	573	17165	9827720
29.	Cantemir	641	375	17903	6708248
30.	Căușeni	731	478	15148	7239536
31.	Cimișlia	195	208	25824	5377136
32.	Leova	2272	1244	8747	10878899
33.	Taraclia	172	233	13673	3180601
34.	Ștefan Vodă	508	210	19951	4190777
UTA Găgăuzia		548	443	22110	9789920
Total		26876	16350	19729	322561660

Sursa: Elaborat de autor în baza datelor BNS.

În rezultatul analizei pieței funciare în Republica Moldova pentru anul 2018 se poate afirma că abordarea hedonică a tranzacțiilor de cumpărare-vânzare a terenurilor agricole se confirmă din datele Tabelului 2. Dacă în unele zone prețurile oferite la vânzarea unui hectar s-au majorat, interesul de cumpărare a scăzut. Totuși, după o mică stagnare, agricultorii încă păstrează interesul față de achiziționarea terenurilor agricole. Principalele criterii de stabilire a prețurilor sunt: bonitatea, amplasarea, accesul la irigare, infrastructura, căile de acces și altele. Consecințele acestei abordări (presupunerea că $\rho=0$) implică o distribuție neadecvată a parametrilor ecuației de regresie și valoarea β este deplasată (bias în abordarea BLUE). Evident că modelul regresional geografic ponderat prezentat în ecuația 1 conține elemente care dau posibilitate de a depăși aceste impedimente prin intermediul matricei de adiacență *W* conform:

$$W_{ij} = \exp[-\frac{1}{2} * \left(\frac{d_{ij}}{h}\right)^2] \quad (2)$$

unde:

d_{ij} – reprezintă distanța între parcela *i* și parcela *j*;

h – criteriul de fidelitate a componentei spațiale în modelul econometric și în opțiunea creșterii acestui parametru valoarea parcelei evaluate include implicit mai multe parcele adiacente cu prețul de tranzacție definit. În concluzie, se poate afirma că metoda regresiei ponderate geografic (GWR) permite evaluarea parametrilor *β* în formatul BLUE și valorile prețului terenurilor agricole evaluate în baza modelului prezentat în ecuația 1 sunt adecvate pieței funciare [11].

3. Rezultate și discuții

Evaluarea distribuției prețului de vânzare-cumpărare a terenurilor agricole necesită o abordare metodologică adecvată, care se bazează pe conceptul econometriei spațiale și dă posibilitatea de a obține valori a tranzacțiilor funciare nedeplasate și BLUE. Datele primare oferite de oficiile cadastrale raionale reprezintă un suport semnificativ în definirea criteriilor de evaluare funciară. Cele mai mari prețuri pentru terenul agricol, tradițional, sunt oferite în zona de nord a țării. Prețul unei cote ajunge până la 70-80 mii lei (45-50 mii lei/ha). În raioanele Dondușeni, Drochia prețul este de aproximativ 45 mii lei/ha. În raionul Briceni prețul unei cote de teren este de 60-80 mii lei/ha sau 40-53 mii lei/ha. La Soroca prețul unui hectar de teren era de aproximativ 50-60 mii lei. Cele mai mari prețuri sunt oferite pentru terenurile amplasate în apropierea râului Nistru, fapt determinat de posibilitățile de irigare a acestora: prețul de vânzare variază între 100 și 150 mii lei/ha. În zona raionului Florești prețul unui hectar era de aproximativ 25-35 mii lei. Prețul unui hectar de teren agricol la Ialoveni varia de la 60 la 100 mii lei, însă vânzările au fost realizate rar după un an anevoios. În raionul Telenești prețul oferit pentru o cotă echivalentă cu 2,2 ha era de 80 mii lei. Respectiv, prețul per hectar este de puțin peste 35 mii lei. În raionul Leova, terenul arabil se vinde cu prețul 15-25 mii lei. Terenurile pentru cultivarea viței de vie se vând cu 30-40 mii lei/ha. În zona de sud (Basarabeasca, Comrat) se oferă prețul maxim de 20-30 mii lei/ha. Totuși, odată cu creșterea prețului până la 30 mii lei, s-a redus numărul de tranzacții [12].

Piața terenurilor agricole în anul 2018 s-a schimbat puțin comparativ cu anul precedent. În 2018 s-a realizat un sondaj în rândul producătorilor agricoli pentru a afla prețul oferit per hectar de teren agricol în diferite raioane ale țării. Mai jos prezentam prețurile medii de comercializare a terenurilor agricole în acest an. Rezultatele cercetării scot în evidență faptul că există o legătură directă dintre eficiență și preț. Astfel, prețuri mai mari pentru terenurile agricole sunt oferite în zonele unde abordarea tehnologică progresivă în agricultură este mai dezvoltată, iar numărul persoanelor implicați în sector este mai mare. Totodată, asupra prețului influențează bonitatea terenului și amplasarea acestuia față de căile de acces. Suprafața parcelei la fel influențează asupra prețului. În zona de nord, la Briceni sunt unele dintre cele mai mari prețuri pentru terenurile agricole, 60-100 de mii de lei (aproximativ 3-5 mii de euro) sunt oferiți per cotă (1,2 ha), iar la Ocnița 60-80 de mii de lei (aproximativ 3-4 mii de euro). Un preț mediu de 30-40 mii lei/ha este oferit în raionul Dondușeni, iar în raionul Drochia prețul unui hectar de teren este de aproximativ 30-35 de mii de lei. La Soroca, prețul mediu de comercializare este de 80-100 de mii de lei, iar cu acces la irigare ajunge și la 150 de mii de lei [13].

Tabelul 3

Datele primare referitor la variabilele endogene și exogene pentru comuna Maiovca, raionul Ocnița în anul 2022

Cod cadastral	Valoarea tranzacției din contract, lei	Suprafața, ha	Bonitatea solului, bal	Perimetrul parcelei, m	Distanța sat, m	Distanța drum, m	Panta, grade	Expoziția, grade	Altitudine, m	Coordonata X	Coordonata Y
62371020007	75000	1,470	62	622	2913	283	5,27	76	226	126382,0592	362866,1174
62371020031	75000	1,330	62	604	2641	340	4,95	86	220	126502,7070	362699,0874
62371020083	108359	1,404	61	644	4047	87	0,57	138	244	125610,4538	364054,4466
62371020084	108359	1,683	61	574	4141	135	1,30	170	246	125665,5074	364066,6200
62371020086	108359	1,434	61	535	4276	270	3,20	136	252	125823,3380	364101,5288
62371020117	75000	1,537	61	554	3710	200	3,53	162	244	126003,0994	363829,8618
62371020203	10000	0,118	78	213	1976	5	2,51	151	246	127286,5596	362503,4590
62371020205	10000	0,118	78	213	2001	7	1,48	117	246	127266,6192	362518,8454
62371020213	10000	0,118	62	221	2091	202	2,40	144	239	127076,5972	362424,9812
62371020233	14196	0,131	62	228	2366	198	4,43	109	241	126853,4562	362607,3942
62371020234	13678	0,131	62	228	2379	198	4,69	126	240	126843,3414	362615,5218
62371020271	13481	0,131	78	216	2446	5	0,83	66	246	126909,4624	362808,2780
62371020272	13725	0,131	78	216	2460	4	0,47	64	246	126898,8326	362817,1738
62371020334	4220	0,132	62	244	2610	191	5,27	114	234	126664,9770	362762,2436
62371020336	4221	0,132	62	216	2611	94	4,71	148	243	126722,0736	362840,6964
62371020341	4223	0,133	62	218	2610	1	2,79	115	246	126793,8481	362904,0614
62371020346	4221	0,132	62	216	2724	92	4,80	109	240	126634,4094	362911,9146
62371020351	5000	0,133	62	216	2653	93	5,63	102	241	126689,1962	362867,4074
62371030019	13906	0,129	62	238	3353	128	4,53	108	235	126283,4284	363456,6898
62371030042	13265	0,129	62	240	3398	230	5,32	88	237	126323,5220	363559,6034

Sursa: Elaborat de autor în baza datelor primare colectate.

La Râșcani, prețul mediu este de 40-45 de mii de lei. La Florești prețul mediu a unui hectar de teren agricol este de 30-35 de mii de lei. La Glodeni, prețul mediu este de 50 mii lei/ha, la Șoldănești 25-40 de mii de lei, iar la Fălești 40-50 de mii de lei. La Criuleni, prețul unui hectar de teren agricol este de aproximativ 60-100 de mii de lei. La Hâncești, prețul per hectar variază de la 25-45 de mii de lei, iar la Strășeni un hectar costă 25-30 de mii de lei. La Cimișlia, în medie, un hectar de teren agricol poate fi cumpărat cu 40-45 de mii de lei, în unele localități ajungând și la 47 de mii de lei sau chiar mai mult [13].

Tabelul 4

Rezultatele evaluării prețului terenurilor agricole în comuna Maiovca r-l Ocnița în anul de referință 2022

Cod cadastral	Suprafața, ha	Valoarea tranzacțiilor din contract, lei	Valoarea calculată cu modelul SAR, lei
62371080064	1,4441	40000	50828
62371080065	1,4188	40000	51350
62371080098	1,3029	73000	44217
62371080125	1,6929	70000	57627
62371080126	1,6869	70000	57890
62371090041	0,3937	7000	15710
62371090060	1,2681	37000	46207
62371090061	1,4074	30000	50567
62371100108	1,1224	72000	41112
62371100273	1,2108	60000	41365
62371110129	1,1154	35000	37717
62371110186	1,2192	60000	43136
62371110235	1,4665	70000	49574
62371130029	1,1767	55000	42634
62371130037	1,1402	60000	37322
62371140204	1,5574	75000	53350
62371140301	1,2400	50000	43757
62371140377	1,0961	12000	38364
62372060418	0,2823	8500	11392
62372060419	0,1411	4250	6327
62372060498	0,2825	10735	11496
62372060536	0,2826	15000	11976

Sursa: Elaborat de autor în baza datelor primare colectate. Spatial autoregressive model (SAR).

La Cahul, prețul mediu de comercializare al unui hectar de teren agricol este de 50 de mii de lei. Pentru anul 2018 au fost analizate prețurile reflectate in contractele de vânzare-cumpărare. S-au calculat prețurile medii, preventiv excluzând extremele, care nu reflectă situația reală pe piață.

În cadrul cercetării curente au fost colectate datele primare conform variabilelor indicate în modelul econometric ponderat spațial din ecuația 1 pentru comuna Maiovca raionul Ocnița în anul de referință 2022. Contractele care includ tranzacții multiple cu parcele diferite per proprietar sunt excluse din Tabelul 3 ca exemplu de date eronate care nu trebuie luate în considerație pentru prelucrarea econometrică. Informația primară include codul cadastral al

parcelei unice (după proprietar) cu coordonatele cartografice (coordonata X și coordonata Y în formatul hărților 4026). Valoarea tranzacțiilor incluse în contractul de vânzare-cumpărare este prezentată în lei la cursul valutar pentru perioada respectivă, de aceea evaluarea curentă a parcelelor în valută ($ USA) trebuie ajustată la trendul ratei dobânzii BNM.

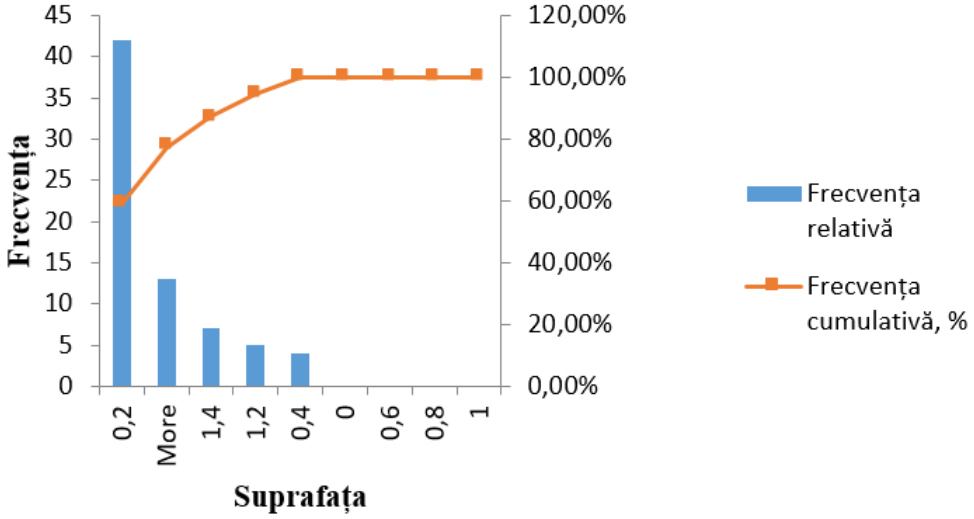

Figura 3. Histograma repartizării suprafeței terenurilor agricole în comuna Maiovca conform opțiunii cumulative și frecvența relativă.

Sursa: Elaborat de autor în baza datelor primare colectate.

Suprafața terenurilor agricole este prezentată în hectare, însă tranzacțiile cu o suprafață mai mică de 10 m^2 au fost eliminate din considerente cadastrale (destinația acestor parcele este evident neagricolă și impun o abordare eronată). Bonitatea solului are o gradație de la zero la 100 baluri, însă unele parcele sunt amplasate în locuri cu o calitate net inferioară și au o destinație alternativă. Indicatorul de calitate a parcelei care reflectă forma adecvată utilizării cu scop agricol (varianta pătrată, unde lățimea și înălțimea sunt egale la unghiul adiacent de 90°) este perimetrul în raport cu suprafața terenului [14]. Distanța până la sat a parcelei evaluate reprezintă un factor important în evaluarea spațială a terenurilor agricole sub aspectul necesității transportării recoltei spre depozit sau la proprietar acasă. De asemenea, unele parcele amplasate în apropierea nemijlocită de spațiul locativ a comunei (intravilan)au un preț mai mare din cauza că sunt premize legislative de transferare a intravilanului în suprafață cu destinație industrială sau construcție a caselor de locuit. Unitatea de măsură pentru variabila exogenă - distanța până la drum, este evaluată în metri și reprezintă factorul semnificativ referitor la accesul lejer la parcelă. Definiția de drum de acces presupune utilizarea unui înveliș rigid cu indicarea coordonatelor tronsonului pe hărțile INGEOCAD. Factorul care reflectă calitatea amplasării parcelei în terenul agricol este panta, evaluată în grade și această variabilă semnificativ influențează prețul tranzacțiilor de vânzare-cumpărare. Expoziția terenului este prezentată în grade și valoarea maximală 180 grade reprezintă orientarea sudică(cea mai solicitată), iar valoarea minimală zero grade reflectă orientarea nordică (cu o solicitare redusă). Ultimul indicator tehnologic inclus în modelul econometric este altitudinea amplasării parcelei care se calculează în metri și cererea avansată se referă la situarea în zona de șes sau înălțime moderată a terenurilor agricole.

Abordarea cadastrală a informației primare referitor la 17829 din tranzacțiile funciare în Republica Moldova pentru anul 2022 atestă un set de date tehnologice care includ caracteristica parcelei în procesul de vânzare-cumpărare și valoarea din contract a acesteia. În rezultatul prelucrării datelor primare din Tabelul 3 cu ajutorul aplicației SAR la etapa

primară prin metoda celor mai mici pătrate (OLS) este calculat cu regresia liniară Cobb-Douglas în care variabilele tehnologice sunt logaritmate și sunt evaluate valorile parametrilor ecuației de regresie (elasticitatea parțială a factorilor exogeni cadastrali). Calitatea modelului econometric spațial propus poate fi apreciată cu ajutorul coeficientului de determinație R^2, care este egal cu 0,6972 pentru comuna Maiovca și cu această cotă parte a variabilității totale se poate afirma că variabilele tehnologice au o pondere parțială diferită cu valoarea 1,65 pentru suprafața terenurilor agricole, 0,94 pentru bonitatea solului unde aste amplasată parcela și valori minoritare pentru ceilalți factori. Precizia evaluării coeficienților de elasticitate conform distribuției Student se încadrează în diapazonul de 95% și putem afirma că valorile prețului terenurilor agricole evaluate au intervalul de încredere acceptabil pentru tranzacțiile funciare. Testul Durbin-Watson de heteroscedascititate a reziduurilor în modelul econometric spațial este egal cu 0,8755 și atestă o dispersie normală (Gauss) cu o repartizare a abaterilor nedeplasată [15].

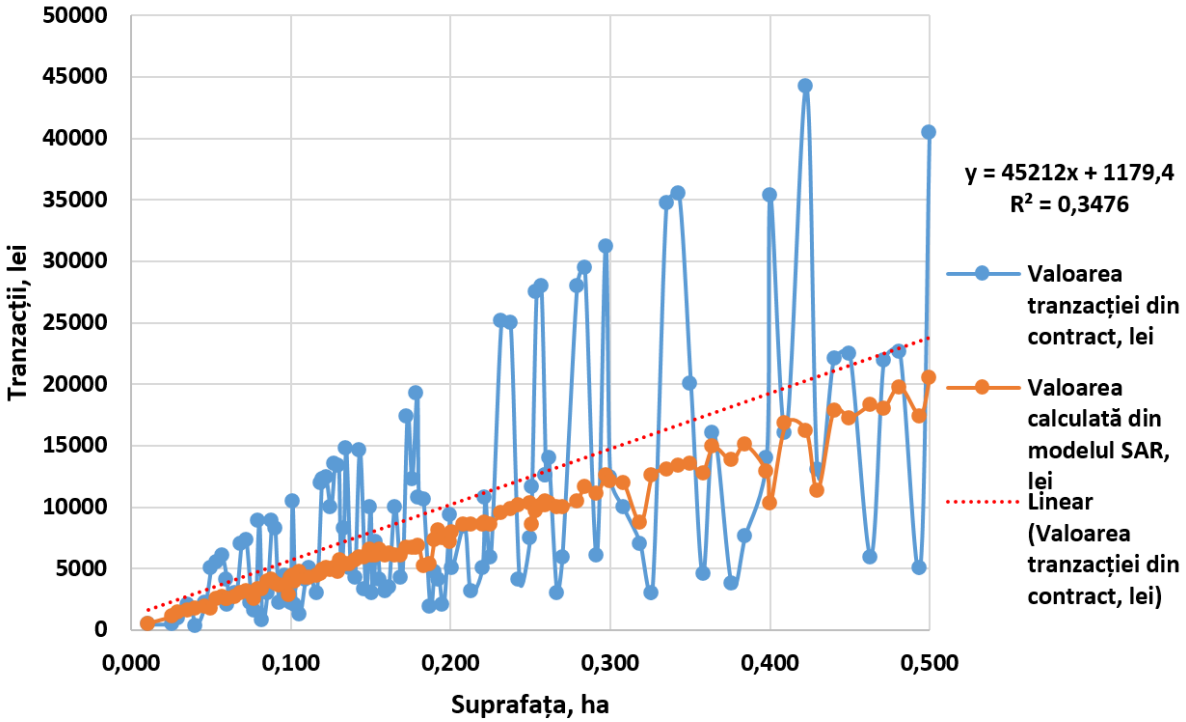

Figura 4. Graficul dependenței valorii tranzacției de cumpărare-vânzare și valoarea calculată a terenurilor agricole referitor la suprafața parcelei în diapazonul 0 ÷ 0,5 ha.

Sursa: Elaborat de autor în baza datelor primare colectate.

Evaluarea în conformitate cu modelul econometric spațial geografic ponderat SAR a datelor primare pentru comuna Maiovca arată o valoare a coeficientului de determinație R^2 = 0,6890 și confirmă valabilitatea modelului prin cota parte a elasticității factorilor exogeni. Abordarea directă a aprecierii prețului terenurilor agricole concomitent cu evaluarea indirectă econometrică spațială invocă valoarea elasticității suprafeței parcelei egală cu 0,9219 pentru varianta directă, 0,0717 în cazul opțiunii indirecte și 0,9937 pentru opțiunea totală. Distribuția Student cu precizia de 95% pentru parametrii ecuației de regresie spațială confirmă o probabilitate mai mică de 0,05 și este un fapt satisfăcător pentru calculele ulterioare cadastrale [16].

În Tabelul 4 sunt prezentate rezultatele calculului prețurilor terenurilor agricole din comuna Maiovca raionul Ocnița pentru anul 2022 cu indicarea codului cadastral aferent,

suprafața parcelei și valoarea tranzacției de cumpărare-vânzare conform contractului. Factorii exogeni incluși în cadrul modelului econometric pot fi caracterizați în modul următor:

a) valoarea medie a suprafeței terenurilor agricole este de 0,57 ha cu intervalul de încredere de la 0,42 până la 0,71 ha cu abaterea medie pătrată 0,0714. Acest indicator tehnologic corelează masiv r = 0,89 cu valoarea tranzacției din contract în lei cu o precizie de evaluare net superioară p = 0,05. Valoarea minimală a suprafeței parcelei în eșantion este de 0,099, iar valoarea maximală reprezintă 1,69 ha, cu indicatorul Standard Skewness egal cu 2,47 și Standard Kurtosis -2,33. În Figura 3 este prezentată informația rezultativă a distribuției suprafeței parcelelor în eșantion.

b) media aritmetică a bonității solului parcelelor incluse în eșantion este egală cu 69,9 baluri și abaterea medie pătrată reprezintă 1,076 cu intervalul de încredere în opțiunea distribuției Student 95% de la 67,81 până la 72,10. Coeficientul de variație referitor la bonitate reprezintă 12% și aceasta confirmă omogenitatea datelor primare cu valorile Skewness -2,41 și Kurtosis 1,22 conform testului de normalitate Jarque-Bera. Bonitatea solului în eșantion variată între valoarea minimală 36,0 și valoarea maximală 85,0, ce atestă o calitate relativ înaltă a terenurilor agricole referitor la productivitate. Coeficientul de corelație a calității solului are valoare maximală cu altitudinea amplasării parcelei r = 0,54, reprezintă o valoare considerabilă în referință cu expoziția geografică a pantei terenului r = 0,21 și este net negativ cu factorul exogen panta r = -0,61, iar precizia evaluării este satisfăcătoare cu o probabilitate mai mică de p = 0,05 [17].

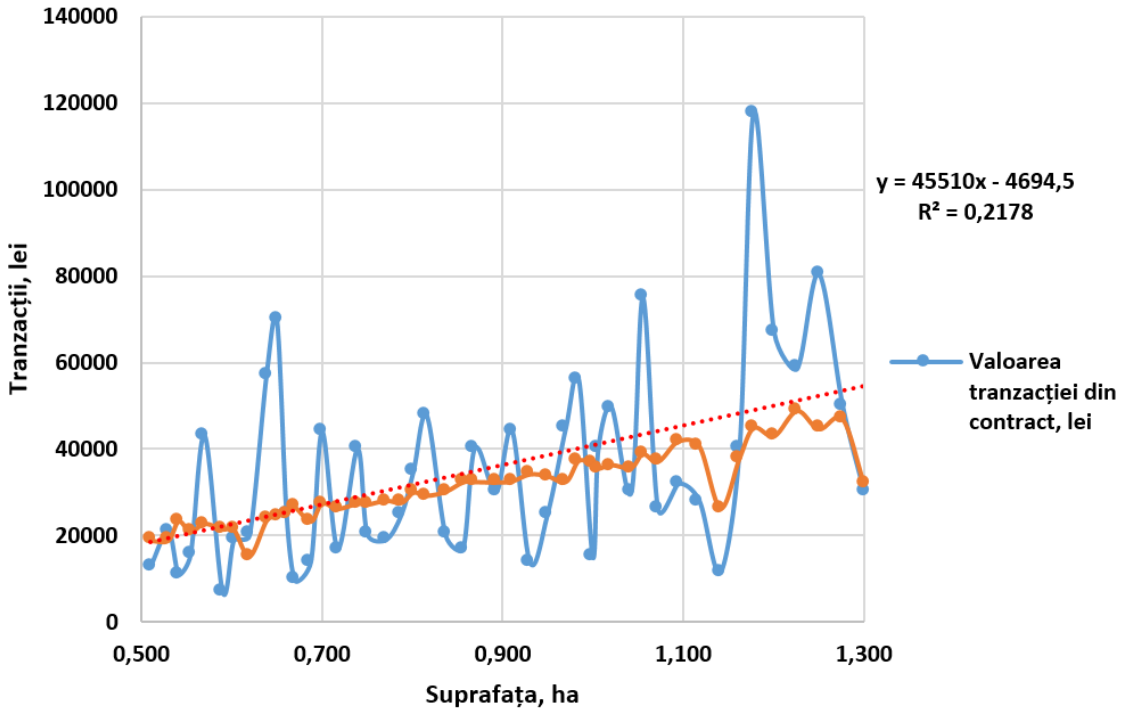

Figura 5. Graficul dependenței valorii tranzacției de cumpărare-vânzare și valoarea calculată a terenurilor agricole referitor la suprafața parcelei în diapazonul 0,5 ÷ 1,3 ha.
Sursa: Elaborat de autor în baza datelor primare colectate.

c) media aritmetică a bonității solului parcelelor incluse în eșantion este egală cu 69,9 baluri și abaterea medie pătrată reprezintă 1,076 cu intervalul de încredere în opțiunea distribuției Student 95% de la 67,81 până la 72,10. Coeficientul de variație referitor la bonitate reprezintă 12% și aceasta confirmă omogenitatea datelor primare cu valorile Skewness -2,41 și Kurtosis 1,22 conform testului de normalitate Jarque-Bera. Bonitatea solului în eșantion

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d) forma parcelei, care în datele primare este exprimată prin perimetru, are o valoare medie aritmetică de 374 metri și abaterea medie pătrată de 24 m se încadrează în intervalul de încredere conform distribuției Student 95% de la 326 m până la 422 m. Perimetrul maximal în eșantion este de 820 m și cu valoarea minimală de 166 m generează o distribuție a datelor primare conform testului de normalitate Jarque-Bera în valoare de 2,29 pentru Skewness și -2,26 referitor la Kurtosis. Repartizarea datelor în eșantion referitor la omogenitate este caracterizată prin coeficientul de variație egal cu 54% și reprezintă o valoare acceptabilă din punct de vedere a analizei dispersionale. Intensitatea legăturii între factorii exogeni a modelului econometric este evaluată prin intermediul coeficientului de corelație și perimetrul are o afinitate maximală față de suprafața parcelei cu o valoare maximală de r = 0,93. De asemenea perimetrul parcelei corelează intens cu valoarea tranzacției de vânzare-cumpărare r = 0,81, însă corelează negativ la cote majore cu altitudinea amplasării terenului agricol cu r = -0,25, iar precizia calculului are o probabilitate net inferioară și reprezintă p = 0,0297.

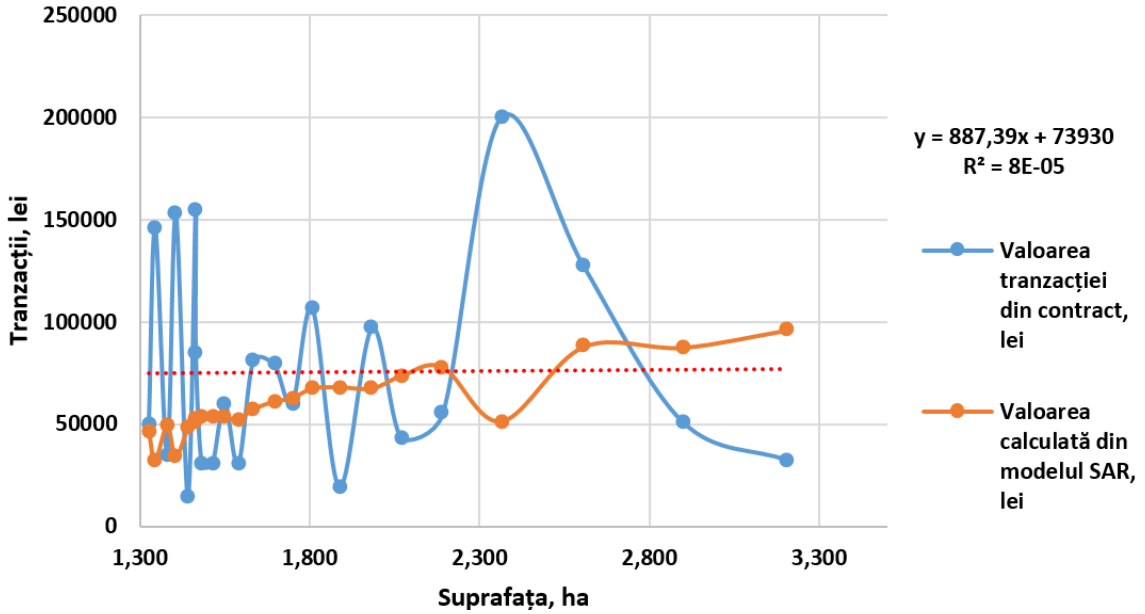

Figura 6. Graficul dependenței valorii tranzacției de cumpărare-vânzare și valoarea calculată a terenurilor agricole referitor la suprafața parcelei în diapazonul 1,3 ÷ 3,5 ha.

Sursa: Elaborat de autor în baza datelor primare colectate.

În Figura 4 este prezentată dependența liniară a valorii terenurilor agricole (din contract sau calculată cu indicarea trendului) pentru diferite diapazoane a suprafeței parcelei. Cumpărătorii terenurilor agricole psihologic au o preferință intuitivă față de suprafețe mari și în graficele prezentate (Figurile 4-6) trendul OLS este maximal pentru diapazonul 0,5 – 1,3 ha, cu valoarea coeficientului de regresie 45510. Este evident că valorile terenurilor agricole evaluate conform modelului econometric ponderat geografic SAR sunt net inferioare valorilor evaluate prin intermediul OLS din cauza că regresia liniară este sensibil neadecvată sub aspectul referitor la nestaționariatetea datelor primare care se reflectă prin prețul hedonic al parcelelor. Valorile maximale a suprafeței terenurilor agricole (mai mari de 3 ha) atestă o

suprapunere a valorilor calculate în modelul SAR față de valorile OLS, fapt ce se confirmă din distribuția Pareto a comportamentului consumatorilor (cumpărătorilor) din teoria economică.

Valoarea medie a tranzacțiilor referitor la datele pe Republica Moldova în anul 2022 reprezintă 29055 lei din contractul de vânzare-cumpărare și este egal cu 22275 lei pentru valorile parceleleor calculate conform modelului econometric SAR. Abaterea medie pătrată de 88128 lei care se referă la tranzacțiile din contracte este net superioară indicatorului statistic aferent 32325 lei calculat cu ajutorul modelului econometric spațial, ce confirmă diferența vizibilă în dispersia datelor primare în graficele prezentate. Valoarea minimală a tranzacției din contracte este 77 lei și valoarea maximală 4400 mii lei, iar diapazonul referitor la valoarea calculată a parcelelor se definește de la 91 lei minimal până la 1063 mii lei. Intervalul de încredere conform distribuției Student 95% pentru tranzacțiile înregistrate în contracte se află în diapazonul de la 27761 lei până la valoarea maximală 30348 lei și respectiv valorile calculate a parcelelor sunt în intervalul de la 21801 lei până la 22750 lei. Coeficientul de corelație a tranzacțiilor din contracte cu suprafața parcelelor reprezintă o relație financiară cu o intensitate pronunțată r = 0,82 și respectiv valoarea indicatorului statistic aferent între suprafața terenurilor agricole și datele din modelul econometric spațial prezintă o relație aproape liniară cu intensitate inaltă r = 0,98.

4. Concluzii

Dezvoltarea durabilă a spațiului rural în Republica Moldova este un obiectiv de importanță majoră, ținând cont de condițiile oferite de perspectivele aderării la Uniunea Europeană. Componenta de bază în sporirea eficienței utilizării resurselor funciare în sectorul agrar al țării reprezintă evaluarea adecvată a loturilor de teren cu destinație agricolă care nu este realizat la momentul de față în varianta masivă pentru cele aproximativ patru milioane de parcele identificate prin codul cadastral.

Obiectivul de bază în lucrarea prezentă sub aspectul argumentării metodologice a prețului hedonic în tranzacțiile de cumpărare-vânzare a terenurilor agricole impune necesitatea utilizării modelului econometric spațial. A fost realizat setul complet de calcule pentru comuna Maiovca raionul Ocnița cu prezentarea tabelară a informației tehnologice referitor la 8127 parcele și valorile calculate a terenurilor agricole integral pe sat. Grafic este prezentată analiza comparativă a rezultatelor calculului prin intermediul modelului econometric spațial SAR, valorile din tranzacțiile de vânzare-cumpărare și trendul liniar pentru trei diapazoane specific distincte sub aspectul distribuției prețului parcelei pe piața funciară. Pentru valorile minore 0 – 0,5 ha valorile calculate prin metoda regresiei geografic ponderate sunt net inferioare valorilor trenului liniar OLS și din contra valorile majore a suprafețelor tranzacționate 1,3 – 3,5 ha trendul liniar OLS este net inferior valorilor calculate prin metoda econometrică spațială. Aspectul respectiv necesită o abordare specifică în politicile agrare a factorilor de decizie în sectorul agrar referitor la comportamentul consumatorilor (cumpărătorilor) pe piața funciară.

Modelul propus pentru evaluarea terenurilor agricole este adecvat problemei puse spre realizare și poate servi ca instrument de lucru în implementarea practică.

Notă. Articolul dat se publică conform studiului realizat în cadrul Universității Tehnice din Moldova. Proiectul de cercetări științifice „Cercetări privind Asigurarea Dezvoltării Durabile și Creșterii Competitivității Republicii Moldova în Context European / CADDCCRMCE / 020408”, realizat în cadrul Agenției Naționale pentru Cercetare și Dezvoltare în anul 2024.

Conflict of Interest: The authors declare no conflict of interests.

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ANALYSIS OF THE ESTABLISHMENT AND MAINTENANCE COSTS OF TABLE GRAPE PLANTATIONS ACCORDING TO THE PERGOLA SUPPORT SYSTEM

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Abstract. Evaluating the costs of establishment and maintenance of table grape plantations, grown through the Pergola management system, is a significant opportunity for winegrowers in the Republic of Moldova. This system, relatively new in the country, remains unadopted for many of the table grape producers. The present research highlights the methodological and technical aspects related to the costs associated with the cultivation of table grapes through the Pergola management system, which must be adapted to the specific climatic conditions of Moldova and to the current market requirements. The main objective of the research is to analyze the structure of costs that influence the yield of plantations in the long term, including the initial establishment expenses and the subsequent maintenance expenses. The author points out that although the maintenance costs of Pergola table grape plantations are high, the growing demand for quality grapes adds significant economic value to this vineyard management system. The research details the composition of the establishment and maintenance costs of table grape plantations, namely fertilization costs, irrigation costs, mechanized service costs. Concrete examples show what the structure of these costs is, thus demonstrating the importance of a correct assessment of costs in the process of establishing and maintaining table grape plantations.

Keywords: *production cost, planting density, fertilization, irrigation, planting material, mechanisation services.*

Rezumat: Evaluarea costurilor de înființare și întreținere a plantațiilor de struguri pentru masă, cultivate prin sistemul de conducere Pergola, constituie o oportunitate semnificativă pentru viticultorii din Republica Moldova. Acest sistem, relativ nou în țară, rămâne neadoptat pentru mulți dintre producătorii de struguri de masă. Prezenta cercetare evidențiază aspectele metodologice și tehnice legate de costurile asociate cultivării strugurilor pentru masă prin sistemul de conducere Pergola, necesar a fi adaptat la condițiile climatice specifice Moldovei și la cerințele actuale ale pieței. Obiectivul principal al cercetării este de a analiza structura costurilor care influențează randamentul plantațiilor pe termen lung, incluzând cheltuielile inițiale de înființare și cele ulterioare de întreținere. Autorul subliniază că, deși costurile de întreținere a plantațiilor de struguri de masă tip Pergola sunt ridicate, cererea tot mai mare pentru struguri de calitate adaugă o valoare economică semnificativă acestui sistem de conducere a plantațiilor viticole. Cercetarea detaliază componența costurilor de înființare și întreținere a plantațiilor de struguri de masă, și anume costurile de fertilizare, costurile de

irigare, costurile serviciilor mecanizate. Exemple concrete arată care este structura acestor costuri, demonstrând astfel importanța unei evaluări corecte a costurilor în procesul de înființare și întreținere a plantațiilor de struguri pentru masă.

Cuvinte cheie: *cost de producție, densitate de plantare, fertilizare, irigare, material săditor, servicii mecanizate.*

1. Introducere

Consumul de struguri în stare proaspătă a fost întotdeauna o necesitate esențială pentru oameni, deoarece reprezintă un aliment destul de valoros. Creșterea continuă a populației determină o cerere tot mai mare pentru struguri proaspeți. Cultura soiurilor de viță de vie pentru struguri de masă are o importanță economică și socială demnă de atenție. Din perspectiva economică, vița de vie pentru struguri de masă se dovedește a fi destul de rentabilă. Strugurii pot fi vânduți imediat, în stare proaspătă, ceea ce elimină costurile suplimentare asociate procesării. Aceste soiuri permit recuperarea rapidă a investițiilor, asigurând o rotație eficientă a resurselor financiare în cadrul entităților agricole [1].

În Republica Moldova, se observă o scădere a suprafeței plantațiilor viticole cu soiuri de masă, deși acestea au potențialul de a deveni competitive pe piețele europene. În prezent, doar 17,2 mii hectare sunt cultivate cu struguri pentru masă, dintre care 14,6 mii ha sunt productive. Spre comparație, în anul 2016, suprafața constituia 19,9 mii ha, inclusiv 17,8 ha pe rod [2]. Această situație subliniază necesitatea revitalizării sectorului strugurilor de masă și implementării strategiilor eficiente de promovarea acestor soiuri.

Cultivarea strugurilor de masă este esențială nu doar pentru sectorul viticol, ci și pentru agricultură în ansamblu. Soiurile de struguri de masă contribuie la diversificarea agriculturii, îmbunătățind atât calitatea producției de struguri, cât și rentabilitatea acesteia. Cunoașterea soiurilor disponibile permite producătorilor și comercianților să evalueze cererea pe piețele naționale și internaționale. Prin urmare, soiurile de struguri de masă nu doar că îmbogățesc oferta agricolă, dar și sprijină dezvoltarea economică, facilitând accesul la piețele externe și promovând produsele locale.

Soiurile de viță de vie destinate consumului proaspăt se evidențiază prin trăsături biologice și ecologice specifice, esențiale pentru a lua decizii bine fundamentate în ceea ce privește zonarea acestora. La plantarea soiurilor de struguri pentru masă, este important să se ia în considerare mai multe aspecte, cum ar fi: selecția terenului pentru înființarea plantației, alegerea soiului potrivit, stabilirea sistemului de cultură adecvat, evaluarea rezistenței soiului și a diferitor organe ale plantei de viță de vie la ger, precum și implementarea unei tehnologii de cultură eficiente [3, 4]. Cunoașterea acestor caracteristici ajută la maximizarea eficienței economice în culturile respective. Valoarea economică a fiecărui soi de struguri de masă depinde, în principal, de proporția producției comerciale în raport cu producția totală.

În producerea strugurilor de masă, sistemele de conducere a viței de vie joacă un rol esențial în sporirea producției și calității strugurilor. Fiecare sistem de conducere are avantajele sale specifice, iar alegerea unui sistem depinde de condițiile climatice, de tipul de sol și de soiul de struguri cultivat. Un sistem bine ales poate duce la o recoltă bogată și la struguri mai sănătoși și mai gustoși [5-7].

În ultimii ani, tot mai mulți producători de struguri de masă din Republica Moldova aleg să investească în plantații de viță de vie prin sistemul Pergola. Acest sistem se bazează pe o schelă oblică care sprijină lăstarii viței, creând o boltă de frunze bine iluminat, care

susține ciorchinii de struguri în partea inferioară. Această structură asigură o aerisire optimă, contribuind la prevenirea bolilor fungice [8].

Comparativ cu metoda tradițională de cultivare pe spalier vertical, sistemul intensiv Pergola aduce o serie de avantaje. Acesta permite o utilizare mai eficientă a radiației fotosintetice, ceea ce contribuie la creșterea potențialului de producție. Un alt beneficiu este grad mai înalt de coacere a strugurilor, care duce la îmbunătățirea calității acestora. De asemenea, acest sistem optimizează consumul de apă și asigură o aerisire bună, creând un mediu mai puțin favorabil pentru boli și dăunători. Astfel, se reduce nevoia de tratamente fitosanitare, ceea ce garantează un produs mai sigur pentru consumatori. În plus, lucrările de întreținere și recoltare sunt mai eficiente. Pe de altă parte, producătorii de struguri de masă care doresc să adopte sistemul Pergola, ar trebui să opteze pentru soiuri rezistente la înghețurile de iarnă și să asigure un sistem de fert-irigare adecvat, pentru a maximiza beneficiile acestui sistem modern de cultivare [9].

În același timp, sistemul Pergola prezintă și câteva dezavantaje față de cel tradițional, cum ar fi costuri de înființare și întreținere mai ridicate [10]. Astfel, pentru a lua decizii corecte în privința implementării acestui sistem, este necesară o analiză detaliată a costurilor implicate.

2. Materiale și metode

În acest studiu de cercetare a fost analizată componența costurilor de înființare și întreținere a plantațiilor de struguri pentru masă după sistemul de conducere Pergola. În acest scop, au fost aplicate metodele tradiționale, cum ar fi observația, comparația, analiza și sinteza, fiind luați în considerare următorii indicatori:

Densitatea plantelor de viță de vie – reprezintă numărul de plante cultivate pe o unitate de suprafață, exprimată în plante pe hectar:

$$N = \frac{S}{d \times D}, \quad (1)$$

unde:

N – numărul de plante la hectar;

S – suprafața pentru plantare, ha;

d – distanța între plante, m;

D – distanța între rânduri, m.

Costuri de fertilizare – cheltuielile asociate cu achiziționarea, aplicarea și managementul îngrășămintelor necesare pentru asigurarea unei nutriții adecvate a plantelor.

Costuri de irigare – cheltuielile necesare pentru asigurarea unui sistem de udare eficient, care să mențină plantele sănătoase și să optimizeze producția de struguri (instalarea sistemului de irigare, costurile de întreținere, consumul de apă, analiza umidității solului etc.).

Costuri materiale – cheltuielile necesare achiziționării și întreținerii materialelor esențiale pentru cultivarea și îngrijirea viței de vie (butași, sistemul de suport, echipamente și unelte etc.).

Costuri servicii mecanizate – cheltuielile asociate cu utilizarea echipamentelor și utilajelor pentru diverse activități agricole (prelucrarea solului, plantarea viței de vie, îngrijirea plantelor, recoltarea etc.).

Datele utilizate pentru analiză au fost preluate de la producătorii de struguri de masă din Republica Moldova, care au adoptat sistemul de conducere Pergola.

3. Rezultate și Discuții

Cultivarea strugurilor de masă este o afacere profitabilă, având în vedere cererea crescândă pe piață de struguri pentru consumul direct. Multe terenuri agricole din Republica Moldova sunt deosebit de potrivite pentru cultivarea viței de vie, ceea ce oferă un avantaj considerabil viticultorilor. În plus, viticultorii beneficiază de subvenții și proiecte investiționale care sprijină plantarea viței de vie, iar perioada de recuperare a investițiilor este favorabilă. O îngrijire corectă a plantațiilor asigură o exploatare pe termen lung a acestora. Pe lângă aspectele economice, plantațiile viticole au un impact ecologic semnificativ, contribuind la prevenirea alunecărilor de teren și a eroziunii solului [11].

Viabilitatea economică a unei plantații este influențată semnificativ de costurile de înființare și îngrijire a acesteia. Planificarea și gestionarea eficientă a cheltuielilor respective este esențială pentru a asigura succesul pe termen lung al producerii strugurilor de masă. Planificarea unei plantații de struguri de masă este un proces complex, ce implică mai multe etape, cum ar fi pregătirea solului, selecția soiului, stabilirea densității plantelor, alegerea tipului de plantare și a sistemului de irigare, adoptarea tehnicii agricole potrivite. Deciziile luate în fiecare etapă vor avea efecte nu doar asupra aspectului plantației viitoare, ci și asupra costurilor de investiție necesare pentru realizarea acesteia [12].

Costurile de înființare a plantațiilor de struguri de masă se împart în mai multe categorii esențiale [13], fiecare având un impact semnificativ asupra bugetului total. De asemenea, cheltuielile de întreținere a plantațiilor pot varia considerabil în funcție de practica agricolă adoptată, de la tratamentele fitosanitare la tăierile de formare, având un impact direct asupra calității recoltei. Prin urmare, fiecare detaliu contează și poate determina succesul unei plantații de struguri de masă. Costurile pentru înființarea plantațiilor de struguri pentru masă includ serviciile de proiectare a plantațiilor; pregătirea terenului şi a solului pentru plantare; fertilizarea solului înainte de plantare; achiziționarea materialului săditor şi plantarea efectivă; îngrijirea și protecția viței de vie tinere; completarea golurilor în plantațiile tinere; instalarea plaselor antigrindină sau antiploaie (Figura 1).

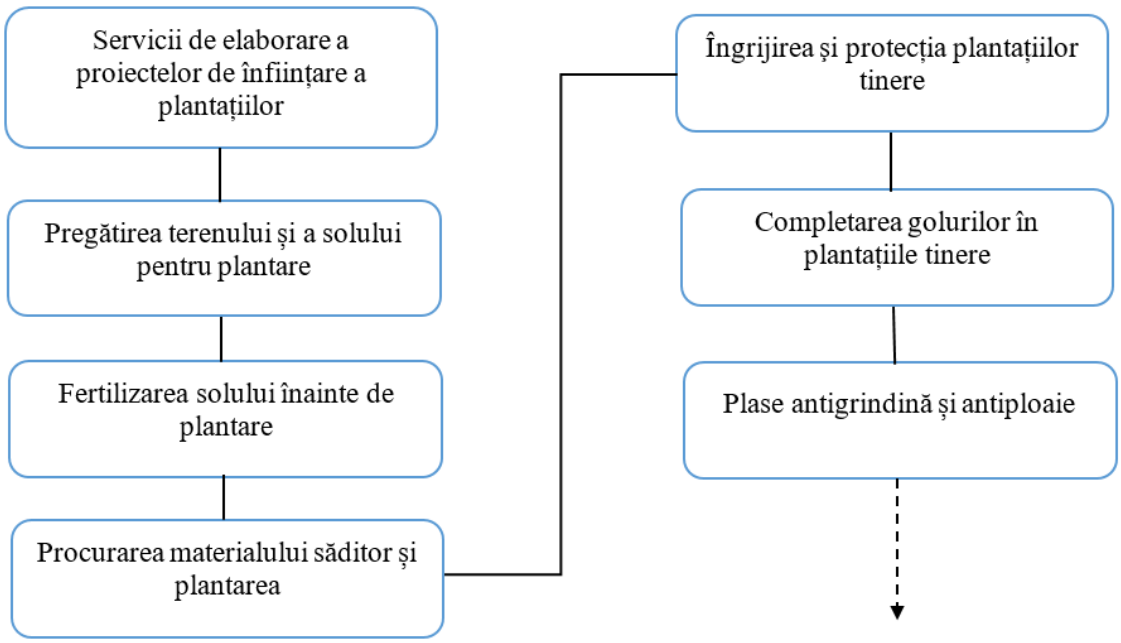

Figura 1. Elemente fundamentale ale costurilor de înființare a plantațiilor de struguri pentru masă.

Sursa: elaborat de autor în baza [13].

Costurile de înființare și întreținere a plantațiilor de struguri de masă depind semnificativ de densitatea de plantare, exprimată prin numărul de plante la hectar. Alegerea distanțelor optime este, astfel, o etapă importantă în înființarea plantațiilor de struguri de masă. În sistemul Pergola, schemele de plantare utilizate sunt de 2,5×2,5 m sau 3×2 m. Pentru a determina numărul optim de plante necesare pentru o plantație nouă, se aplică un calcul specific, care ia în considerare dimensiunile terenului și distanțele de plantare [14].

Astfel, dacă suprafața plantației pe sistem Pergola este de 6 ha, distanța dintre plante pe rând 2,5 metri și distanța dintre rânduri 2,5 metri, rezultă că:

1) Suprafața ocupată de o plantă = Distanța între plante × Distanța între rânduri = 2,5 m × 2,5 m = 6,25 m²;

2) Densitatea de plantare (plante/hectar) = 10 000 m² / Suprafața unei plante = 10 000 m² / 6,25 m² ≈ 1 600 plante/ha;

3) Numărul total de plante = Densitatea de plantare (plante/ha) × Suprafața (ha) = 1 600 plante/ha × 6 ha = 9 600 plante.

Așadar, pe o suprafață de 6 ha, cu densitatea și distanțele specificate, sunt necesare aproximativ 9 600 de plante de viță de vie.

Densitatea de plantare este determinată de fertilitatea solului, forma de conducere, condițiile climaterice, vigoarea soiului etc. La stabilirea densității se recomandă alegerea unei distanțe optime și în funcție de capacitatea de mecanizare a proceselor, tipul plantației, factorii de mediu etc.

La înființarea plantațiilor de struguri de masă, alegerea materialelor are o importanță majoră pentru asigurarea unei recolte de calitate. Parii (din lemn sau ciment) sunt fundamentali pentru susținerea viilor. Sârma zincată este o opțiune populară datorită durabilității sale. În plus, folosirea plaselor antigrindină și antiploaie oferă o protecție eficientă a plantațiilor împotriva condițiilor meteorologice extreme (Tabelul 1). Fiecare alegere de material influențează nu doar sănătatea viței, dar și calitatea strugurilor obținuți.

Tabelul 1

Costuri de înființare a plantațiilor de struguri pentru masă pe sistemul de conducere Pergola (schema 3×2 m)

Elemente de cheltuieli	Unitatea de măsură	Cantitatea	Total, lei/ha
Plante la hectar	buc.	1670	**30060**
Sistemul de irigare			**40250**
Sistemul de suport			**387779**
Ancore pe marginea perimetrului	buc.	120	30000
Pari beton (7 x 8 x 3,85)	buc.	833	130781
Pari beton (9 x 9,5 x 3,85)	buc.	124	29016
Funie oțel d5	buc.	6800	55080
Funie oțel d7	buc.	1425	19950
Sârmă zincată d2,4	kg	1500	55200
Flanse (9 x 9,5)	buc.	120	3600
Lăcăți griple d3,2	buc.	520	8528
Morseti M8	buc.	2100	12600
Braț intermediar (50 x 70) 4 găuri	buc.	820	23616
Braț frontal 40m	buc.	68	6664
Braț frontal 60m	buc.	68	7344
Cârlig pentru fixarea sârmei	buc.	6000	5400

Continuare Tabelul 1

Lucrări de instalare			**50000**
TOTAL sistem Tendone de bază			**508089**
Opțiune: Plasă antigrindină			**180460**
Sârmă zincată de 18 (Ø3,5)	kg	400	14000
Plasă antigrindină	m2	12300	107625
Capuci și alte accesorii		1681	58835
TOTAL sistem Tendone + antigrindină			**688549**
Opțiune: Peliculă antiploaie			**331135**
Sârmă zincată de 18 (Ø3,5)	kg	400	14000
Peliculă antiploaie	m^2	12300	258300
Capuci și alte accesorii		1681	58835
TOTAL sistem Tendone + antiploaie			**1019684**

Sursa: elaborat de autor.

După implementarea sistemului de suport și plantarea butașilor, devine esențial să se instaleze un sistem de irigare, care este o cerință fundamentală pentru sistemul Pergola. Vița de vie, în special în primii ani, are nevoie de apă pentru a se dezvolta bine. Costurile variază în funcție de tipul sistemului de irigare ales, cum ar fi de aspersiune sau de picurare. Pentru Pergola, cel mai recomandat sistem de irigare este cel prin picurare, deoarece furnizează apa direct la rădăcinile plantelor, asigurându-le astfel cantitatea optimă necesară pentru o creștere sănătoasă. În plus, aceste sisteme sunt ușor de utilizat, nu necesită investiții mari, consumă mai puțină apă și ajută la prevenirea bolilor cauzate de umiditatea excesivă.

Costul sistemului de irigare depinde de o serie de factori specifici, inclusiv suprafața plantației, schema de plantare, configurația terenului (relief), distanța până la sursa de apă, echipamentele de pompare utilizate și tipul de sistem de picurare ales etc. Pentru stabilirea costurilor de implementare a sistemului de irigare prin picurare se elaborează schema de montare (proiectul tehnic) și se estimează cheltuielile pentru fiecare tip de teren [15]. O modalitate modernă de stabilire a necesarului de investiții pentru instalarea sistemului de irigare prin picurare este calculatorul online. Acesta permite utilizatorilor să introducă parametrii relevanți, precum dimensiunea terenului, tipul de cultură și condițiile locale. Instrumentul dat oferă o estimare detaliată a costurilor, inclusiv pentru echipamente, instalare și întreținere, facilitând astfel o planificare mai preciză și mai eficientă a investiției [16, 17].

În procesul de evaluare a costurilor, este important să se acorde atenție cheltuielilor de fertilizare, deoarece acestea influențează semnificativ costul total de producție, Tabelul 2.

Tabelul 2

Costul fertilizării plantațiilor de struguri pentru masă pe sistemul de conducere Pergola

Perioada tratamentului	Tratament radicular	Cantitatea la ha	Tratament foliar	Cantitatea la ha
Desfacerea mugurelui (apariția primelor frunze)	Fulhumin	10 L	Hosmosprint	1,5 L
	Chelat Fe	5 kg	K-Gold	1,0 L
Struguri vizibili (5-8 cm)			Citopower	2,0 L
			Maxgrow	2,5 L
			Supercal-B	2,0 L

Continuare Tabelul 2

Alungirea ciorchinelor (după 6 zile de la tratamentul nr. 2)	NPK 20-20-20 Fulhumin	25 kg 10 L	Hosmosprint Maxgrow	2,0 L 2,0 L
Mărirea dimensiunii boabelor (8-12 mm)	Fulhumin Nitrat de calciu $Ca(NO_3)_2$ Sulfat de potasiu K_2SO_4 Sulfat de magneziu $MgSO_4$ Chelat Fe	10 L 5 kg 25 kg 12,5 kg 5 kg	Freeamin Hosmosprint Calibro Supercal-B Giberelină (pastile)	2,0 L 2,0 L 1,0 L 2,5 L 5 buc.
După 7 zile de la tratamentul nr. 4	Nitrat de calciu $Ca(NO_3)_2$ MKP Chelat Fe Fulhumin	25 kg 25 kg 5 kg 10 L	Freeamin Hosmosprint Supercal-B Giberelină (pastile)	2,0 L 2,0 L 2,5 L 3 buc.
Anti-crăpare (perioada de pârgă)			Karpa	4 kg
După 7 zile de la tratamentul nr. 5			Supercal-B	2,5 L
Maturarea și colorarea fructelor			Rip fruit	2,5 L
După 7 zile repetare tratamentul nr. 8			Rip fruit	2,5 L
Costul fertilizării la 1 ha în funcție de tratament, lei		**8650**		**12497**

Sursa: elaborat de autor.

Din datele prezentate în tabel, observăm că tratamentul foliar pentru plantația de struguri de masă pe sistem Pergola se ridică la 12497 lei/ha, în timp ce tratamentul radicular costă 9650 lei/ha, costul ambelor tratamente fiind de 33645 lei/ha. Deși tratamentul foliar este semnificativ mai costisitor, el aduce beneficii considerabile, cum ar fi o protecție mai bună împotriva dăunătorilor sau îmbunătățirea calității strugurilor. Este important să se ia în considerare aceste aspecte în contextul raportului cost-beneficiu al fiecărei metode, având în vedere că ambele sunt indispensabile pentru obținerea unor struguri de masă de calitate superioară.

Bugetul total al unei plantații viticole este influențat și de cheltuielile de mecanizare. Cheltuielile suportate de producătorii de struguri de masă variază semnificativ în funcție de gradul de mecanizare. Un producător care folosește tractoare și mașini pentru tăierea viței de vie va avea costuri mai mari inițial pentru achiziția echipamentelor, dar va economisi timp și forță de muncă, reducând astfel cheltuielile pe termen lung. Pe de altă parte, un viticultor care folosește preponderent munca manuală, poate avea costuri inițiale mai mici, dar va suporta cheltuieli mai mari privind salariile lucrătorilor. Astfel, gradul de mecanizare influențează nu doar cheltuielile, ci și profitabilitatea pe termen lung a producătorilor de struguri de masă [18].

Structura cheltuielilor de mecanizare depinde de caracteristicile plantației, care sunt unice pentru fiecare. Evident, o plantație mai mare necesită investiții mai mari în echipamente mecanizate, în timp ce una mai mică poate opta pentru soluții mai simple și mai ieftine. Anumite soiuri de struguri necesită metode specifice de îngrijire și recoltare. Astfel, dacă strugurii pentru vin pot fi recoltați mecanizat, atunci strugurii pentru masă necesită o atenție manuală mai mare, influențând structura cheltuielilor. Tehnologia utilizată influențează și ea

aceste costuri. Investițiile în tehnologie avansată, cum ar fi senzori pentru monitorizarea umidității solului sau drone pentru evaluarea stării viței de vie, sporesc costurile inițiale, dar aduc beneficii pe termen lung prin optimizarea resurselor, Tabelul 3.

Tabelul 3

Costul unitar a lucrărilor de întreținere a plantațiilor de struguri pentru masă pe sistemul de conducere Pergola, lei/ha

Denumirea lucrărilor	Retribuirea muncii, lei	Motorină		Materiale lubrifiante		Total cheltuieli variabile, lei	Piese de schimb și deservirea tehnicii, lei	Amortizarea mijloacelor fixe, lei	Alte cheltuieli, lei	Costul serviciilor mecanizate, lei
		Norma de consum, L/ha	Suma, lei	Cantitatea, L	Suma, lei					
Arătura de semidesfundare	106,65	35,00	577,50	2,80	98,00	782,15	78,22	32,40	44,64	937,40
Nivelarea arăturii de semidesfundare	11,85	8,00	132,00	0,64	22,40	166,25	16,63	12,30	9,76	204,93
Introducerea îngrășămintelor organice	23,70	12,00	198,00	0,96	33,60	255,30	25,53	14,50	14,77	310,10
Arătura de toamnă	47,40	22,00	363,00	1,76	61,60	472,00	47,20	25,90	27,26	572,36
Cultivarea între rânduri	17,78	6,50	107,25	0,52	18,20	143,23	14,32	14,70	8,61	180,86
Afânarea mecanizată între plante pe rând	53,33	8,00	132,00	0,64	22,40	207,73	20,77	19,70	12,41	260,61
Săparea gropilor pentru plantare	1,78	0,10	1,65	0,01	0,28	3,71	0,37	0,08	0,21	4,37
Introducerea îngrășămintelor minerale	14,22	6,00	99,00	0,48	16,80	130,02	13,00	12,90	7,80	163,72
Evacuarea crengilor din plantație	17,78	6,00	99,00	0,48	16,80	133,58	13,36	8,90	7,79	163,62
Cositul ierbii intre rânduri	14,22	3,00	49,50	0,24	8,40	72,12	7,21	13,20	4,63	97,16
Tocatul crengilor pe rând	29,63	5,00	82,50	0,40	14,00	126,13	12,61	15,47	7,71	161,92
Erbicidarea pe rând	17,78	2,50	41,25	0,20	7,00	66,03	6,60	11,52	4,21	88,35
Stropirea plantațiilor	26,07	4,00	66,00	0,32	11,20	103,27	10,33	15,30	6,44	135,34
Total	**382,2**	**x**	**1948,7**	**x**	**330,7**	**2661,5**	**266,2**	**196,9**	**156,2**	**3280,7**

Sursa: elaborat de autor.

Analizând structura costului unitar pentru întreținerea plantațiilor de struguri pentru masă pe sistemul de conducere Pergola, constatăm că ponderea cea mai mare revine cheltuielilor aferente serviciilor mecanizate – 35,6%. Această proporție relatează o eficiență sporită în întreținerea plantațiilor. Utilizarea tehnologiei reduce timpul și forța de muncă necesară, ceea ce conduce la o producție mai rentabilă și mai constantă. Totodată, este

important să se monitorizeze aceste costuri pentru a asigura gestiunea eficientă a resurselor producătorului de struguri pentru masă.

Analizând structura costurilor pentru înființarea și întreținerea plantațiilor de struguri de masă în sistem Pergola până la intrarea pe rod, observăm că cele mai mari cheltuieli sunt legate de mijloacele de producție, urmate apoi de costurile operațiunilor manuale și, în final, de serviciile mecanizate (Tabelul 4). De asemenea, cheltuielile neprevăzute reprezintă o parte componentă a acestor costuri, din mai multe motive. De exemplu, înghețurile târzii sau ploile abundente pot afecta sănătatea viței de vie și astfel apare necesitatea unor investiții suplimentare pentru protejarea sau refacerea plantelor. În plus, apariția dăunătorilor sau a bolilor poate duce la costuri neanticipate pentru tratamente chimice sau biologice. De asemenea, unele probleme cu infrastructura, cum ar fi deteriorarea sistemelor de suport sau de irigație, pot necesita reparații urgente. Aceste situații imprevizibile generează cheltuieli care nu sunt incluse în bugetul inițial, făcându-le o parte importantă a costurilor totale ale plantației.

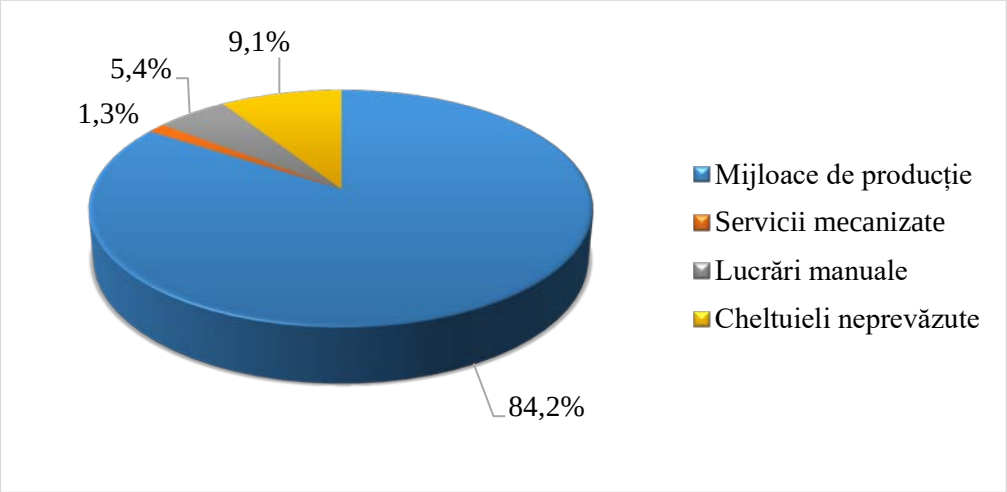

Figura 2. Structura costurilor de înființare și întreținere a plantațiilor de struguri de masă pe sistem Pergola până la intrarea pe rod.
Sursa: *elaborat de autor.*

Deși nu este stabilit un nivelul optim fix al costurilor de înființare și întreținere a plantațiilor de struguri pentru masă, acesta fiind dependent de o multitudine de factori economici, sociali și naturali, este evidentă influența semnificativă a acestora asupra dezvoltării în timp a plantației viticole. Prin urmare, planificarea corectă și gestionarea eficientă a acestor cheltuieli joacă un rol esențial în activitatea producătorilor de struguri pentru masă.

4. Concluzii

Costurile de înființare și întreținere a plantațiilor de struguri pentru masă după sistemul de conducere Pergola sunt mai mari comparativ cu sistemul tradițional Spalier vertical. Acestea, însă, se recuperează în timp datorită randamentelor ridicate și a prețurilor de vânzare mai mari, ceea ce asigură profituri mai mari viticultorilor care au implementat acest sistem.

Principalele elemente de cheltuieli aferente înființării și întreținerii plantațiilor de struguri pentru masă, includ mijloacele de producție necesare, cum ar fi sistemele de suport (sârmă, pari), plase antigrindină și antiploiae, materialul săditor (butași) etc. De asemeanea,

se iau în calcul costurile de fertilizare și irigare a plantației, serviciile mecanizate și munca manuală.

Îngrijirea plantației în perioada de vegetație, până la intrarea pe rod, necesită investiții considerabile, cele mai costisitoare fiind mijloacele de producție necesare pentru înființarea plantației. Totuși, producătorii de struguri de masă care au adoptat sistemul Pergola, trebuie să conștientizeze că aceste cheltuieli vor fi recuperate ulterior pe deplin, generând profituri semnificative.

Conflicts of Interest: The author declares no conflict of interest.

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AN OVERVIEW AND ANALYSIS OF THE NAMIBIAN FINANCIAL SYSTEM FOCUSING ON THE BANKING SECTOR

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Abstract. This article examines the evolution of Namibia's financial system post-independence in 1990. The structure and composition of the financial system is discussed along its contributions to employment creation and economic growth. The ownership structure of the banking sector and its overall performance is also outlined. The finding reveals that there has been a significant increase in the influence of non-bank financial intermediaries, meanwhile the dominance of the financial sector continues to shrink with mounting credit risk pressures. The financial sector's contribution to employment creation has been quite minimum and is likely to continue being like in the foreseeable future as developments in the artificial intelligence world accelerate. The practical policy interventions emanating from this assessment necessitate a serious consideration.

Keywords: *financial system; credit risk; banking sector; Namibia.*

Rezumat. Articolul examinează evoluția sistemului financiar al Namibiei după obținerea independenței în a. 1990. Structura și compoziția sistemului financiar sunt discutate împreună cu contribuțiile sectorului la crearea de locuri de muncă și creșterea economică. Structura de proprietate a sectorului bancar și performanța sa generală este, de asemenea, subliniată. Constatarea relevă că a existat o creștere semnificativă a influenței intermediarilor financiari nebancari, în timp ce dominația sectorului financiar continuă să se restrângă odată cu presiunile crescânde ale riscului de credit. Contribuția sectorului financiar la crearea de locuri de muncă a fost destul de minimă și este probabil să continue și în viitorul apropiat, pe măsură ce evoluțiile din lumea inteligenței artificiale se accelerează. Intervențiile practice de politică care decurg din această evaluare necesită o analiză serioasă.

Cuvinte cheie: *sistem financiar; riscul de credit; sectorul bancar; Namibia.*

1. Introduction

Namibia is a member of a currency board arrangement, the Common Monetary Area (CMA), other members being Lesotho, Eswatini and South Africa, which is the leader of the arrangement. To ensure import stability amongst member countries, the currencies are pegged on a one-to-one parity with that of the South African rand (the major trading partner

to all the member countries in the CMA). This arrangement strips member states, who are subordinates of South Africa, of their ability to independently set a monetary framework of their choice. Notwithstanding, through capital restrictions and prudential requirements, member states have some limited leeway in deviating from the repo rates adopted by the South African Reserve Bank (SARB). This manoeuvrability is what has enabled the Central Bank in Namibia (Bank of Namibia (BoN)) to seldom maintain a differentiated repo rate from that of the SARB, especially when it is deemed necessary to regulate its own domestic affairs that relate to money supply and endogenously driven inflation [1].

Moreover, the CMA member states are required to maintain a minimum international reserve coverage, especially the South African rand, in order to ensure import price stability from its major trading partner – South Africa [1]. According to [2], extensive regulatory regimes have been put in place for market risk, country risk and consolidated supervision, of anti-money laundering or combatting the financing of terrorism. Furthermore, the effectiveness of the information-sharing provisions is another regulatory framework put in place with the SARB. The oversight regulation of the financial system is said to have considerably improved, owing to numerous legislations adopted in the financial sector [2]. The implementations of the upgraded bills on NAMFISA, BoN, Financial Institutions and Markets (FIM), Banking Institutions Act (BIA), Microlending, Deposit Insurance and Financial Services Adjudicator (FSA) have been established with international norms that are central in improving the regulation.

The quality of on-site supervision and the launch of risk-based supervision of banks, implemented since 2008, have over the years been of vital importance to the stability of the Namibia banking and financial system [2]. Equally important, the wide-range supervisory examination manual of the IMF plays a hand due to the challenging and severe on-site examination. Furthermore, the Prompt Corrective Action regime is an effective set of tools for addressing all forms of unsafe practices.

Considering the above, this study presents an overview of the evolution and performance of Namibia's financial system with a specific focus on the banking sector. Therefore, the study is divided into seven sections. Firstly, the study looks at the structure of Namibia's financial system. Secondly, the composition of Namibia's state-owned financial institutions is discussed. Thirdly, the composition of Namibia's Non-Banking Financial Institutions (NBFI) is presented. Fourthly, the contribution of Namibia's financial sector to GDP and employment creation. Fifthly, the paper also describes the ownership structure of Namibia's banking sector. Sixthly, a descriptive evaluation of the performance of Namibia's banking indicators is provided. Lastly, the study's conclusion is provided.

2. The structure of Namibia's financial system

Namibia has for many years been classified by the World Bank as an upper middle income with an advanced financial system as per developing countries' standards. This status has often been disputed by many Namibians, including the late President (H.E Hage Geingob) who on multiple occasions has disputed such a biased ranking and pleaded with the World Bank to downgrade it to a lower income status. The reason for this argument is predominantly due to the country's colonial history which saw the vast majority of black Namibians disposed their land. Consequently, the country has continued to suffers from huge income inequality which has placed it amongst the top five most unequal countries in the world, with a GINI coefficient index of 64.2 % as of 2019 World Development Indicators. Its financial system

comprises of a Central Bank (also known as the Bank of Namibia (BoN)), private banks, state-owned financial institutions, and Non-Bank Financial Institutions (NBFI). Prior to Namibia's independence in 1990, Namibia (previously known as South West Africa) was simply a province of South Africa. As such, the functions of the central bank were predominantly performed by the South African Reserve Bank (SARB). The BoN was established in 1990 in terms of Article 128 of the Namibian constitution [3]. Nevertheless, it only managed to introduce its own currency, the Namibian Dollar (N$) in 1993.

During the early years of independence, Namibia's financial structure in terms of the total size of the financial system was strongly dominated by the banking sector [4]. However, decades later the influence of some NBFI such as the pension funds and insurance companies, become formidably dominant. In fact, from 1991 to 1995 the share of the banking sector, in relation to the total assets of the financial system gradually shrunk from 72.7% to 67.5% and further to 51.4% in 2001 (this excludes the stock exchange). However, during that same time period, the share of NBFI (total combination of pension funds, unit trusts and insurance companies) gradually rose from 23.3% to 32.5% and further to 48.6% in 2001. The increasing influence of the NBFI, if not properly managed, is likely to exacerbate the already high credit risks condition of the Namibian financial system. The percentage change in the amount of total assets for Namibia's banking sector for the period, 2020 - 2021 stood at 37.2% [5]. In contrast to the share of assets of NBFI, in 2021, 20% of its share of total assets was from the insurance companies (both long- and short-term combined) alone, whilst 57.5% was from the pension funds [6].

3. The composition of Namibia's financial institutions

The Namibian financial institution comprises of four specialised state-owned financial institutions, and nine privately-owned financial institutions. The state-owned institutions include: the Namibia Post Office (NamPost) Savings Bank - a division of NamPost Limited, the Agricultural Bank of Namibia Limited (AGRIBANK), the National Housing Enterprise Limited (NHE), and the Development Bank of Namibia Limited (DBN). On the other hand, the privately-owned institutions comprise of: Banco Privado Atlántico Europa Limited, Bank BIC Namibia Limited, Bank Windhoek Limited, First National Bank Namibia Limited, Nedbank Namibia Limited, Standard Bank Namibia Limited, Letshego Bank Namibia Limited, Trustco Bank Namibia Limited, and ABSA Ltd.

The NamPost Savings Bank provides basic savings and transactions services through the postal network and micro-loans to individuals across the country. The offices of the state-owned financial institutions are operational in all 14 regions of the country, thereby supporting the governmental objectives intended of widening the country's financial inclusion and development. With regards to farming activities, the AGRIBANK is the principal governing institution tasked with the mandate of extending financial assistance (through loans) to farmers and would-be farmers to assist them in purchasing livestock and/or any other related agricultural products, including housing finance for small-scale farmers [7].

The BoN describes the NHE as a statutory body in which the government is the sole shareholder mandated to provide/construct houses for the vast majority of citizens falling within the low and middle-income bracket [7]. Through the NHE, citizens are afforded a dignified shelter, which is a constitutional the right. The DBN, formally formed in April of 2004, has an overarching goal of contributing to the socio-economic wellbeing and economic growth [8]. The institution is also responsible of sourcing funds intended to finance some of

the country's developmental agendas as outlined in various developmental documents (Vision 2023, NDPs, HHPs, etc…). The same institution is equally allowed, if necessary, to fund individuals and businesses with bankable project proposals, amongst others. The total loans and advances during the 2020/21 financial year (FY) stood at N$7.92 billion. This amount is said to be lower when compared to the N$8.47 billion registered in the preceding FY. The decline is largely attributed to the shocks that occurred in the global economy at the time.

With regards to the privately-owned institutions, of the four largest (Bank Windhoek Limited, First National Bank Namibia Limited, Nedbank Namibia Limited, and Standard Bank Namibia Limited), three of them, headquartered in South African, were estimated to account for a combined total bank asset of 98% in 2018.

Given the country's colonial history which is often cited as the reason for its extremely high GINI ratio (second highest in the world), any improvements aimed at harnessing the financial sector's contribution to employment and economic growth are greatly welcome as they are likely to invert the existing income disparity between the rich and the poor.

4. The composition of Namibia's Non-Banking Financial Institutions (NBFI)

There are quite a number of NBFI operating within the Namibian financial system. These include the pension funds, life insurers and the non-life insurers that are made up of insurance companies, microfinance institutions, medical aids, the Namibian Stock Exchange, trusts/money market funds and stockbrokers. The NBFI are believed to play a crucial intermediate role in the country's financial system by linking institutional investors to financial markets and banks.

According to the International Monetary Fund (IMF) [2], the bulk of pension funds' assets are managed by investment managers, with a total of 37% of total assets invested within Namibia, while 41% is invested in South Africa and the rest trickles to other investment destinations around the world. Furthermore, the majority of life insurance companies directly manage their own investments, with only 5% of their investments placed under the guard of investment managers. Insurance companies (life insurers and non-life insurers of both short term and long term) accounted for approximately 10% of the total assets of the Namibian financial system during the year 2001. However, according to [9]'s annual report, approximately 20% of total assets were recorded in 2021, which is a percentage lesser when compared to the records of the previous year. From 1994 to 2001, percentage share of unit trusts in terms of total financial assets rose from as little as 1%, since the formation of the first unit trust, to approximately 5.5%. By the end of the second quarter of 2022, unit trust schemes accounted for 27% of total assets per investor.

The number of asset managers and stoke brokers have continued to increase since the mid-90s, from zero to approximately 18 for asset managers and 7 stock brokers in 2001. In addition, the establishment of the Namibian Stock Exchange (NSX) in 1992 introduced regulations that required institutional investors to invest at least 35% of their assets domestically. The placement of the development capital portfolio of the Government Institutional Pension Fund (GIPF) with assets managements companies in 1994-95, were cited as some of the reasons for the rapid development of these institutions after independence.

Between the periods 1991 to 2001, the assets of pension funds averaged approximately 31.9% of the total assets of Namibia's financial system. From 2016 to 2021, approximately 55.9% of the total assets was derived from pension funds [9]. With regards to

the number of institutions, the pension funds institutions increased from as little as 200 institutions at independence to about 500 in 2001. As of 2022, there were 135 pension funds registered under the NAMFISA. Currently, the pension system consists of a universal, non-contributory pension, private, and occupational schemes which covers approximately 30% of the total labour force, including the GIPF. As of 2021, the assets of the pension fund sector stood at the tune of N$212,932,000, a figure higher than the previous year which stood at approximately 180,522,000. Approximately 40% of pension fund assets are invested domestically while the remainder is split between South Africa/CMA and overseas investment destinations [2].

The insurance market in Namibia is dominated and concentrated by subsidiaries from mainly South African financial groups. This sub-sector consists of 16 life insurers, 14 general insurers and one state owned reinsurer. Assets in the insurance sector include insured pension funds products providing an explicit capital guarantee. These pension fund assets are held on the balance sheets of the life insurance companies. Long term insurance companies make up the largest share of assets under management in terms of assets under administration per source of funds. According to [9]'s annual report, total assets of long and short-term insurance companies amounted to N$73,860,000 in 2021 as compared to N$68,168,000 in the previous year. With regards to the medical aid industry, though small, it has been growing. In 2016, the industry's total assets were N$1,443,000, but by the end of the year 2021, the figure had almost doubled to the tune of N$2,287,000.

In Namibia, the unit trust market includes the Money market unit trusts which invests in treasury bills, certificate of deposits, and direct deposits with banks. The first unit trust in Namibia was only established in August 1994 by Sanlam. Since then, the sub-sector has enormously grown to include eight registered unit trust management companies by the end of 2000. These included the Old Mutual Unit Trust Management company, the Sanlam Unit Trust Management company, the Commercial Bank of Namibia Unit Trust Management company, the Standard Bank Unit Trust Management company, and Investec Namibia. The benefits of unit trust membership come from the mutual pooling of resources for investment under professional management. It is important to note that activities in these funds fluctuate with liquidity in the banking sector. This is because banks compete through increased deposit rates as their liquidity needs increase.

In relation to the stock market, the Namibian Stock Exchange (NSX) is the only licensed stock exchange entity in the country as per the stock exchange control Act (No.1 of 1985). The listed securities on the stock exchange market comprise of mostly dual-listed South African companies and primary-listed Namibian companies. The NSX records low levels of liquidity due to the buy-and-hold strategy that most investors in the country use as well as the partially insufficient instruments available. One of the reasons for investors holding on to trading instruments is due to the need of conforming to the local investment requirements. It is also important to note that there are four registered stockbrokers in Namibia that act as intermediaries between investors and the stock exchange. These institutions have risen since independence, although the services they offer are still very limited when compared to those offered by South Africa.

5. The contribution of Namibia's financial sector to GDP and employment creation

The importance of the financial sector, in terms of its contribution to GDP and employment, has continued to evolve through the years, after independence from

colonialism. As seen from both Tables 1 and 2, the contributions have not always been consistently incremental, as in some years the sectors contributed little, while in others it contributed slightly more. Needless to say, in term of its contribution to GDP and employment creation, the financial sector has always been amongst the top 5 sectors (out of a total of 13 sectors) of the tertiary industry.

Table 1

Percentage contributions to GDP of the top 5 tertiary industries, 1996-2021

Tertiary industries	1996-2000	2001-2005	2006 – 2010	2011 – 2015	2016 – 2021	Avg. Rank]
Wholesale & retail trade, repairs	8.3	10.7	10.9	11.4	10.2	8.6 [1]
Real estate & business services	8.6	9.0	8.2	8.5	5.5	6.3 [2]
Arts, entertainment, & recreation	1.4	6.9	6.1	5.7	5.5	4.3 [3]
Financial & insurance services	3.1	3.9	4.8	5.9	7.2	4.2 [4]
Transport & Storage	3.6	2.7	2.7	2.8	3.0	2.5 [5]

Source: Authors' compilation using data from the NSA and BoN
Note: The other sectors include, Hotels and restaurants; Information Communication; Professional, scientific and technical services; Administrative and support services; Public administration and defence; Education; Health; and Private household with employed persons.

Tables 1 demonstrates that the average percentage contribution to GDP by the financial sector has consistently featured the top 5 most influential sectors, in terms of its percentage contribution to GDP in the tertiary industry. More specifically, the information reveals that the financial sector ranked third during the post-independence, 1996 – 2000 years. Nonetheless, between the periods 2001 – 2005, the Arts, entertainment, and recreation sector became increasingly developed, and overtook the position of the financial sector causing it to decline into the fourth position. Between the periods, 2006 – 2021, it retained its initial position as can be observed from the reported descriptive statistics. Overall, the average percentage GDP contribution of the financial sector was calculated to be 4.2% during the periods 1996 – 2021, which caused it to rank as the fourth most contributing in the category of tertiary industries.

With respect to its employment contribution to total labour force (in Percentage), Table 2 presents a comparative analysis of the top 5 tertiary industries that contributed most to the total labour force, using the available statistics from the Namibia Statistics Agency (NSA) for the periods between 2012 to 2018.

Table 2

Employment (%) of labour force of the top 5 tertiary industries, 2012-2018

Tertiary industries	2012	2013	2014	2016	2018	Average	Rank
Wholesale & retail trade, repairs	11.9	N/A	11.6	12.1	10.7	9.3	1
Financial & insurance services	2.0	2.1	2.1	3.0	2.5	2.3	2
Transport & Storage	3.6	0.8	3.7	0.9	0.8	2.0	3
Real estate & business services	0.3	6.3	0.1	0.2	0.2	1.4	4
Arts, entertainment, & recreation	0.5	N/A	0.6	0.6	1.0	0.5	5

Source: Authors' computations using data from the NSA Labour Force Survey of 2012 - 2018. Note that the 2012 Namibia Labour Force Survey (NLFS) is the earliest survey ever conducted in Namibia, whereas the 2018 NLFS is the latest survey at the time of this study.

Based on Table 2, the average employment contribution to the total labour force by the financial sector, during the space of five years of available data point, was 2.3%. Such a contribution has caused it to rank as the second highest contributor, amongst the tertiary industries. This seems to back the recurring assertions made by several studies which argue that the financial sector plays an important social-economic role [10-12]. The evolution of the Namibian financial system is unlikely to yield any significant future employment opportunities due to the evolutions taking place in the Artificial Intelligence (AI) world. The continual advancements in AI engenders financial institutions to explore alternative cheaper ways of conducting business, whilst simultaneously maximising their profits. The automation of most aspects of their businesses that used to be mechanical to robotics, signals a significant shift that will no doubt eclipse the future employment prospects for this sector.

All in all, the financial sector's contribution to GDP growth rate has slightly increased over the year relative to other sectors within the tertiary industry. However, its contribution to employment creation, projected to decline due to advancements in AI, has since remained unchanged.

6. Ownership structure of Namibia's banking sector

Namibia's current banking system comprises of seven commercial banks, an E-bank, and a foreign bank branch. The banks include: Banco Privado Atlantico Europa Limited, Bank BIC Namibia Limited, Bank Windhoek Limited, First National Bank Namibia Limited, Nedbank Namibia Limited, Standard Bank Namibia Limited, Letshego Bank Namibia Limited, Trustco Bank Namibia Limited, and ABSA Ltd.

As a matter of fact, out of the four largest banks, three are subsidiaries of South African banks representing a combined total bank asset of 98% [2]. Banks operating with the Namibia's banking sector are subject to BoN's regulations and supervisions, despite the majority of them being externally owned. The Central Bank (BoN) is the sole issuer of money supply, and the guarantor of financial and price stability that augments economic growth, amongst other mandates [13].

7. The performance of Namibia's banking indicators

From the recession that was caused by the unfortunate COVID-19 pandemic in Namibia, the banking sector performance, though positive, has been deteriorating. On the other hand, levels of capital and liquidity continue to be well over the required amounts (in bank institutional terms). Additionally, the Namibian Financial Institution Supervisory Authority [NAMFISA][14] reported an increase in liquid assets at the tune of N$19.0 billion to N$20.1 billion from 2019 to 2020, respectively. The increase is said to have been heavily influenced by Government's payments of deferred tax payments, Value Added Tax (TAX) refunds and the corporates repatriating funds. Furthermore, there has been a slightly improvement in the loan repayments by debtors operating within the banking sector. This is evident when one observes the sluggish declines recorded by the NPL ratios. The demands for credit from businesses and households has also been slowing down, as the growth in the private sector credit extension (PSCE) was recorded to have declined from 6.8% in 2019 to 2.4% in 2021 [5].

In terms of the banking sector's balance sheet, positive growth was still recorded during the recession. In fact, NAMFISA [14] reported a 1.3% increase that amounted to N$144.0 billion at the end of 2020 from 2019. On the contrary, the net loans and advances reduced from N$101.2 billion to N$100.7 billion, during the review period. This is a further indication of a decline in the demand for credit. With regards to the liability side of the banking sector, more liabilities came from demand deposits. These deposits accounted for a rise of 51% of

total funding from 47.1% and comprising of mainly wholesale deposits that are volatile and may pose a risk to the overall financial stability.

Furthermore, the [14]'s report stated that the sector's total assets rose from N$142.2 billion in 2019 to N$144.0 billion in 2019, thus signifying a 1.3% growth rate that was lower than the previous year which was 7.6%. Likewise, the increasing rate of assets failed to exceed 2.2% average rate of inflation. Moreover, during the review period (2019 - 2020), total assets declined from 71.2% to 69.1% while net loans and advances continued to record the largest share of the asset's category. On the other hand, cash and balances with banks increased by 8.8% from N$13.6 billion in 2019 to N$14.8 billion in 2020.

With regards to capital and liabilities, the [14] report indicated that non-banking institutions contributed the most in terms of funding the banking sector. The contributions consist of demand deposits, notice and fixed deposits as well as negotiable certificates of deposit. During the same review period mentioned earlier, 2020 recorded 1.6% non-bank funding unlike the 8.4% in the previous year. The non-banking deposits comprised the highest share of non-bank funds, which were largely made up of wholesale deposits. In terms of capital adequacy, the total risk-weighted capital (RWCR) slightly declined to 15.2% in 2020 from 15.3% in 2019, although it still remained above the statutory minimum of 11%. This implied that the banking sector is sufficiently capitalised due to its continuing to hold a capital position that is not below the domestic provident requirement of 11.0% for RWCR.

In 2021 the asset quality of the banking sector deteriorated as the level of non-performing loans (NPL) ratios rose to 6.4% [14]. This NPL ratio, which was considered to be very high as besides it being above the 4.0%-point limit set by the BoN, it was above the 6% trigger point, for times of crisis. The persistent rise in NPLs was attributed to factors such as the hostile economic conditions which has been exacerbated by the after-effects of the global Coronavirus pandemic of 2019 which caused a number of businesses to either scale down their operations or completely shut down. The average rate of NPL for the period 1996 - 2021 was 3.5%. An earlier study by Nikolaidou and Vogiazas [15], a comparative graphical presentation of the NPL for a few selected Sub-Saharan African (SSA) countries, in which Namibia was also included, together with countries of the Central East and South East European (CESEE) regions depicts some interesting facts that are worth noting (see Figure 1).

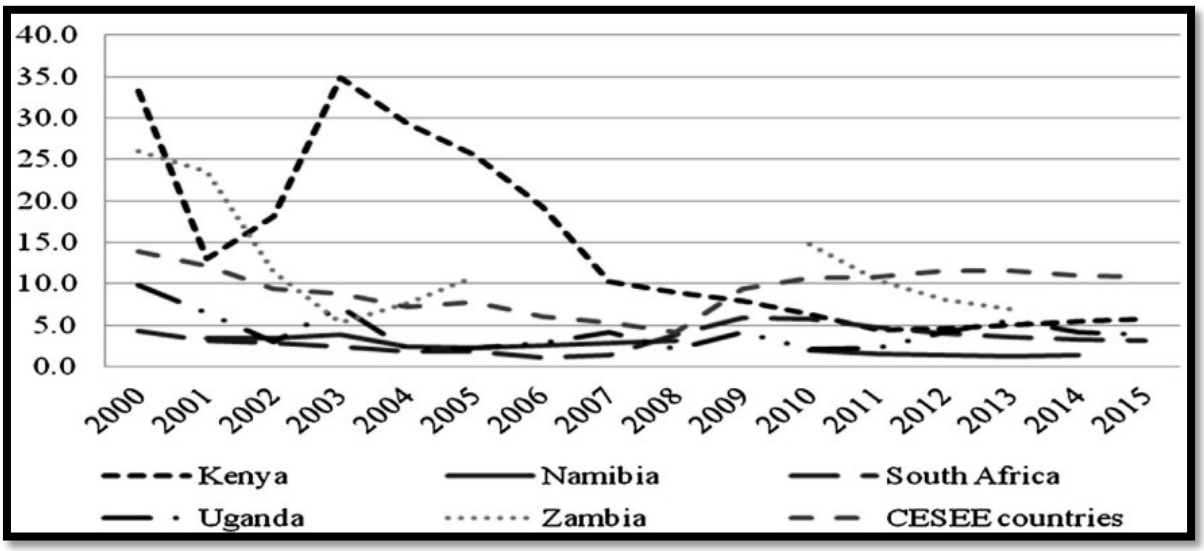

Figure 1. Ratio of NPL for a select SSA and the CESEE countries, 2000 – 2015.
Source: Adopted from Nikolaidou and Vogiazas [15] using World Development Indicators (WDI).

Even though the NPL information depicted in Figure 1 may not necessarily be speaking to the current phenomenon on NPL of the referred countries, as it contains only information dating the periods 2000 - 2015, the information is still relevant for comparison purposes. As can be seen, the ratio of NPL levels for Kenya and Zambia were quite volatile, as characterised by high spikes, when compared to those of their counterparts in the SSA region. In reference to Namibia, it was reported to have had the lowest average rates of NPL estimated at 2.4%, followed by South Africa with a 3.3% and Uganda with an average of 4.2%.

With regards to the after-tax profits, the banking sector recorded a 33.4% reduction of N$1.8 billion in 2020 compared to the amount recorded in 2019 that was N$2.7 billion [14]. During this same period, the net interest income saw a huge percentage fall of 17.3% in line with the lower repo rate from Bank of Namibia along with decreasing interest by commercial banks. Conversely, the same report under that other operating income had risen by N$63 million whilst accumulating a total of 3.7 billion that saw a huge positive contribution to the rise in total income.

The loan to deposit ratio (LDR) of the Namibian banking sector has come under pressure over the years, thereby causing banks to explore alternative avenues of funding other than the conventional deposits. In terms of the cost efficiency ratio, it has over the years fluctuated downwards, with the ratio of loans to assets (LTA) not having any particular trend pattern as can be seen in Figure 2.

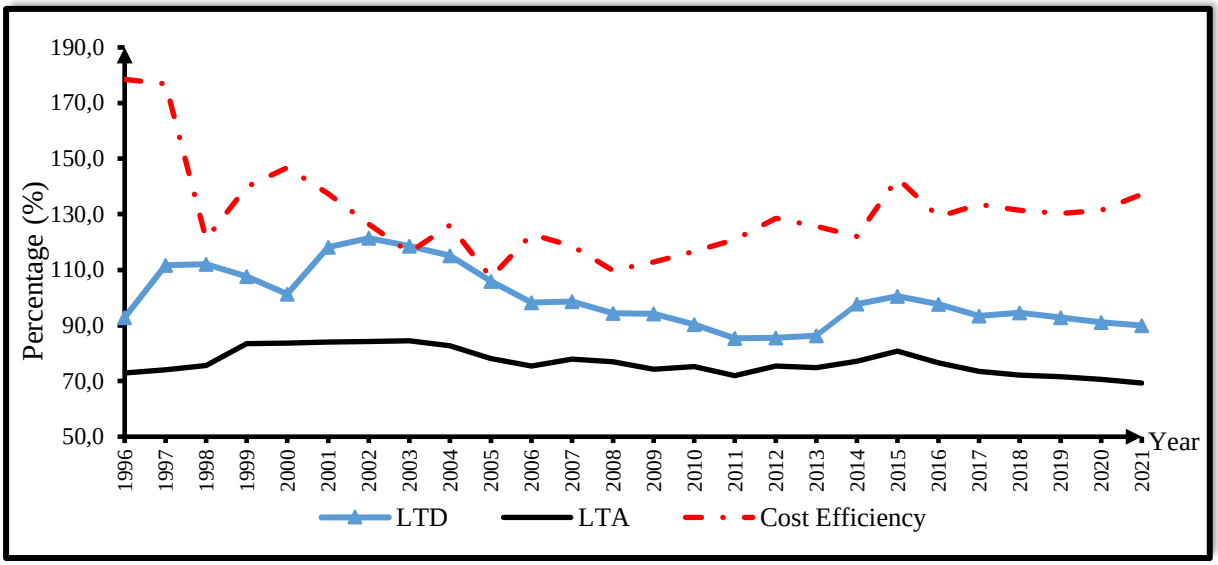

Figure 2. Liquidity and cost efficiency of Namibia's banking sector, 1996Q1 - 2021Q4.
Source: Authors' compilation using data from BoN.

Based on Figure 2, the graphical presentation of the LDR for Namibia's banking sector averaged 97% from 1996 to 2021. The highest ratio (118.5%) was in 2003 whilst the lowest (85.4%) was recorded in 2011. The percentage of LTA shows that it has always been above 70%. The average rate for cost efficiency ratio stood at 130.4%. The peak of this ratio was recorded in 1996, whilst the lowest was registered in 2005.

With regards to mortgages, depicted in Figure 3, more than one-half of bank loans are directed to commercial and residential mortgages. Above all, individuals constantly dominate the total private sector credit. In 1995, individuals' total borrowing was recorded to approaching N$4.2 billion. By the end of the year 2001, the amount had almost doubled to N$8.2 billion. During the same period, the credit extension to the business sector had doubled

from as little as N$2 billion to N$4.5 billion. However, the share to total private sector credit to individuals accounted for approximately 65% whilst the remaining 35% was extended to the business sector.

According to [14] the year 2020 recorded a higher mortgage loan percentage of 52.3% higher than its previous year (51.3% of total lending) on the banking sector balance sheet. This is not surprising because over the years, mortgage loans have dominated the category of loans and advances. Matter of fact, the share of mortgage as a percentage of total loans in the early 90s was merely 30%. The combination of the residential and commercial mortgage loans has continued to make up the largest component of the total loans and advances category, registering over 50% in both 2020 and 2021 [13].

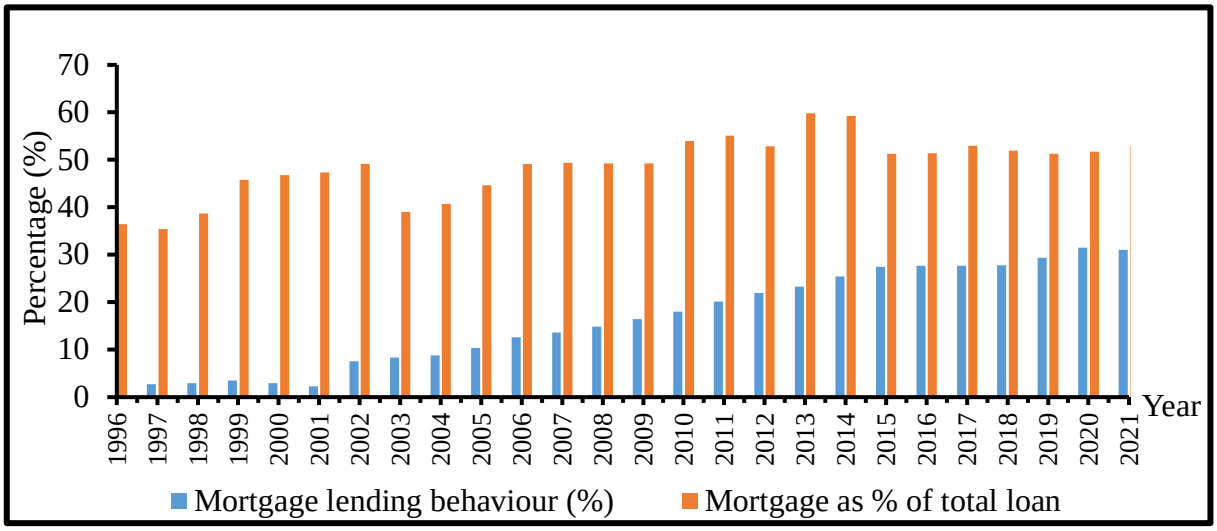

Figure 3. Mortgage lending behaviour (%) and mortgage to total loans (%), 1996-2021.
Source: Authors' compilation using data from BoN.

Regarding the year-on-year growths in the Namibia's banking sector assets, the growth rate was recorded to be below the average inflation rate of 3.6% registered in 2021. Nevertheless, the banking sector continues to make some positive strides as it has proven to be resilient amidst the challenging economic conditions facing the country.

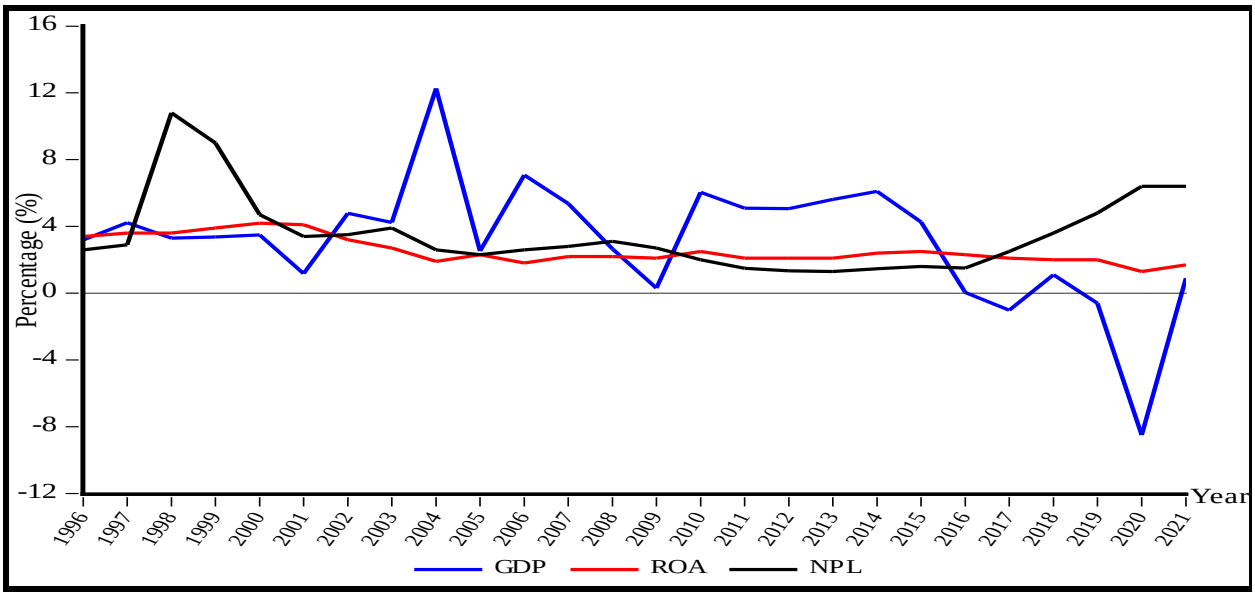

Figure 4. Percentage GDP growth rate, ROA and NPL, 1996Q1 - 2021Q4
Source: Authors' compilation using data from BoN.

Figure 3 illustrates the dynamics in the percentage of mortgage lending behaviour and mortgage as a percentage of total loans between the periods under review.

The data presented in Figure 3 indicates that the ratio of mortgage lending behaviour entered a double-digit zone beginning in 2005 up until the end of the study period. The share of mortgage as a percentage of total private loans averaged at 48.7% for the period under review. The highest mortgage as percentage of total loans (59.8%) was recorded in 2013, with 1997 being the year in which it recorded the lowest (35.4%). The relatedness between the percentage growth rate of the economy, return on asset (ROA) and non-performing loans (NPL) for the period 1996 - 2021 is presented on Figure 4.

Based on Figure 4, for the most part, the ratio of NPL has always hovered above the banking sector's ROA. This is not conducive for the banking sector in general as it ends up eating on their profit margins and may lead to bankruptcy if care is not taken. With regards to how the ratio of NPL relates to economic growth, except for the period 2016 -2021, it is not quite possible to tell without empirically investigating it, which is beyond the scope of this study. All in all, the rate of GDP growth appears to be very volatile, followed by the ratios of NPL and ROA, respectively.

8. Conclusion

This study explored the evolution of the Namibian financial system post-independence in 1990. The findings reveal that there has been a significant increase in the influence of non-bank financial intermediaries, meanwhile the dominance of the financial sector has continued to shrink. Moreover, Namibia's credit risk has been rising, exacerbated by the advent of the COVID19 pandemic. The contribution of the financial sector to employment creation, has been quite minimum and is expected be so due to the advance developments taking place in the artificial intelligence world. Given that the banks operating in the Namibian banking sector space are predominantly foreign owned, the BoN and NAMFISA have a crucial supervisory and legislative role of ensuring that there is stability in the banking and financial system. Beyond these basic mandates, the same institutions should also help citizens to guard against the exploitative behaviours of banking institutions. This can be achieved by ensuring that these profit driven institutions do not unfairly fix higher interest rates, as it is in most cases, and charge citizen hefty bank charges to make them earn abnormal profits. Government could intervene by setting a ceiling on the interest rates, thereby preventing citizens from being unfairly charged and ripped off.

Conflicts of Interest: The authors declare no conflict of interest.

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THE SUSTAINABILITY OF E-LEARNING IN HIGHER EDUCATION

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Abstract. The present study examines the sustainability of e-learning strategies integrated into higher education, with a particular focus on computer science disciplines. As part of a pedagogical experiment conducted at the Technical University of Moldova (TUM), 259 students were evaluated post-experimentally to analyze the effectiveness and long-term impact of these strategies on academic performance and the development of professional skills. The results demonstrated that the implementation of the e-learning-centered pedagogical model led to significant improvements in students' cognitive, emotional, and behavioral engagement, thus confirming the sustainability and relevance of these instructional methods. The contribution of this study lies in highlighting the academic and scientific value of effectively integrating e-learning strategies into the university educational process, as well as in formulating well-founded recommendations for optimizing e-learning strategies to meet the current demands of higher education.

Keywords: *e-learning, sustainability, e-learning strategies, computer science disciplines, pedagogical model, post-experimental evaluation, academic performance.*

Rezumat: Studiul de față a examinat sustenabilitatea strategiilor e-learning integrate în învățământul superior, cu un accent particular pe disciplinele informatice. În cadrul unui experiment pedagogic desfășurat la Universitatea Tehnică a Moldovei (UTM), 259 de studenți au fost evaluați post-experimental pentru a analiza eficacitatea și impactul pe termen lung al acestor strategii asupra performanței academice și dezvoltării competențelor profesionale. Rezultatele obținute au demonstrat că implementarea modelului pedagogic centrat pe e-learning a condus la îmbunătățiri semnificative în ceea ce privește implicarea cognitivă, emoțională și comportamentală a studenților, confirmând astfel sustenabilitatea și relevanța acestor metode de instruire. Contribuția acestui studiu constă în evidențierea valorii academice și științifice a integrării eficiente a strategiilor e-leraning în procesul educațional universitar, precum și în formularea unor recomandări fundamentate pentru optimizarea strategiilor de e-learning, cu scopul adaptării acestora la cerințele actuale ale educației superioare.

Cuvinte-cheie: *e-learning, sustenabilitate, strategii e-learning, discipline informatice, model pedagogic, evaluare post-experiment, performanță academică.*

1. Introducere

În contextul modernizării continue a educației, strategiile e-learning reprezintă un pilon esențial în îmbunătățirea calității învățământului superior, în special în domeniul disciplinelor informatice. Scopul principal al acestui studiu a fost de a aproba implementarea Modelului Pedagogic de Implementare a Strategiilor e-learnig la Discipline Informatice (MPISe-lSDI), ipoteza principală fiind că integrarea strategiilor e-learning în disciplinele informatice contribuie semnificativ la creșterea sustenabilității învățământului superior prin îmbunătățirea performanțelor academice și dezvoltarea competențelor profesionale ale studenților [1]. În contextul procesului Bologna, se subliniază importanța centrării pe student ca metodă esențială pentru creșterea implicării acestora și îmbunătățirea calității educației în învățământul superior [2]. Acest model centrat pe student, a fost conceput pentru a îmbunătăți calitatea formării viitorilor specialiști în domeniul rețelelor de calculatoare, prin adaptarea curriculumului universitar la cerințele actuale ale pieței muncii și la nevoile educaționale ale studenților.

În acest cadru, se evidențiază necesitatea corelării curriculare în învățământul superior pentru a asigura coerența și relevanța formării cadrelor didactice în contextul cerințelor moderne [3]. Experimentul pedagogic desfășurat la UTM a vizat evaluarea impactului pe termen lung al acestor strategii asupra performanțelor academice ale studenților. Evaluarea post-experiment a avut ca obiectiv validarea sustenabilității rezultatelor, prin analiza aprofundată a modului în care metodele e-learning contribuie la dezvoltarea competențelor profesionale și la îmbunătățirea experienței de învățare.

Strategia de transformare digitală a Republicii Moldova pentru anii 2023–2030 subliniază importanța digitalizării ca factor esențial pentru modernizarea economiei și educației, având ca obiectiv principal integrarea tehnologiilor digitale în toate sectoarele cheie [4]. Modelele e-learning constituie baza unei noi paradigme educaționale, oferind abordări inovatoare și eficiente care valorifică tehnologia pentru a remodela experiența de învățare. Utilizarea diverselor instrumente, cum ar fi cursurile online, conferințele web și simulările virtuale, deschide noi orizonturi educaționale, facilitând implicarea activă și îmbunătățirea performanței academice a studenților.

Flexibilitatea și accesibilitatea în e-learning permit studenților să-și gestioneze eficient timpul, echilibrând responsabilitățile academice cu cele personale. Modelele e-learning oferă un cadru pentru organizarea conținutului, facilitarea interacțiunii și promovarea colaborării în mediul digital, contribuind astfel la dezvoltarea competențelor esențiale pentru piața muncii [5].

Integrarea teoriilor pedagogice în modelele e-learning amplifică eficiența procesului educațional, oferind oportunități de învățare activă și colaborativă, stimulând gândirea critică și creativitatea studenților. În studierea disciplinelor informatice la nivel universitar, aceste modele îmbunătățesc accesul la resurse, interacțiunea cu colegii și profesorii, și flexibilitatea învățării, contribuind astfel la formarea competențelor profesionale.

Un curs e-learning include următoarele elemente [6]:

1. **Conținut de învățare.** Acesta cuprinde elemente precum cursuri electronice, module, lecții, prezentări, documente, fișiere audio și alte tipuri de conținut educațional. Conținutul este structurat și organizat în funcție de obiectivele de învățare.
2. **Exerciții și activități practice.** Acestea permit studenților să aplice cunoștințele și să dezvolte abilități relevante într-un mod interactiv, fiind prezentate sub formă de teste, întrebări cu răspunsuri multiple, probleme sau simulări.

3. **Resurse multimedia.** Include elemente precum videoclipuri, animații, imagini, diagrame și alte materiale vizuale și auditive care îmbogățesc procesul de învățare și îl fac mai atractiv și interactiv.

4. **Instrumente de comunicare și colaborare.** Acestea permit studenților să interacționeze între ei și cu profesorii, facilitând discuțiile și munca în echipă.

5. **Evaluări și teste.** Acestea măsoară progresul și cunoștințele studenților prin evaluări periodice și oferă feedback pentru a monitoriza performanța.

6. **Sistem de administrare a învățării.** În unele cazuri, cursul poate fi livrat prin intermediul unui LMS, o platformă specializată care gestionează și oferă acces la conținutul de învățare. LMS urmărește progresul studenților și facilitează administrarea și livrarea conținutului.

Prin integrarea strategică a acestor elemente, cadrele didactice pot proiecta și implementa cursuri electronice care nu doar că angajează și motivează studenții, dar le și echipează cu competențele și cunoștințele necesare pentru succesul academic și profesional. Modelele aplicate în e-learning reprezintă un cadru esențial pentru proiectarea și punerea în practică a instruirii din domeniul disciplinelor informatice la nivel universitar. Aceste modele facilitează dezvoltarea unor strategii sistematice, care integrează teorii educaționale, metode de interacțiune și modalități de evaluare, contribuind astfel la crearea unei experiențe de învățare interactivă, adaptată și eficientă în cadrul studiilor la universitate.

Disciplinele informatice sunt domenii de cunoaștere axate pe studiul calculului și al tehnologiei informației, abordând dezvoltarea, proiectarea, implementarea și utilizarea sistemelor informatice pentru a satisface diverse necesități și a rezolva probleme umane. Aceste discipline cuprind subdomenii precum programarea, bazele de date, rețelele și securitatea cibernetică, inteligența artificială și învățarea automată, dezvoltarea web și designul, sistemele de operare, precum și tehnologia informației. Studiile în informatică echipează indivizii cu cunoștințele și competențele esențiale pentru a impulsiona inovația și a susține progresul într-o lume digitală aflată în continuă schimbare. Astfel, disciplinele informatice joacă un rol crucial în avansul tehnologic și în modelarea societății contemporane.

Tabelul 1

Modele e-learning după Kenneth Fee [7]

Modelul 1	Cursuri online	Acesta reprezintă un model clasic e-learning, în care conținutul este livrat studenților prin intermediul instrumentelor online. Inițial, acest tip e-learning a fost realizat prin web, dar s-a dezvoltat pe măsură ce au apărut noi tehnologii și servicii web. De asemenea, conținutul poate fi livrat prin Intranet, utilizând un Sistem de Management al Învățării (LMS).
Modelul 2	Învățare mixtă (integrată online și offline)	Programe de învățare care integrează învățarea online cu activități offline complementare
Modelul 3	E-learning autogestionat	Studenții au un control semnificativ asupra procesului lor de învățare, își stabilesc propriile finalități de învățare, își aleg resursele și materialele didactice pe care le consideră potrivite și își gestionează propriul ritm de studiu. Ei pot să învețe de la distanță, folosind resurse online, module de învățare sau alte materiale disponibile digital.
Modelul 4	E-learning live	Evenimente de învățare online sincrone, implicarea studenților în mai multe locații, care participă împreună la o oră prestabilită

Continuare Tabelul 1

Modelul 5	Performanța electronică a suportului	Învățarea online la locul de muncă susține sarcini specifice, sisteme sau proceduri operaționale
Modelul 6	Sala de clasă cu resurse digitale	Acest model implică o sală de clasă tradițională, îmbunătățită cu tehnologii, echipamente cu acces la internet, proiectoare și ecrane tactile pentru partajarea audio și video, simulări și alte resurse digitale. Acest model are asemănări cu Modelul IV, e-learning live, dar în realitate se desfășoară față în față.

Modelul pedagogic al cercetării, funcționează ca o schemă sistematică pentru planificarea și gestionarea procesului de instruire, acționând ca un sistem logic și secvențial, compus din elemente esențiale precum:

1. **Standarde de competență.** Definirea cunoștințelor, abilităților și atitudinilor pe care studenții trebuie să le dobândească pentru a fi bine pregătiți.
2. **Relevanța pentru piața muncii**. Asigurarea că instruirea este în concordanță cu cerințele profesionale ale industriei, reflectând nevoile actuale și tendințele pieței muncii.
3. **Corelarea constructivă**. Alinierea standardelor de competență cu nevoile pieței muncii, garantând că curriculum-ul este practic și aplicat.
4. **Curriculum**. Descrierea structurii și a conținutului detaliat al disciplinelor universitare, incluzând toate unitățile de curs necesare pentru a atinge competențele stabilite.

Aceste elemente sunt fundamentale pentru dezvoltarea unui model pedagogic eficient, care să răspundă atât nevoilor educaționale ale studenților, cât și cerințelor pieței muncii, asigurând astfel relevanța și actualitatea programelor de studiu [8].

Alinierea cu piața muncii este examinată pe baza acțiunilor întreprinse la nivel de **program, departament, instituție** și **sistem** pentru a atinge obiectivele de aliniere a locurilor de muncă și a competențelor cerute. Mulți dintre factorii interesați desfășoară activități de aliniere și oferă finanțare și politici pentru a promova alinierea cu piața muncii. În funcție de nivelul instituțional, acești factori pot include lideri ai sistemului de învățământ superior, rectori, șefi de departamente și programe, profesori, studenți, angajatori.

Strategia e-learning adoptată pentru cursul universitar RC reprezintă o combinație între două modele esențiale, și anume modelul mixt (modelul 2) și modelul de sală de clasă cu resurse digitale (modelul 6) după Kenneth Fee [7]. Această combinație a fost concepută pentru a satisface nevoile variate ale studenților și pentru a oferi o experiență de învățare adaptată contextului specific al învățământului superior.

Modelul de mixt a fost integrat pentru a aduce flexibilitate în procesul de învățare, permițând studenților să aibă acces la resurse online și să participe la activități de învățare digitale. Acest aspect este important, deoarece studenții pot avea diferite preferințe de învățare și pot beneficia de abordări diverse pentru a-și atinge finalitățile educaționale. De asemenea, acest model facilitează colaborarea și comunicarea dintre studenți, sprijinind astfel dezvoltarea abilităților sociale și de lucru în echipă.

Pe de altă parte, modelul de sală de clasă cu resurse digitale a fost inclus pentru a menține interacțiunea directă dintre profesori și studenți într-un mediu fizic de învățare. Cu toate acestea, utilizarea tehnologiei digitale în această configurație adaugă o dimensiune suplimentară procesului de predare, învățare și evaluare, facilitând accesul la resurse și instrumente digitale care pot îmbunătăți calitatea și eficiența instruirii.

În cadrul acestui curs, s-a implementat un mix clasic de metode de predare, inclusiv activități pre și post-curs, care sunt disponibile online. Astfel, cursul începe sub forma unei platforme online, bogată în resurse digitale, precum videoclipuri înregistrate și materiale structurate pe subiecte. Aceste resurse sunt accesibile printr-un sistem de management al învățării conținutului (MOODLE), administrat de platforma UTM [9-12].

Pe lângă acest mediu digital, cursul a inclus și componente față în față, unde studenții au oportunitatea de a lucra în grup sau individual în cadrul evenimentelor de referință. Aceste întâlniri directe contribuie semnificativ la atingerea finalităților cursului și facilitează interacțiunea între studenți și profesori.

Lucrările de laborator și practice s-au desfășurat într-un mediu de învățare față în față, în cadrul căruia s-a utilizat software specializat Cisco Packet Tracer pentru a simula configurațiile și sarcinile rețelei.

Această soluție, furnizată gratuit de Cisco Systems, a oferit studenților oportunitatea de a crea și examina atât rețele simple, cât și rețele complexe, contribuind astfel la dezvoltarea abilităților lor de rezolvare a problemelor. De asemenea, a stimulat colaborarea între studenți, facilitând identificarea soluțiilor adecvate în cadrul scenariilor practice. Pe lângă utilizarea Cisco Packet Tracer, studenții au avut acces la echipamente și resurse necesare pentru realizarea lucrărilor practice.

În cadrul cursului Rețele de calculatoare care este oferit în diverse programe de studii din cadrul Facultății de Calculatoare, Informatică și Microelectronică și Facultatea Electronică și Telecomunicații se evidențiază importanța dezvoltării continue a corpului didactic responsabil de predarea disciplinelor inginerești. Colaborarea cu instructori internaționali din proiecte de cercetare poate contribui la aducerea unor perspective inovatoare și experiențe relevante în procesul educațional. Materialele didactice, precum exemplele practice rezolvate în domeniul rețelelor de calculatoare și securității rețelelor, contribuie semnificativ la îmbunătățirea conținutului educațional și la asigurarea unei pregătiri relevante pentru studenți [13, 14].

Prin observarea reacțiilor studenților în cadrul cursului, în care au avut acces direct la lecțiile înregistrate, s-a evidențiat că fiecare modul înregistrat, împreună cu competența didactică a cadrelor didactice, se dovedește a fi un instrument deosebit de eficace în procesul de predare, învățare și evaluare [15].

Această combinație a adus o valoare semnificativă, contribuind la creșterea nivelului de cunoaștere și înțelegere a termenilor inginerești specifici domeniului rețelelor. Rezultatele obținute sugerează că utilizarea tehnicilor de înregistrare și accesul la aceste materiale în cadrul procesului de învățământ pot aduce multiple beneficii în îmbunătățirea performanței și eficacității procesului de învățare. Prin intermediul lecțiilor înregistrate, studenții au avut posibilitatea de a revedea conținutul în orice moment și de a se aprofunda în materie în ritmul propriu. De asemenea, aceste resurse au oferit oportunitatea de a clarifica și consolida cunoștințele, contribuind astfel la un proces didactic mai eficient și optimizat.

Accesul facil la materialele înregistrate a permis studenților să se implice activ în învățare și să abordeze cu încredere aspecte mai complexe ale cursului.

De asemenea, acest aspect a favorizat o învățare mai personalizată și adaptată la nevoile individuale ale fiecărui student. În vederea examinării a modului în care modelele e-learning pot fi implementate în contextul predării cursului universitar RC [16], se analizează în detaliu modelul pedagogic propus și aplicat în cadrul acestei discipline inginerești. Acest

model pedagogic reprezintă un instrument esențial în procesul de predare, învățare și evaluare, având un potențial semnificativ de a optimiza și eficiența procesului educațional [17].

Modelul pedagogic adoptat este structurat în trei blocuri principale: **proiectarea**, **implementarea** și **evaluarea**. Proiectarea presupune elaborarea planului de învățământ, selectarea conținutului didactic și a resurselor necesare, în timp ce implementarea implică procesul de predare, învățare și evaluare. Partea dedicată evaluării are rolul de a evalua progresul studenților și de a asigura feedback-ul necesar pentru îmbunătățirea procesului de învățare. Este important să menționăm că fiecare dintre aceste blocuri este interdependent și influențează eficacitatea procesului de predare, învățare și evaluare.

Pentru a asigura o structură coerentă și eficientă a procesului educațional în cadrul cursului RC implementarea modelului pedagogic propus necesită o corelare pe orizontală bine definită [18]. Astfel, se descrie harta de corelare pe orizontală, care se concentrează pe alinierea finalităților de studii, metodelor de predare - învățare și metodologiilor de evaluare specifice fiecărui modul. Prin acest demers, se poate asigura o interconectare optimă între finalitățile educaționale, modalitățile de predare și evaluare, oferind astfel un cadru coerent și structurat pentru dezvoltarea competențelor specifice în domeniul rețelelor de calculatoare.

Scopul universității este de a pregăti specialiști competitivi pentru piața muncii, adică studenți ce demonstrează competențele prin rezolvarea unor probleme complexe, specifice domeniului lor de specializare. Instruirea centrată pe student, orientată către competențe, a impus o redefinire a rolurilor în cadrul procesului educațional unde profesorul, este un facilitator și își direcționează resursele pentru a maximiza eficiența interacțiunii dintre conținut, student și profesor.

Metodologia de implementare a modelului pedagogic pune în obiectiv potențialul e-learning și al tehnologiilor interactive de a transforma învățământul superior, oferind o perspectivă amănunțită asupra modului în care poate fi aplicat în practică pentru a satisface nevoile variate ale studenților și pentru a răspunde așteptărilor pieței muncii.

2. Metodologia

Chestionarul post-experiment [19] a fost conceput și aplicat pentru a evalua eficacitatea și impactul strategiilor e-learning integrate în cursurile universitare de discipline informatice. Chestionarul, structurat pe baza unui model pedagogic specific, a inclus întrebări care măsoară diverse dimensiuni ale experienței studenților: de la satisfacția generală față de conținutul cursului și resursele digitale utilizate, până la implicarea și atitudinea studenților față de metodele de predare și evaluare.

Instrumentul de cercetare a fost compus din 20 de întrebări împărțite în 8 categorii principale, fiecare acoperind aspecte esențiale ale experienței de învățare prin e-learning. Întrebările au fost formulate pe o scală Likert de la 1 la 5, unde 1 reprezenta „dezacord total” și 5 „complet de acord”, pentru a permite o cuantificare precisă a percepțiilor studenților.

Chestionarul a fost aplicat anonim, permițând astfel studenților să ofere răspunsuri cât mai sincere și relevante, reflectând impactul real al conținuturilor digitale asupra experienței lor de învățare.

În plus, întrebările deschise au oferit studenților oportunitatea de a-și exprima în detaliu opiniile privind punctele forte și slabe ale cursului, precum și sugestii pentru îmbunătățirea acestuia. Implementarea sondajului a fost facilitată prin platforma MOODLE, utilizată pe parcursul predării e-modulelor cursului universitar „*Rețele de calculatoare*”.

Instrumente TIC aplicate la proiectarea cursului universitar Rețele de calculatoare:

- Platforma https://else.fcim.utm.md/my/ , LMS eLearning Space – locație virtuală a cursului, care permite încărcarea și gestionarea conținutului modulelor. pentru cazul discuțiilor utilizat forum [11].
- Microsoft 365 PowerPoint / CANVA pentru elaborarea prezentărilor.
- https://lectii.utm.md/courses/retele-de-calculatoar e-computer-networks/ ca sursă de resurse educaționale deschise privind online cele 17 module înregistrate și cele 10 lucrări de laborator înregistrate pas cu pas pentru elaborare [12-14].
- Înregistratoare audio/video Microsoft 365 STREAM sau CAMTASIA cu rol de instrumente TIC pentru formatare.
- http://repository.utm.md/handle/5014/20549 - elaborarea metodologică se concentrează pe aspectele esențiale ale domeniului rețelelor de calculatoare, având ca scop să asiste utilizatorul în abordarea problemelor specifice legate de proiectarea și administrarea topologiilor de rețea, precum și de analiza și implementarea performanței acestora în structurile rețelelor de calculatoare [15-16].

3. Prezentarea datelor colectate

Studiul privind strategiile e-learning în predarea disciplinelor informatice din curricula universitară a avut ca obiectiv principal evaluarea eficienței modelului pedagogic MPISe-lSDI și a metodologiei de implementare. Pentru a atinge acest obiectiv, a fost proiectat și realizat un experiment pedagogic la Universitatea Tehnică a Moldovei, care s-a desfășurat pe parcursul a trei ani (2019-2022).

Experimentul a inclus trei etape esențiale: constatare, formare și control. Prima etapă (2019-2020) a implicat 64 de studenți și a vizat evaluarea stadiului inițial al competențelor acestora. Etapa de formare (2020-2021) a cuprins 77 de studenți care au fost instruiți conform modelului MPISe-lSDI, utilizând strategii e-learning. Etapa finală, cea de control (2021-2022), a implicat 92 de studenți din grupul de control și 98 de studenți din grupul experimental, evaluând impactul modelului pe termen lung.

Variabilele experimentului au fost atent controlate: conținutul curriculumului, echipamentele tehnice și durata experimentului au fost constante pentru ambele grupuri, iar metodologia de predare a diferit prin utilizarea strategiilor e-learning doar în grupul experimental. Evaluarea a urmărit rezultatele învățării, măsurate prin indicatorii de performanță educațională demonstrați de studenți pe parcursul întregului experiment.

Etapa de constatare (2019-2020) a avut ca scop evaluarea stării actuale a cunoștințelor și competențelor studenților în domeniul rețelelor de calculatoare. Aceasta a implicat o analiză detaliată a componentelor modelului pedagogic MPISe-lSDI, evaluând proiectarea cursului, relevanța materialelor de studiu, infrastructura tehnologică disponibilă, precum și metodele de comunicare și evaluare între studenți și profesori.

Curriculumul a inclus obiective, teme de studii și bibliografie, dar se baza pe prelegeri tradiționale și lucrări de laborator cu echipamente limitate. Studenții foloseau echipamente de bază (comutatoare, routere, calculatoare) și software pentru configurări simple, dar erau limitați în simularea arhitecturilor complexe. Infrastructura tehnologică existentă, deși insuficientă pentru cerințe avansate, a permis dobândirea unor competențe fundamentale.

Chestionarele de evaluare distribuite la finalul cursului au relevat neconcordanțe cu cerințele europene, indicând necesitatea modernizării curriculumului și dezvoltării de resurse digitale interactive. În semestrul următor, modelul MPISe-lSDI a fost dezvoltat și implementat, cu îmbunătățiri continue în funcție de feedback-ul și contextul academic.

În anul academic 2020-2021, la UTM, etapa de formare, curricula pentru disciplinele informatice a fost revizuită conform abordării prin competențe, integrând noile cerințe în profilul absolventului și actualizând cursul „Rețele de Calculatoare” cu module noi, precum securitatea rețelelor și tehnologii emergente. Strategiile didactice au fost reconfigurate pentru a include metode de învățare activă, evaluări periodice și feedback continuu, iar lucrările de laborator au fost regândite pentru a oferi experiențe practice relevante.

Instrumentele TIC au fost extinse prin integrarea resurselor digitale și utilizarea platformelor online, precum NetaCAD, Webex și Microsoft Teams. Competențele generale și specifice au fost definite progresiv, dezvoltând abilități precum proiectarea și administrarea rețelelor, utilizarea avansată a instrumentelor TIC, implementarea politicilor de securitate și capacitatea de rezolvare a problemelor. Aceste modificări au fost esențiale pentru alinierea formării academice la cerințele pieței muncii și pentru asigurarea unei dezvoltări coerente a competențelor studenților.

Etapa de control din anul academic 2021-2022 a avut ca scop principal evaluarea impactului strategiilor e-learning implementate. În această fază, s-a monitorizat continuu performanța academică a studenților, comparând rezultatele grupului experimental cu cele ale grupului de control. Analiza detaliată a datelor și evaluarea metodologiilor au permis ajustarea și optimizarea strategiilor didactice.

Au fost comparate rezultatele între cele două grupuri pentru a determina eficiența modelului MPISe-lSDI. În această etapă, ipoteza alternativă (H_1) presupunea că e-learning îmbunătățește semnificativ performanțele studenților față de mediul tradițional, iar ipoteza nulă (H_0) sugera contrariul.

Această etapă a fost crucială pentru configurarea finală a modelului MPISe-lSDI, permițând identificarea și corectarea eventualelor dificultăți înainte de implementarea pe scară largă. De asemenea, a facilitat pregătirea studenților pentru tranziția către noile metode de predare și evaluare, asigurând un model pedagogic robust, scalabil și adaptat cerințelor educației moderne.

Studiul investighează ipoteza conform căreia implementarea unui model pedagogic care integrează strategii e-learning, alături de o metodologie specifică pentru predarea, studierea și evaluarea disciplinelor informatice la nivel universitar, contribuie la îmbunătățirea rezultatelor învățării, precum și la dezvoltarea competențelor profesionale și abilităților practice ale studenților, esențiale pentru cerințele pieței muncii în cadrul cursului „*Rețele de calculatoare*”.

Rezultatele au demonstrat o creștere semnificativă a implicării și satisfacției studenților care au urmat cursul prin e-learning, comparativ cu cei care au parcurs cursul în mod tradițional. Analiza datelor la cea etapă a relevat scoruri superioare pentru studenții din mediu e-learning în categoriile de entuziasm, organizarea conținuturilor, atitudine individuală, evaluare și utilizarea bibliografiei. Aceste dimensiuni au fost evaluate pe baza unui chestionar anonim, structurat pentru a măsura diferite aspecte ale experienței de învățare pe o scală de la 1 la 5, unde 5 indică cel mai înalt nivel de satisfacție.

Studenții au apreciat în mod deosebit atitudinea individuală și calitatea evaluării, evidențiind relevanța practică a cunoștințelor dobândite prin proiecte și resurse digitale. Aceste constatări subliniază eficiența strategiilor e-learning în îmbunătățirea experienței educaționale și în dezvoltarea competențelor necesare pentru viitoarea carieră, demonstrând potențialul semnificativ al modelului pedagogic aplicat în formarea de specialiști bine pregătiți.

După finalizarea etapei de control a experimentului și validarea modelului pedagogic MPISe-lSDI, acesta a fost implementat în semestrul II al anului academic 2021-2022 la Facultatea de Calculatoare, Informatică și Microelectronică (FCIM). Modelul a fost aplicat inițial în cadrul cursului universitar RC, care este inclus în planurile de studii ale mai multor specialități și este oferit în limbile română, rusă și engleză. Pentru a asigura accesul echitabil, lecțiile au fost înregistrate în limba română, cu prezentările disponibile în limba engleză, iar cursul integral în limba engleză a fost pus la dispoziție pe platforma universității, lectii.utm.md.

După implementarea inițială, în semestrul II al anului academic 2021-2022, modelul MPISe-lSDI a fost adoptat și de alți profesori care predau cursul RC. Pentru a evalua impactul acestui model post-experiment, a fost creat un formular de colectare a datelor și impresiilor studenților, diseminat prin Microsoft Forms și completat de 259 de studenți.

4. Interpretarea rezultatelor

Interpretarea rezultatelor obținute din chestionarul aplicat studenților oferă o imagine clară asupra experienței și implicării acestora în cursurile e-learning. Chestionarul a fost completat de 259 de studenți de la Facultatea de Calculatoare, Informatică și Microelectronică (FCIM), ceea ce permite o analiză reprezentativă a tendințelor de participare și familiaritate cu mediul online de învățare. Această secțiune analizează răspunsurile studenților cu privire la numărul de cursuri e-learning absolvite, evidențiind modul în care strategiile e-learning sunt percepute și adoptate în cadrul universitar. În cele ce urmează, vor fi prezentate și interpretate principalele rezultate obținute, pornind de la distribuția studenților în funcție de numărul de cursuri e-learning finalizate (Figura 1).

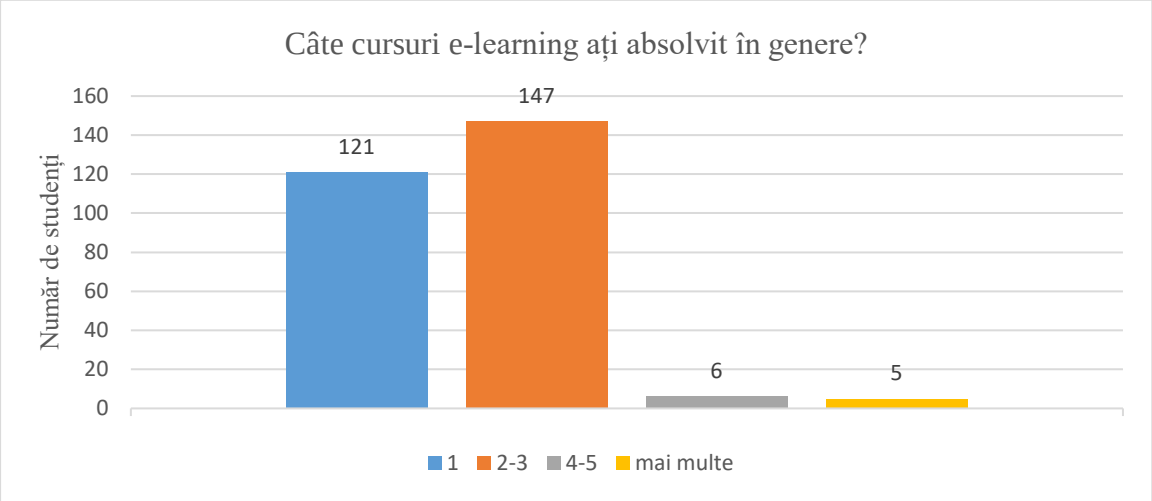

Figura 1. Distribuția studenților în funcție de numărul de cursuri e-learning finalizate.
Sursa: creat de autor în baza rezultatelor sondajului.

În Figura 1 se ilustrează distribuția studenților de la FCIM în funcție de numărul de cursuri e-learning pe care le-au absolvit. Datele prezentate au fost colectate prin intermediul unui chestionar aplicat unui eșantion de 259 de studenți, anul I și II de studii. Rezultatele arată că majoritatea studenților au finalizat între unul și trei cursuri e-learning.

Această distribuție sugerează că majoritatea studenților sunt expuși la un număr limitat de cursuri e-learning, ceea ce poate reflecta atât gradul de integrare a acestui tip de instruire în curriculum, cât și nivelul de familiaritate și confort al studenților cu metodele de învățare online. Numărul redus de studenți care au finalizat mai mult de trei cursuri e-learning indică

o oportunitate de a încuraja și extinde utilizarea acestor metode de instruire în cadrul facultății.

Se evidențiază o distribuție neuniformă a numărului de cursuri e-learning finalizate de studenți, subliniind necesitatea de a explora mai profund factorii care influențează participarea și succesul în aceste cursuri, pentru a putea optimiza strategiile e-learning în cadrul instituției.

Este esențial să se faciliteze și să se promoveze interacțiunile online în cadrul cursurilor e-learning, deoarece acestea joacă un rol crucial în creșterea implicării active și în succesul educațional al studenților (Figura 2).

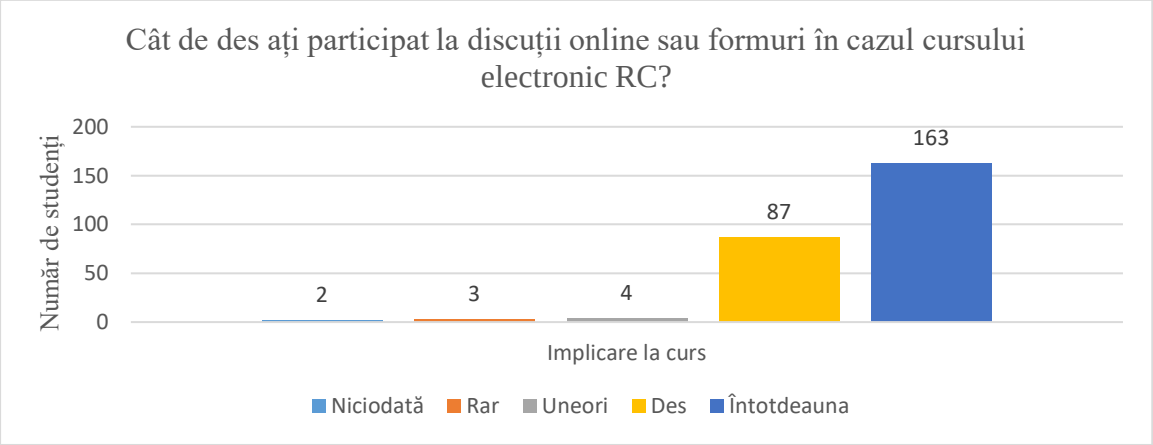

Figura 2. Implicarea studenților în discuțiile online și forumurile cursului e-learning RC.
Sursa: creat de autor în baza rezultatelor sondajului.

În Figura 2 se prezintă frecvența cu care studenții au participat la discuțiile online sau forumurile asociate cursului electronic de RC.

Rezultatele evidențiază faptul că majoritatea studenților au fost activi în participarea la discuții și forumuri.

Aceste date sugerează un nivel ridicat de angajament și implicare în activitățile colaborative și discuțiile de pe platforma online asociată cursului RC, ceea ce indică o eficacitate semnificativă a strategiilor e-learning implementate. Participarea frecventă la discuții și forumuri poate reflecta, de asemenea, interesul și motivația studenților față de conținutul cursului, precum și calitatea și relevanța materialelor și activităților propuse în cadrul acestuia.

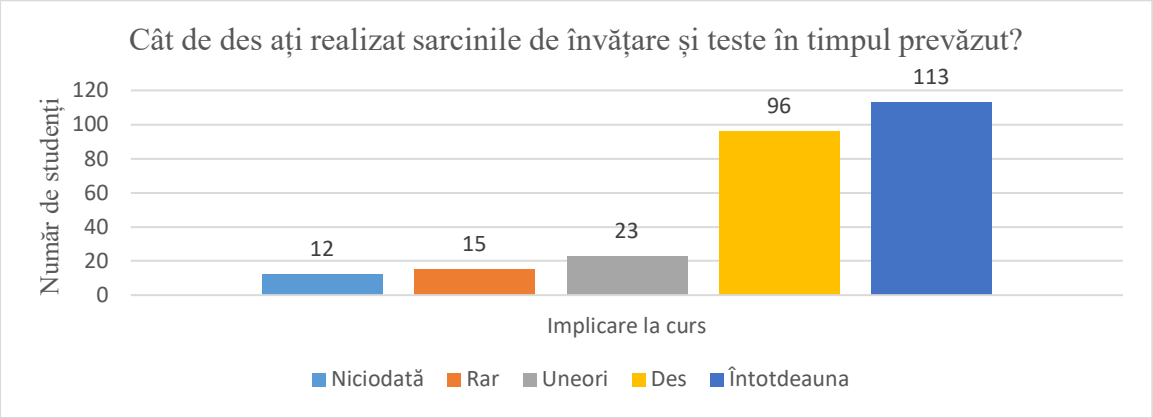

Figura 3. Frecvența realizării sarcinilor de învățare și a testelor în timpul prevăzut.
Sursa: creat de autor în baza rezultatelor sondajului.

Continuitatea și rigurozitatea în realizarea sarcinilor de învățare și a testelor la timp reprezintă un alt indicator esențial al implicării studenților în cadrul cursurilor e-learning (Figura 3).

Această figură prezintă frecvența cu care studenții au realizat sarcinile de învățare și testele la timp în cadrul cursului de RC.

Majoritatea studenților, respectiv **113** de studenți, au indicat că și-au îndeplinit **„Întotdeauna”** sarcinile și testele în intervalul de timp prevăzut, urmat de **96** de studenți care au făcut acest lucru **„Des”**. Un număr mai redus de studenți au raportat că și-au îndeplinit sarcinile **„Uneori”** (23 studenți), **„Rar”** (15 studenți) sau **„Niciodată”** (12 studenți).

Aceste date reflectă un nivel general bun de disciplină și respectare a termenelor în rândul studenților, ceea ce este important pentru succesul în cadrul unui mediu de învățare online. Această constatare subliniază importanța gestionării eficiente a timpului și a auto-disciplinei în cadrul cursurilor e-learning, elemente care contribuie semnificativ la obținerea rezultatelor academice dorite.

Pentru a evalua în continuare gradul de implicare și responsabilitate al studenților în cadrul cursului RC, a fost analizată și frecvența cu care aceștia au accesat materialele de curs și resursele suplimentare disponibile online (Figura 4).

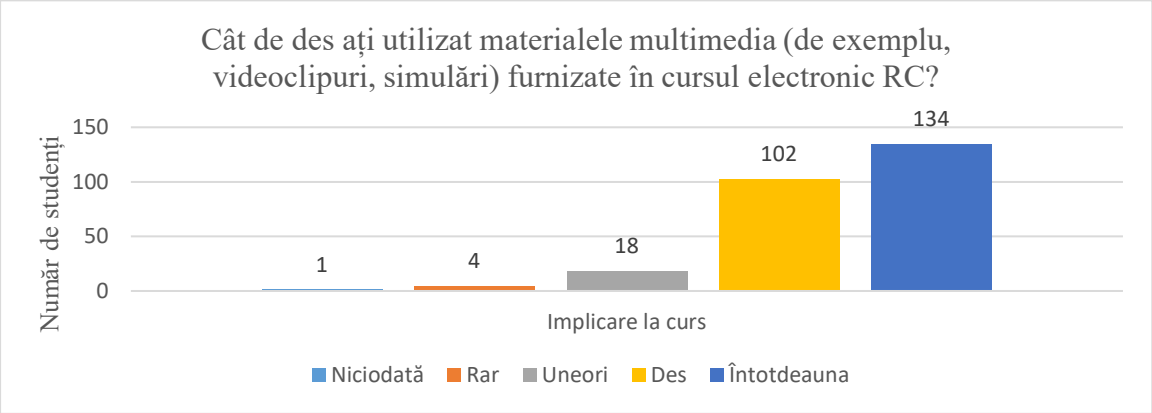

Figura 4. Frecvența accesării materialelor de curs și a resurselor suplimentare în cadrul cursului e-learning RC.

Sursa: creat de autor în baza rezultatelor sondajului.

În Figura 4 se ilustrează frecvența cu care studenții au accesat materialele de curs și resursele suplimentare oferite în cadrul cursului e-learning de RC.

Rezultatele arată că un număr semnificativ de studenți, probabil majoritatea, au accesat **„Întotdeauna”** materialele de curs și resursele suplimentare, sugerând o implicare activă și un interes constant față de conținutul oferit. Alți studenți au accesat aceste resurse **„Des”** sau **„Uneori”**, în timp ce un număr foarte mic de studenți au declarat că au accesat resursele **„Rar”** sau **„Niciodată”**.

Aceste rezultate indică faptul că accesul regulat la resursele de curs este un factor important în susținerea procesului de învățare și în asigurarea succesului academic în mediul e-learning. În plus, o atenție deosebită a fost acordată realizării laboratoarelor de simulare folosind instrumente TIC, esențiale pentru aplicarea cunoștințelor teoretice în soluționarea problemelor din viața reală (Figura 5).

În Figura 5 se prezintă frecvența cu care studenții au realizat laboratoare de simulare, utilizând instrumente TIC, pentru a rezolva probleme inspirate din viața reală în cadrul cursului de Rețele de Calculatoare (RC).

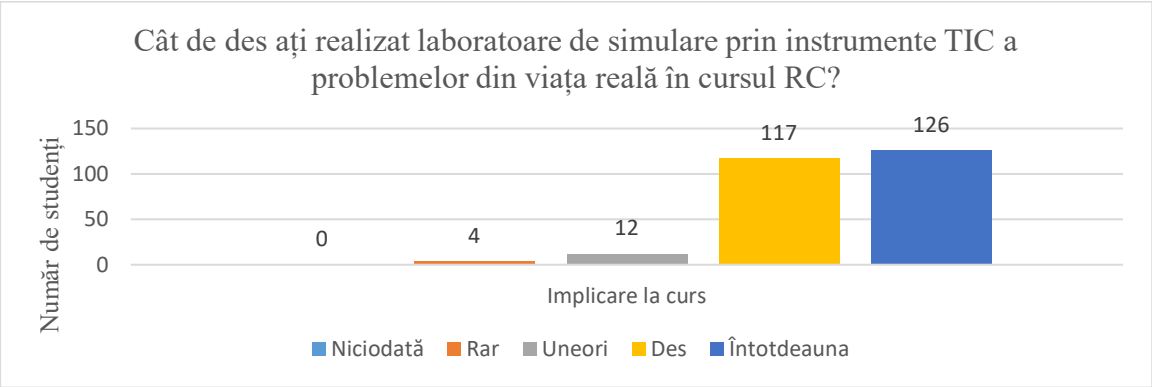

Figura 5. Frecvența realizării laboratoarelor de simulare prin instrumente TIC în cadrul cursului RC.

Sursa: creat de autor în baza rezultatelor sondajului.

Aceste date subliniază importanța și eficacitatea integrării simulărilor TIC în cadrul cursurilor e-learning, evidențiind capacitatea acestora de a oferi studenților o experiență practică relevantă și aplicabilă, esențială pentru dezvoltarea competențelor necesare în domeniul rețelelor de calculatoare.

Pe lângă realizarea laboratoarelor și a sarcinilor practice, participarea activă la prelegeri online și webinare este un indicator esențial al implicării studenților în cadrul cursurilor e-learning (Figura 6).

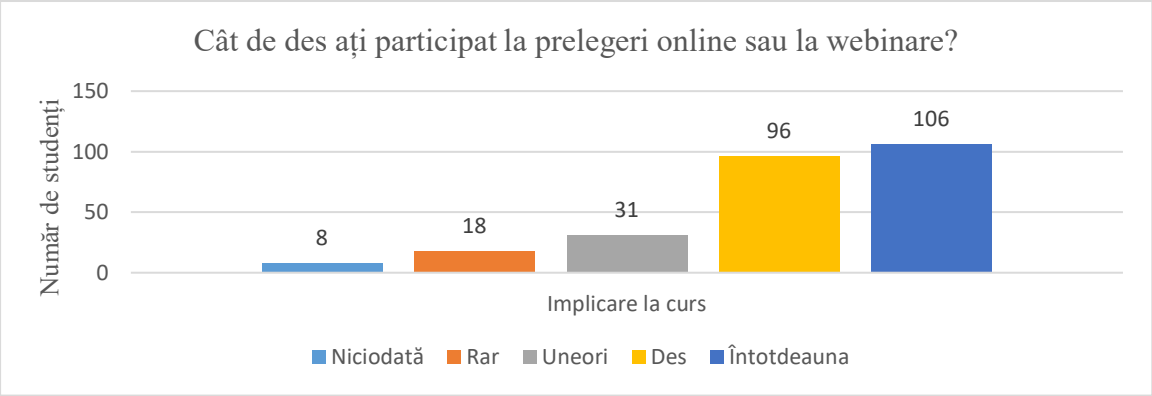

Figura 6. Frecvența participării studenților la prelegerile online și webinarele din cadrul cursului RC.

Sursa: creat de autor în baza rezultatelor sondajului.

Această figură arată frecvența cu care studenții au participat la prelegeri online sau webinare organizate în cadrul cursului de RC.

Rezultatele arată că majoritatea studenților au participat frecvent la aceste activități, cu **106** de studenți care au participat **„Întotdeauna”** și **96** care au participat **„Des”**. Un număr mai mic de studenți au participat **„Uneori”** (31 studenți), **„Rar”** (18 studenți), iar doar **8 studenți** au declarat că nu au participat niciodată la prelegeri online sau webinare.

Aceste date subliniază importanța prezenței și participării active la sesiuni de predare sincrone, care oferă studenților oportunitatea de a interacționa direct cu profesorii și colegii, contribuind astfel la o mai bună înțelegere a materialului și la succesul general în cadrul cursului.

Un alt aspect important al experienței de învățare în mediul e-learning este gradul de implicare emoțională a studenților în interacțiunea cu profesorul cursului (Figura 7).

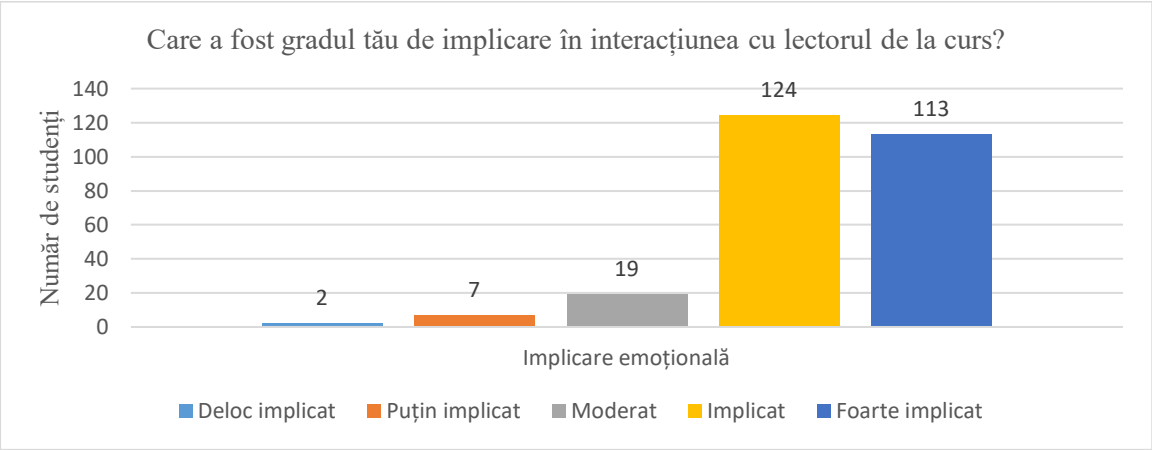

Figura 7. Gradul de implicare emoțională a studenților în interacțiunea cu profesorul de la curs.
Sursa: creat de autor în baza rezultatelor sondajului.

Această Figura ilustrează gradul de implicare emoțională a studenților în interacțiunea cu lectorul cursului de RC.

Rezultatele arată că majoritatea studenților au avut un grad ridicat de implicare emoțională în interacțiunea cu lectorul. Aceste date subliniază importanța unui contact emoțional puternic între studenți și profesori în cadrul cursurilor e-learning, deoarece această interacțiune poate contribui la un sentiment de apartenență și la o mai bună implicare în activitățile educaționale. Gradul ridicat de implicare emoțională reflectat în această figură sugerează că studenții valorizează interacțiunea cu lectorul, ceea ce poate avea un impact pozitiv asupra motivației și performanței lor academice.

Un alt element esențial al experienței educaționale în mediul online este interesul studenților față de conținutul cursului, aspect care poate influența semnificativ implicarea lor emoțională și succesul academic (Figura 8).

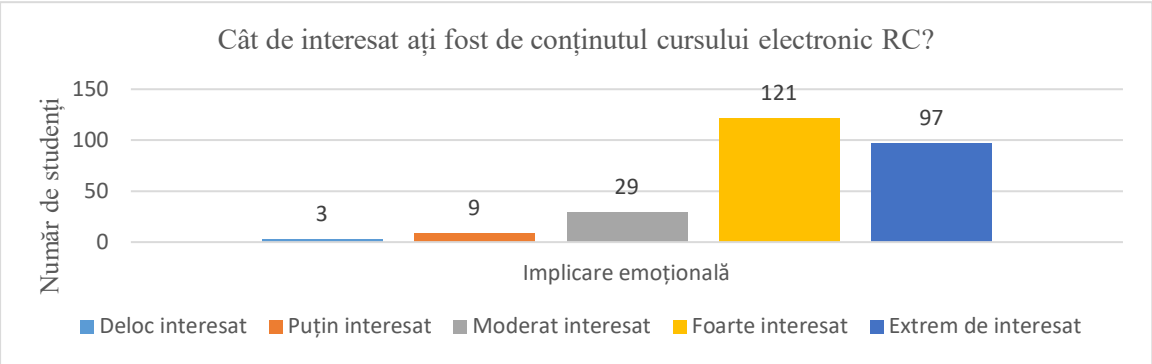

Figura 8. Nivelul de interes al studenților față de conținutul cursului electronic RC.
Sursa: creat de autor în baza rezultatelor sondajului.

Această figură prezintă nivelul de interes al studenților față de conținutul cursului electronic de RC.

Rezultatele arată că majoritatea studenților au manifestat un interes ridicat față de conținutul cursului. Aceste rezultate sugerează că materialele și conținutul oferit în cadrul cursului RC au fost în mare parte relevante și captivante pentru studenți, ceea ce poate fi un factor decisiv în motivarea lor de a participa activ și de a se angaja în activitățile de învățare. Gradul ridicat de interes raportat este un indicator pozitiv al calității și atractivității conținutului educațional.

Aplicarea practică a conceptelor studiate în cursurile e-learning este crucială pentru consolidarea învățării și pentru dezvoltarea competențelor necesare în situații reale (Figura 9).

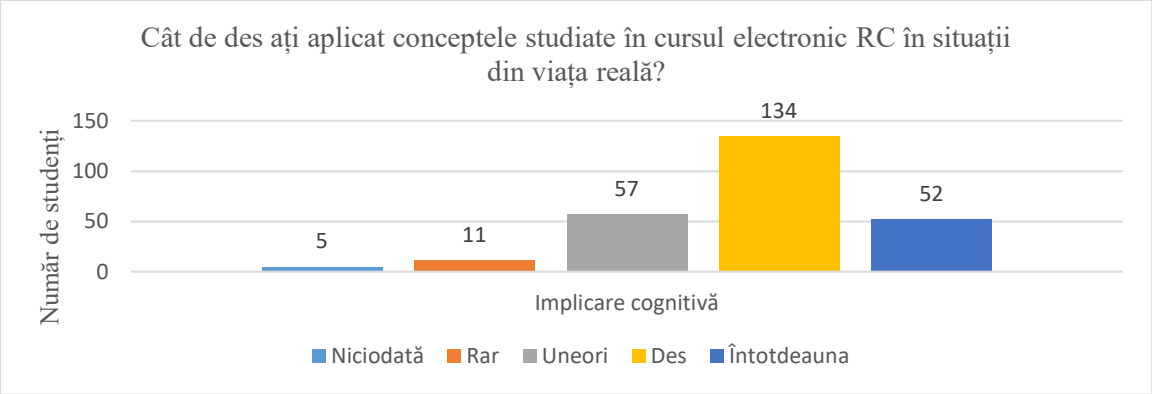

Figura 9. Frecvența aplicării conceptelor studiate în cursul RC în situații din viața reală.
Sursa: creat de autor în baza rezultatelor sondajului.

Această figură ilustrează cât de des au aplicat studenții conceptele învățate în cursul electronic de RC în situații reale.

Rezultatele indică faptul că majoritatea studenților au aplicat frecvent conceptele învățate, cu **134 de studenți** care au raportat că au făcut acest lucru **„Des”** și **52 de studenți** care au indicat că au aplicat conceptele **„Întotdeauna”**. **57 de studenți** au aplicat conceptele **„Uneori”**, în timp ce un număr mic de studenți au declarat că au făcut acest lucru **„Rar”** (11 studenți) sau **„Niciodată”** (5 studenți).

Aceste rezultate subliniază relevanța și aplicabilitatea practică a materialelor didactice oferite în cadrul cursului RC, indicând faptul că majoritatea studenților au reușit să transfere cunoștințele teoretice dobândite în contexte reale, ceea ce este esențial pentru dezvoltarea profesională și succesul în carieră.

Reflecția asupra materialului studiat este esențială pentru o înțelegere profundă și pentru consolidarea cunoștințelor în cadrul cursurilor e-learning (Figura 10).

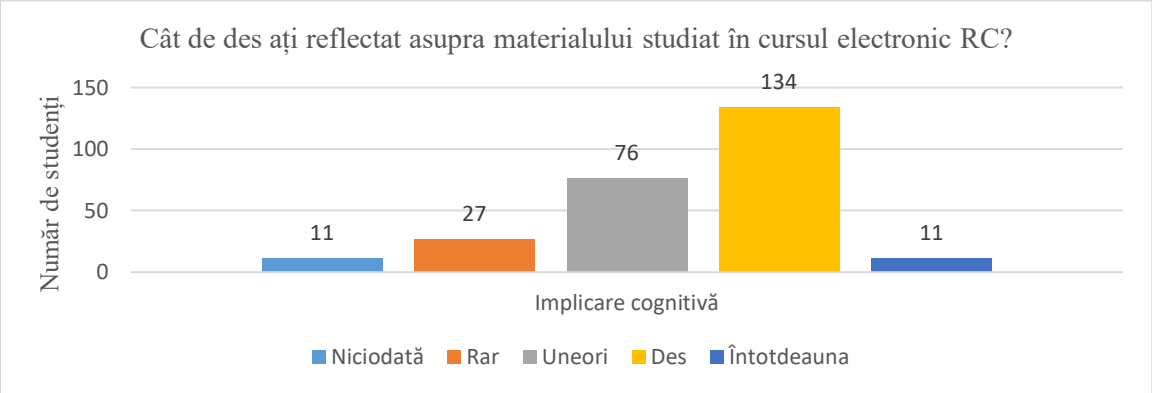

Figura 10. Frecvența cu care studenții au reflectat asupra conținutului studiat în cadrul cursului RC.
Sursa: creat de autor în baza rezultatelor sondajului.

În Figura 10 se ilustrează cât de frecvent au reflectat studenții asupra materialului studiat în cursul electronic de RC.

Rezultatele arată că majoritatea studenților au reflectat frecvent asupra materialului studiat. Aceste date evidențiază importanța procesului de reflecție în cadrul învățării,

sugerând că majoritatea studenților au fost angajați activ în procesul de înțelegere și consolidare a cunoștințelor, ceea ce este esențial pentru succesul academic și pentru dezvoltarea gândirii critice.

În plus față de reflecția asupra materialului studiat, o altă dimensiune importantă a implicării cognitive este măsura în care studenții caută resurse suplimentare pentru a aprofunda înțelegerea cursului (Figura 11).

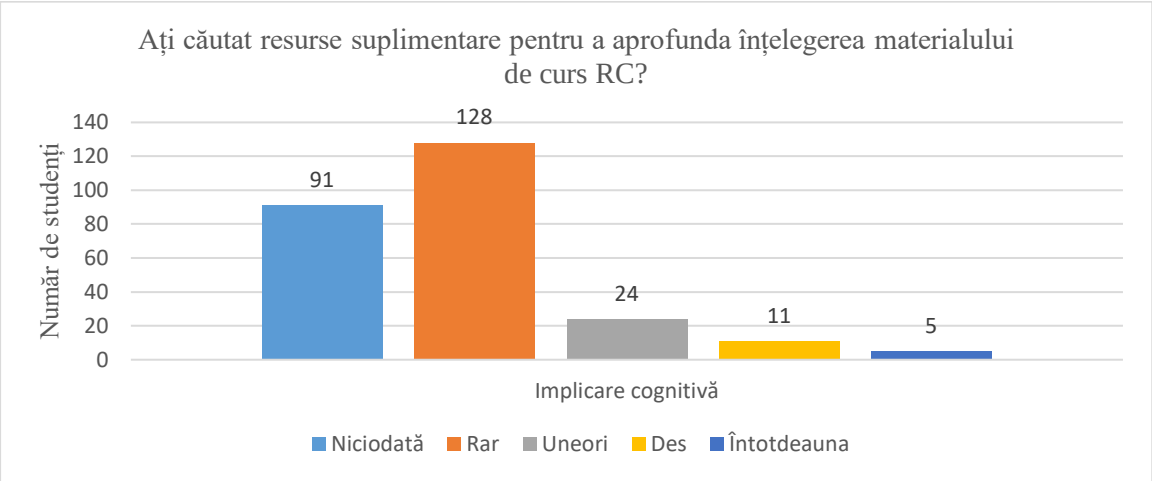

Figura 11. Frecvența căutării de resurse suplimentare pentru aprofundarea materialului de curs RC.
Sursa: creat de autor în baza rezultatelor sondajului.

Această Figură ilustrează cât de frecvent au căutat studenții resurse suplimentare pentru a aprofunda înțelegerea materialului din cursul de RC.

Rezultatele arată că majoritatea studenților nu au simțit nevoia de a căuta resurse suplimentare. Aceste date sugerează că, în general, studenții au considerat că materialul furnizat în cadrul cursului a fost suficient pentru a înțelege conținutul, sau că nu au simțit nevoia de a explora mai mult subiectele discutate. Totuși, pentru studenții care au căutat resurse suplimentare, acest comportament poate reflecta un angajament mai profund și dorința de a obține o înțelegere mai solidă a conceptelor predate.

Evaluarea generală a nivelului de satisfacție al studenților cu privire la participarea în cadrul cursului electronic RC este esențială pentru a înțelege impactul acestuia asupra experienței lor de învățare (Figura 12).

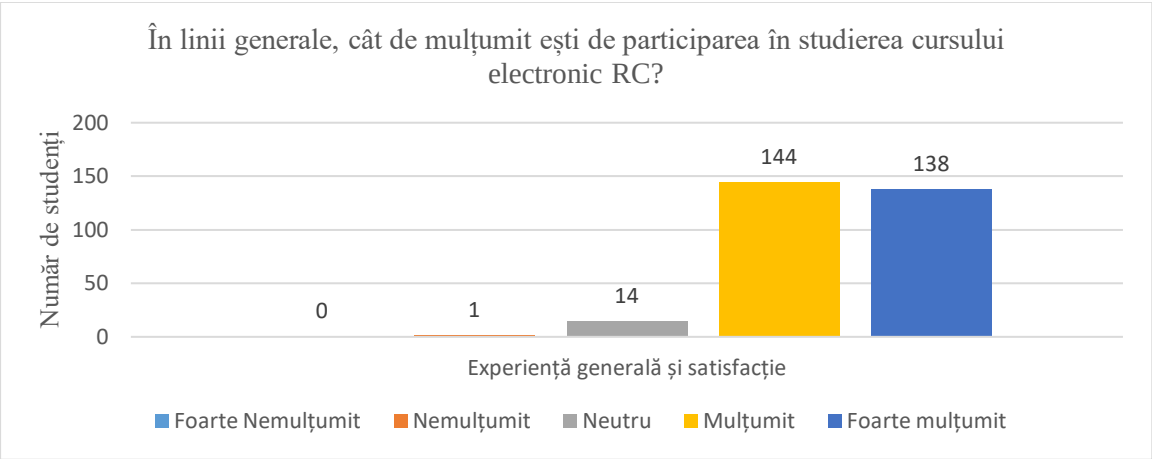

Figura 12. Nivelul de satisfacție al studenților privind participarea la cursul electronic RC.
Sursa: creat de autor în baza rezultatelor sondajului.

În Figura 12 se prezintă gradul de satisfacție generală a studenților față de participarea lor în cursul electronic de RC.

Rezultatele arată un nivel foarte ridicat de satisfacție în rândul studenților, cu **144 de studenți** care s-au declarat **„Mulțumit”** și **138 de studenți** care au fost **„Foarte mulțumit”** de experiența lor în cursul RC. Un număr foarte mic de studenți au raportat o satisfacție **„Neutră”** (14 studenți), **„Nemulțumit”** (1 student), și niciun student nu s-a declarat **„Foarte Nemulțumit”**.

Aceste date subliniază succesul cursului RC în a oferi studenților o experiență de învățare pozitivă și satisfăcătoare, reflectând eficacitatea metodelor de predare și a materialelor utilizate în cadrul acestui curs. Nivelul ridicat de satisfacție indică faptul că majoritatea studenților au perceput cursul ca fiind valoros și benefic pentru dezvoltarea lor academică și profesională.

Un aspect de bază al participării la cursurile e-learning este percepția studenților asupra impactului acestei implicări asupra succesului lor academic (Figura 13).

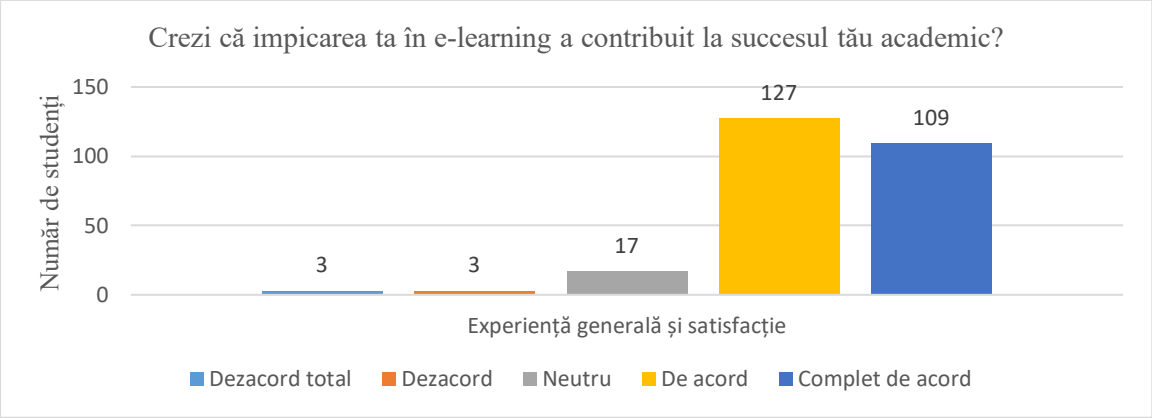

Figura 13. Percepția studenților asupra contribuției implicării în e-learning la succesul lor academic.

Sursa: creat de autor în baza rezultatelor sondajului.

Această figură prezintă răspunsurile studenților la întrebarea referitoare la cât de mult cred că implicarea lor în e-learning a contribuit la succesul academic.

Rezultatele arată că majoritatea studenților consideră că implicarea lor în e-learning a avut un impact pozitiv asupra succesului academic. Aceste date sugerează că, în general, studenții percep implicarea în e-learning ca fiind benefică pentru succesul lor academic, subliniind importanța acestui tip de învățare în cadrul programelor de studiu. Percepția pozitivă reflectată de aceste rezultate poate servi drept argument în favoarea integrării continue și extinse a metodologiilor e-learning în educația universitară.

Un indicator important al satisfacției și eficacității unui curs este disponibilitatea studenților de a-l recomanda altora, bazată pe propria lor experiență de implicare (Figura 14).

Această figură prezintă cât de probabil este ca studenții să recomande altora cursul electronic de RC, având în vedere experiența lor de implicare.

Rezultatele arată că majoritatea studenților ar recomanda cu încredere acest curs, cu **138 de studenți** care au indicat că este **„Foarte probabil”** și **135 de studenți** care au declarat că este **„Probabil”** să recomande cursul altora. Un număr foarte mic de studenți au rămas **„Neutru”** (9 studenți), **„Puțin probabil”** (3 studenți), sau **„Foarte puțin probabil”** (1 student) în ceea ce privește recomandarea cursului.

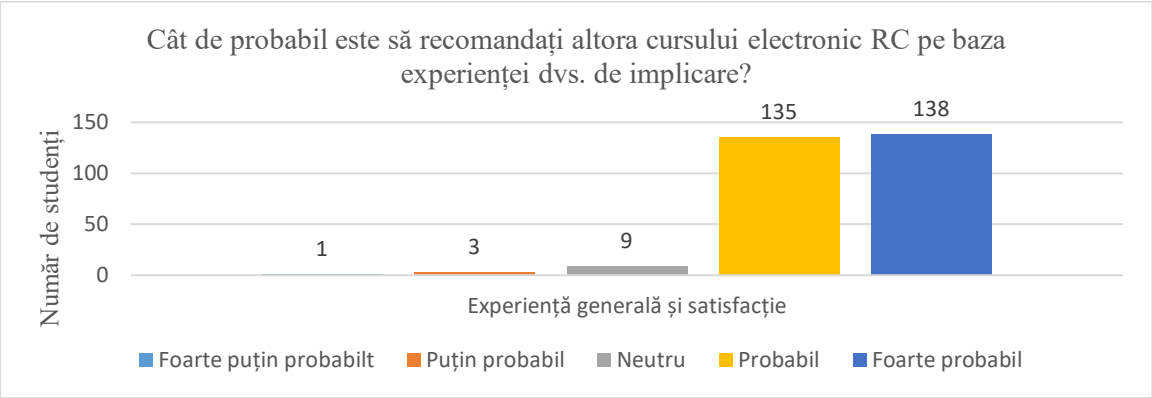

Figura 14. Probabilitatea ca studenții să recomande cursul electronic RC pe baza experienței lor de implicare.

Sursa: creat de autor în baza rezultatelor sondajului.

Aceste date sugerează un nivel ridicat de satisfacție și încredere în calitatea cursului RC, reflectând o experiență pozitivă de învățare care îi motivează pe studenți să-l recomande și altor colegi. Disponibilitatea de a recomanda cursul este un indicator puternic al valorii percepute a acestuia și poate contribui la creșterea popularității și a înscrierilor viitoare.

5. Concluzii și recomandări

Implementarea cursului e-learning „Rețele de calculatoare" s-a dovedit a fi o inițiativă de succes, reflectată printr-o receptivitate pozitivă din partea studenților și o eficiență crescută în procesul de învățare. Principalele concluzii evidențiate sunt următoarele:

1. **Eficiența învățării**. Studenții au demonstrat o înțelegere mai rapidă și profundă a conținuturilor datorită metodologiilor interactive și resurselor digitale integrate în curs. Utilizarea simulatoarelor și a altor instrumente e-learning a contribuit semnificativ la clarificarea conceptelor complexe și la dezvoltarea abilităților practice.
2. **Economia de timp**. Cursul a permis o gestionare mai eficientă a timpului atât pentru studenți, cât și pentru profesori. Studenții au putut accesa materialele didactice conform propriului ritm, ceea ce a dus la o creștere a autonomiei în învățare și la o reducere a timpului necesar pentru asimilarea informațiilor.
3. **Adaptabilitatea la nevoile studenților**. Platforma e-learning a oferit un mediu flexibil și accesibil, adaptabil diverselor stiluri de învățare și nevoi ale studenților, ceea ce a condus la o îmbunătățire generală a performanței academice.
4. **Satisfacția studenților**. Feedback-ul obținut din chestionarele aplicate a relevat un grad ridicat de satisfacție în rândul studenților, aceștia apreciind accesibilitatea resurselor, claritatea explicațiilor și interactivitatea cursului.
5. **Impactul asupra competențelor profesionale**. Cursul a avut un impact pozitiv asupra dezvoltării competențelor tehnice și digitale ale studenților, pregătindu-i mai bine pentru provocările viitoare din domeniul IT.

Pentru a maximiza impactul pozitiv al cursului „Rețele de calculatoare" și pentru a asigura o implementare eficientă a strategiilor e-learning în alte discipline, se recomandă următoarele:

1. **Extinderea utilizării metodologiilor e-learning**. Se sugerează implementarea strategiilor e-learning și în alte cursuri din curricula universitară, în special în disciplinele informatice, pentru a îmbunătăți calitatea și eficiența procesului de instruire.

2. **Dezvoltarea continuă a resurselor digitale educaționale**. Este esențial să se continue dezvoltarea și actualizarea resurselor digitale utilizate în curs, pentru a reflecta cele mai recente evoluții tehnologice și cerințele pieței muncii.
3. **Formarea continuă a cadrelor didactice**. Se recomandă organizarea de cursuri de formare continuă pentru cadrele didactice, axate pe utilizarea eficientă a platformelor e-learning și a instrumentelor digitale, pentru a asigura o predare de calitate și adaptată nevoilor actuale ale studenților.
4. **Monitorizarea și evaluarea constantă a impactului**. Se propune instituirea unui sistem de monitorizare și evaluare continuă a impactului cursurilor e-learning asupra performanței academice și a satisfacției studenților, pentru a ajusta și optimiza în mod constant metodologia didactică.
5. **Creșterea accesibilității și echității**. Pentru a asigura accesul egal al tuturor studenților la resursele e-learning, este important să se investească în infrastructură digitală și să se asigure suportul necesar pentru studenții din medii defavorizate.

Conflicte de interes. Autorii nu declară nici un conflict de interese.

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THE IMPACT OF APPRENTICESHIP ON THE EMPLOYMENT OF TECHNICAL VOCATIONAL EDUCATION GRADUATES

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Abstract. Over time, it has been proven that the most effective way to train specialists, especially for the 3-5 qualification level, is by involving the trainees in practical activities carried out within economic entities, giving them the opportunity to learn in real working conditions . In this article, we aim to address the apprenticeship and their impact on the students graduating from vocational technical education from the perspective of their employment after graduation. The research methods used were quantitative (1286 respondents) involving final year students from 13 educational institutions (5 - centers of excellence, 1 - college, 7 - vocational schools). The questioning of the respondents focused on the students' appreciation of the quality and relevance of internships within the economic entities, as well as topics aimed at their opportunity to engage in the labor field. Given the subject under investigation, we believe that the results included in this article will be of great interest to representatives of educational institutions, economic entities, as well as researchers in the field.

Keywords: *apprenticeship, economic entities, internship, technical professional education, work-based learning.*

Rezumat. Pe parcursul timpului s-a confirmat că cea mai eficientă modalitate de pregătire a specialiștilor, în special pentru nivelul 3-5 de calificare, este prin implicarea formabililor în activități practice desfășurate în cadrul unităților economice, oferindu-le astfel oportunitatea de a învăța în condiții reale de muncă. În prezentul articol ne propunem să abordăm stagiile de practică realizate în cadrul unităților economice și impactul acestora asupra elevilor absolvenți din învățământul profesional tehnic din perspectiva angajării lor după absolvirea studiilor. Metodele de cercetare utilizate au fost cantitative (1286 de respondenți) elevi din ultimul an de studii, din cadrul a 13 instituții de învățământ (5 – centre de excelență, 1 – colegiu, 7 – școli profesionale). Chestionarea respondenților s-au focusat pe aprecierea elevilor vizavi de calitatea și relevanța stagiilor de practică în cadrul unităților economice, precum și subiecte ce vizează oportunitatea lor de a se angaja în câmpul muncii. Având în vedere subiectul cercetat, credem că rezultate incluse în prezentul articol va reprezenta un interes sporit pentru reprezentanții instituțiilor de învățământ, ai unităților economice, precum și a cercetătorilor din domeniu.

Cuvinte cheie: *învățământ profesional tehnic, învățare la locul de muncă, unități economice, stagii de practică.*

1. Introducere

În acord cu prevederile Codului educației al Republicii Moldova și cu documentele de politici în domeniu [1-5] evidențiem că misiunea învățământului profesional tehnic constă în formarea profesională a elevilor care să posede competențele profesionale necesare pentru a se angaja în câmpul muncii și a corespunde necesităților pieței muncii.

În literatura de specialitate există mai multe studii și analize care scot în evidență diverse exemple și practici de pregătire a tinerilor specialiști capabili să se integreze profesional și social în câmpul muncii. Printre acestea este de menționat: realizarea învățământului dual în învățământul profesional tehnic [6-8], diverse practici formare profesională la locul de muncă în țări precum Grecia [9], Luxembourg [10], Irlanda [11], Elveția [12], alte studii internaționale [13-19], precum și recomandarea Consiliului Uniunii Europene din 15 martie 2018 privind un cadru european pentru ucenicii de calitate și eficace [20].

Indiferent de soluțiile identificate, acestea au la bază un element indispensabil în procesul de formare profesională, și anume conlucrarea cu sectorul privat.

În condițiile unor parteneriate reușite dintre instituțiile de învățământ profesional tehnic cu unitățile economice se poate asigura un nivel de formare a specialiștilor în domeniu care să corespundă pe deplin necesitățile pieței muncii. Dacă la nivelul instituției de învățământ profesional tehnică accentul în procesul de formare profesională se axează pe acumularea de ***cunoștințe*** și pe formarea unor ***abilități***, atunci la unitățile economice, formarea profesională a elevilor se axează pe dezvoltarea ***abilităților*** și pe formarea de ***atitudini***. Menționăm că în acord cu prevederile documentelor de politici în domeniul învățământului profesional tehnic „competenţa profesională reprezintă capacitatea confirmată de a folosi ***cunoştinţele***, ***abilităţile*** şi ***atitudinile*** personale şi sociale în situaţii de muncă sau de studiu, în dezvoltarea profesională şi personală” [2, pag. 16].

În sistemul de învățământ profesional tehnic, componenta practică se asigură prin prisma orelor de laborator, în cadrul atelierelor precum și prin prisma stagiilor de practică care se desfășoară la unitățile economice. În mare măsură formarea practică predomină formării teoretice. Analizând prevederile Planului cadru pentru învățământul profesional tehnic [3] se constată o ponderea a orelor destinate stagiilor de practică după cum urmează:

Tabelul 1

Ponderea numărul de ore destinate stagiilor de practică în cadrul programelor de formare profesională tehnică

Nr. crt	Programele de formare profesională tehnică	Ponderea nr. de ore pentru stagiile de practică
1.	Învățământul profesional tehnic secundar (nivelul III ISCED)	
	cu durata de un an (în baza de studii liceale)	40 %
	cu durata de doi ani (în baza de studii gimnaziale)	24 - 25%
	cu durata de trei ani, meserii conexe (în baza de studii gimnaziale)	20 %
2.	Învățământul profesional tehnic secundar dual (nivelul III ISCED)	70 – 80 %
3.	Învățământul profesional tehnic postsecundar și postsecundar (nivelul IV – V ISCED)	16 – 25 %
4.	Învățământul profesional tehnic postsecundar și postsecundar dual (nivelul IV – V ISCED)	50 %

Este de menționat că Planul cadru pentru învățământul profesional tehnic [3], suplimentar orelor destinate stagiilor de practică, prevede și un număr semnificativ de ore practice care se desfășoară în atelierele și laboratoarele instituțiilor de învățământ profesional tehnic. În cadrul prezentului articol se examinează impactul stagiilor de practică desfășurate de către elevii din învățământul profesional tehnic în cadrul unităților economice din perspectiva angajării lor în câmpul muncii.

În acest sens, pentru elevi din învățământul profesional tehnic secundar „stagiile de practică în producție se realizează în cadrul unităților economice (întreprinderi, organizații, atelierele şi gospodăriile didactice ale instituțiilor de învăţământ profesional tehnic, asociații de stat sau private ș.a.)" [4, pct. 5], iar pentru elevi din învățământul profesional tehnic postsecundar și postseundar nonterțiar sunt planificate mai multe stagii de practică precum: „practica de iniţiere în specialitate, practica de instruire, practica de specialitate: pedagogică, tehnologică, de producţie, de certificare, artistică, clinică etc., precum și practica ce anticipează probele de absolvire" [5, pct. 7], iar „ponderea numărului de ore desfășurate în cadrul unității economice nu poate fi mai mică de 40 % din numărul total de ore prevăzute în Planul de învățământ pentru stagiile de practică" [5, pct. 15].

2. Materiale utilizate și metode aplicate

Prezentul articol este elaborat urmare a examinării legislației naționale referitor la organizarea și desfășurarea stagiilor de practică a elevilor din învățământul profesional tehnic [7, 19, 20], precum și chestionării a 1286 de elevi din grupele absolvente a 13 instituții de învățământ profesional tehnic (5 – centre de excelență, 1 – colegiu, 7 – școli profesionale).

Chestionarea respondenților s-a realizat prin intermediul Google Forms. Chestionarul a inclus întrebări ce vizează aprecierea calității organizării și desfășurării stagiilor de practică în cadrul unităților economice, precum și viziunea elevilor din grupele absolvente referitor la oportunitatea de angajare în câmpul muncii după absolvirea studiilor.

3. Rezultate

Obiectivul cercetării a vizat determinarea rolului stagiilor de practică la unitățile economice a elevilor din învățământul profesional tehnic din perspectiva angajării lor în câmpul muncii după absolvirea studiilor.

3.1 Desfășurarea stagiilor de practică

În acord cu prevederile actelor normative [1, 3-5] elevii pe perioada studiilor beneficiază de stagii de practică la unitățile economice în cadrul cărora ei sunt obligați să realizeze integral cerințele curriculumului stagiului de practică. Stagiile de practică efectuate în cadrul unităților economice „se organizează și se desfășoară în baza Contractului privind efectuarea stagiului de practică și / sau a Convenţiei-cadru de parteneriat" [5, pct.18], iar responsabilitatea de organizare a stagiului de practică revine instituției de învățământ profesional tehnic. În acest sens, instituțiile de învățământ profesional tehnic monitorizează în mod sistemic feedbackul elevilor vizavi de calitatea și relevanța stagiilor de practică desfășurate în cadrul unităților economice.

În cadrul cercetării s-a optat pe colectarea feedbackului de la elevii din grupele absolvente. Ca urmare a examinării răspunsurilor acestora prezentăm cele mai relevante rezultate constate. Așadar, din perspectiva identificării unui loc de practică, există o tendință majoritară printre elevi de a-și selecta singuri unitatea economică pentru desfășurarea stagiului de practică. Aproximativ două treimi dintre elevi au indicat că au identificat și ales independent locul de practică (Figura 1).

Figura 1. Identificarea unității economice pentru desfășurarea stagiului de practică.
Sursa: elaborat de autor în baza răspunsurilor elevilor, 1286 respondenți.

Totuși, este important să notăm că o proporție semnificativă de elevi primesc propuneri de la instituția de învățământ cu privire la unitatea economică unde să-și desfășoare activitatea practică. Aceasta subliniază rolul și implicarea instituțiilor de învățământ în procesul de identificare și validare a locurilor de practică, conform reglementărilor.

În ansamblu, rezultatele sugerează că există o colaborare eficientă între elevi și instituțiile de învățământ în selecția și validarea locurilor de practică, contribuind astfel la asigurarea unei experiențe de practică corespunzătoare și conforme cu cerințele educaționale și profesionale.

În vederea acomodării elevilor la stagiile de practică, de către unitățile economice sunt realizate mai multe acțiuni/ activități. Din răspunsurile respondenților constatăm că acestea sunt focusate informarea elevului despre activitățile specifice stagiului de practică (Figura 2).

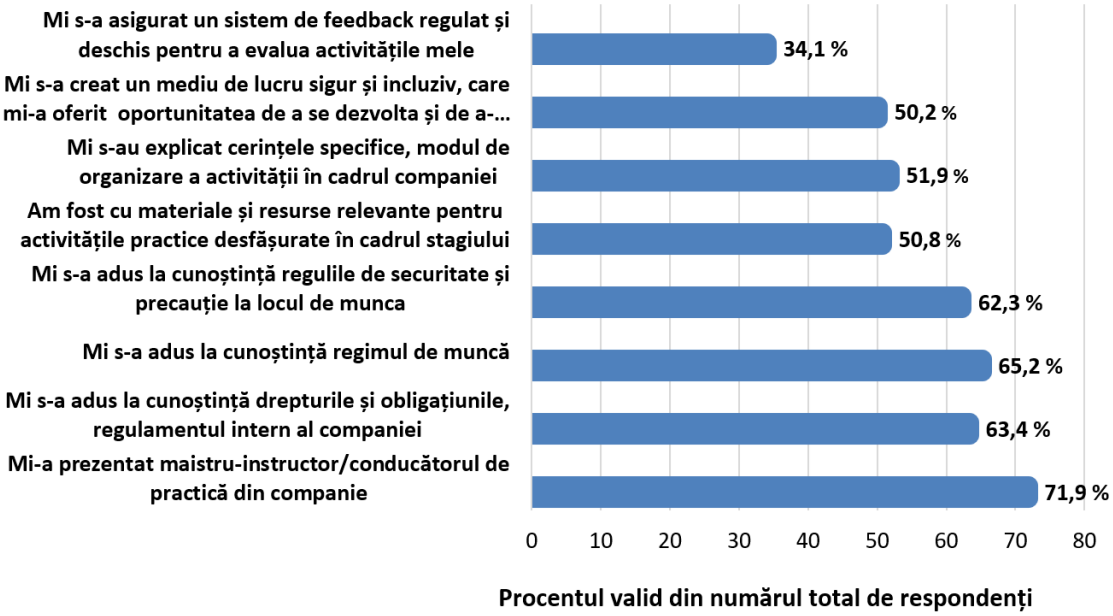

Figura 2. Acțiuni întreprinse de către unitate economică la începutul stagiului de practică.
Sursa: elaborat de autor în baza răspunsurilor elevilor, 1286 respondenți.

Proporția relativ mică a elevilor care au menționat existența unui sistem de feedback regulat și deschis arată că este nevoie de o mai mare atenție acordată acestui aspect al experienței de practică.

Prin urmare, consolidarea acestor aspecte poate contribui la o experiență mai completă și mai valoroasă pentru elevi în timpul stagiului lor de practică.

Un rol esențial în organizarea și desfășurarea stagiului de practică îl exercită conducătorul de practică (maistru-instructor).

Din perspectiva aprecierii de către elevi a suportului și a îndrumării oferite de conducătorul de practică din cadrul unității economice în timpul stagiului de practică se constată că circa 87,2% din elevi au apreciat că suportul oferit de către acesta este bun sau excelent (Figura 3).

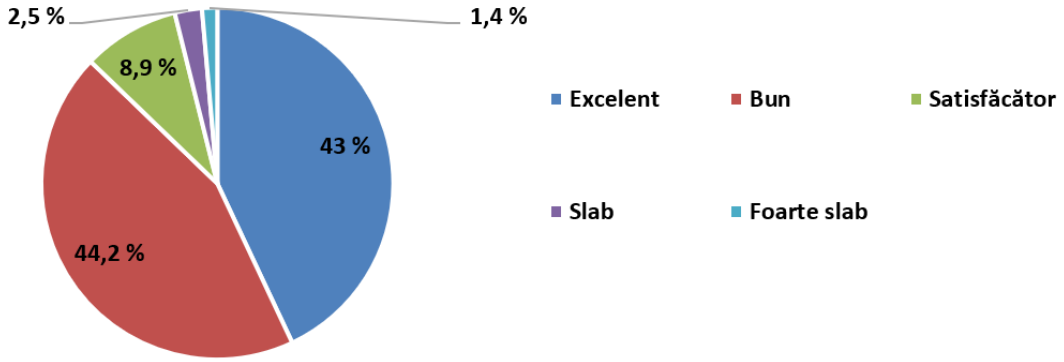

Figura 3. Îndrumarea elevilor în cadrul stagiului de practică de către conducătorul de practică.

Sursa: elaborat de autor în baza răspunsurilor elevilor, 1286 respondenți.

Din perspectiva abilităților dezvoltate în cadrul stagiului de practică observăm dezvoltarea unei game variate de abilități tehnice specifice domeniului, ceea ce reprezintă o oportunitate semnificativă pentru elevi de a-și aplica cunoștințele teoretice în practică. De asemenea, abilitățile de comunicare și colaborare, precum și capacitatea de rezolvare a problemelor sunt considerate importante și au fost dezvoltate în timpul stagiului de practică (Figura 4).

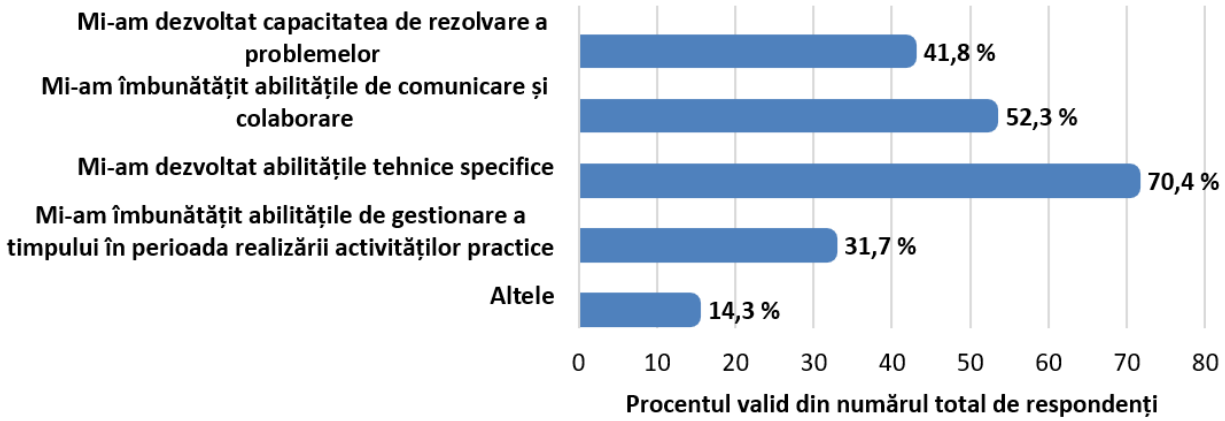

Figura 4. Abilități dezvoltate în cadrul stagiului de practică.

Sursa: elaborat de autor în baza răspunsurilor elevilor, 1286 respondenți.

În cadrul cercetării au fost scoase în evidență unele aspecte care ar putea să contribuie la îmbunătățirea condițiilor de desfășurarea a stagiilor de practică.

Printre aceste putem enumera accesul la resurse și tehnologii moderne sau oportunități variate de învățare. Răspunsurile elevilor este redat în Figura 5.

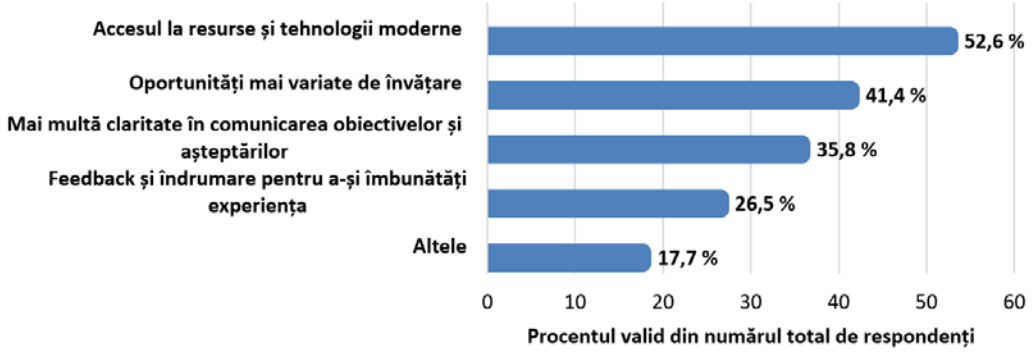

Figura 5. Arii de îmbunătățire a stagiului de practică.
Sursa: elaborat de autor în baza răspunsurilor elevilor, 1286 respondenți.

Este de menționat că în mare măsură, circa 92,3% din elevii consideră că stagiul de practică contribuie la dezvoltarea performanțelor elevilor (Figura 6).

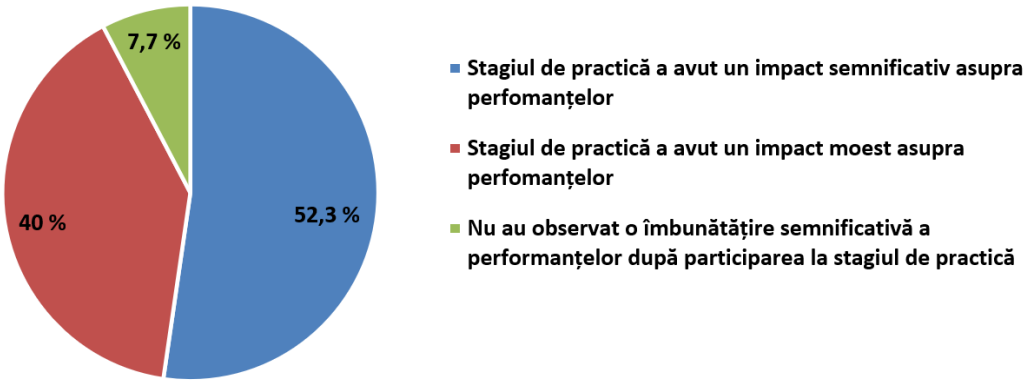

Figura 6. Impactul stagiului de practică asupra performanțelor elevilor.
Sursa: elaborat de autor în baza răspunsurilor elevilor, 1286 respondenți.

În mare măsură elevii consideră că experiențele dobândite în timpul stagiului de practică sunt percepute ca fiind relevante pentru viitorul lor profesional și personal. Totuși, un procent semnificativ recunoaște că utilitatea acestor abilități depinde de modul în care le vor aplica în practică (Figura 7).

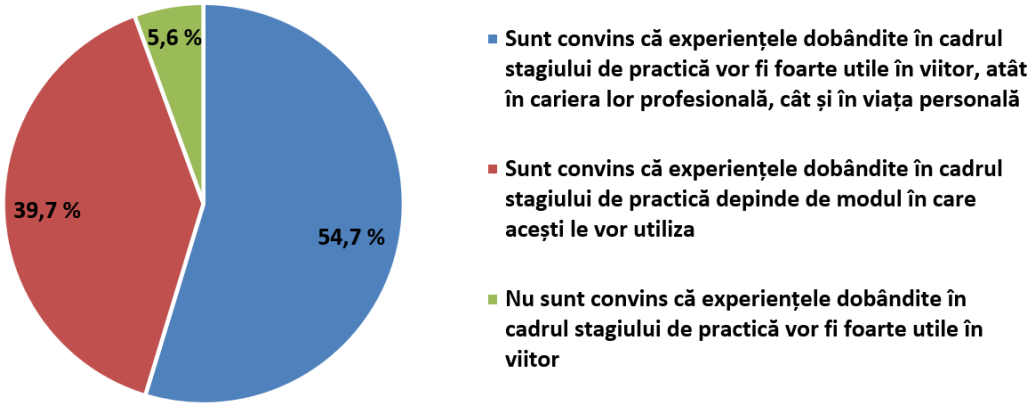

Figura 7. Relevanța stagiului de practică.
Sursa: elaborat de autor în baza răspunsurilor elevilor, 1286 respondenți.

3.2 Viziunea elevilor referitor la oportunitatea de angajare după absolvirea studiilor

Deși misiunea de bază a învățământului profesional tehnic este de a pregăti forța de muncă calitativă care să se încadreze în câmpul muncii, cu excepția învățământului dual, se constată o rată destul de modestă de încadrare a tinerilor în câmpul muncii [21].

Potrivit statisticilor publicate de Biroul Național de Statistică, doar patru din zece tineri cu vârsta între 15 și 34 de ani sunt activi, fie prin înmatricularea la studii, fie prin angajarea în câmpul muncii.

În acest sens, pentru Republica Moldova încadrarea tinerilor în câmpul muncii este o problemă esențială și se impun măsuri active de ocupare a tinerilor. În vederea aprecierii tendințelor pe care le au absolvenții din învățământul profesional tehnic din perspectiva angajării lor în câmpul muncii, în cadrul cercetării au fost constate următoare rezultate.

Elevii din învățământul profesional tehnic sunt încrezători în posibilitatea de a obține un loc de muncă relevant în domeniul lor de studiu după absolvire. Urmare a chestionării elevilor doar 7,1 % din respondenți au o încredere scăzută în posibilitatea de a obține un loc de muncă relevant în domeniul lor de studiu după absolvire (Figura 8).

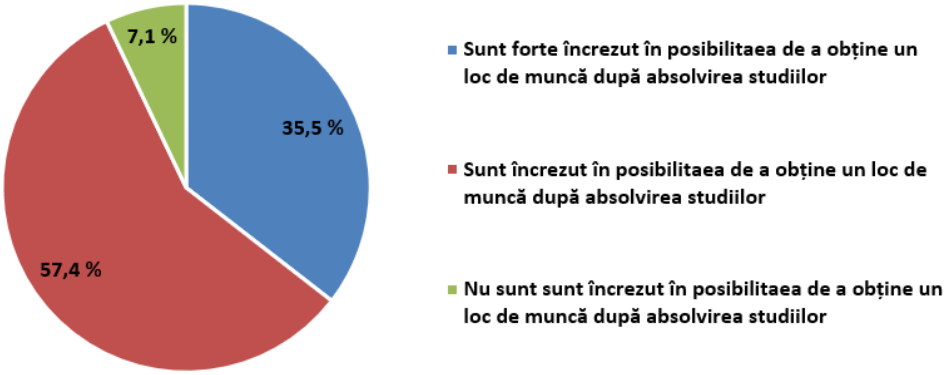

Figura 8. Nivelul de încredere al absolvenților privind identificarea unui loc de muncă.
Sursa: elaborat de autor în baza răspunsurilor elevilor, 1286 respondenți.

Rezultatele chestionării elevilor privind principalele preocupări ce vizează de procesul de angajare după absolvirea studiilor reflectă o gamă diversă de îngrijorări. În acest sens lipsa experienței de muncă și competiția acerbă pe piața muncii sunt printre cele mai frecvente preocupări, sugerând necesitatea dezvoltării unor programe și resurse care să sprijine elevii în dobândirea experienței relevante și în navigarea eficientă într-un mediu de angajare competitiv (Figura 9).

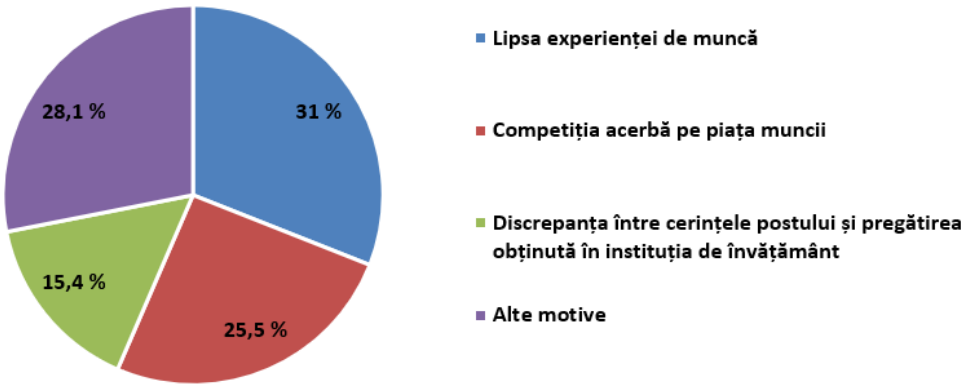

Figura 9. Preocupărilor elevilor referitor la posibilitatea de angajare după absolvirea studiilor.
Sursa: elaborat de autor în baza răspunsurilor elevilor, 1286 respondenți.

Din răspunsurile respondenților se constată că circa 66,6 % din absolvenți iau în considerare oportunitatea de a se angaja în cadrul unității economice în care și-au desfășurat stagiul de practică. În același timp circa 11,9 % din elevi nu doresc să se angajeze la muncă în cadrul unității economice în care și-au desfășurat stagiul de practică (Figura 10).

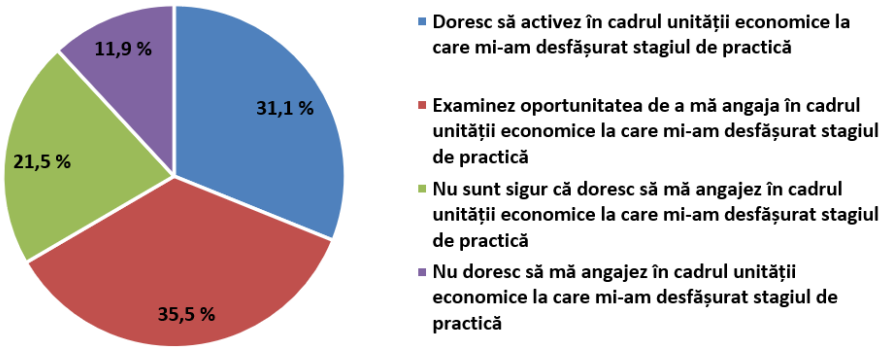

Figura 10. Angajarea în cadrul unității economice la care elevii și-au desfășurat stagiul de practică.
Sursa: elaborat de autor în baza răspunsurilor elevilor, 1286 respondenți.

Din perspectiva intențiilor elevilor după finalizarea studiilor se constată că peste 27 % din ei au intenția de a pleca la muncă peste hotare, precum și majoritatea din ei doresc să fie activi: fie să își continue studiile (35,9 %) sau să se angajeze în câmpul muncii (48,5%). Totuși circa 24,3 % din absolvenți rămân a fi indecși asupra planurilor lor de viitor (Figura 11).

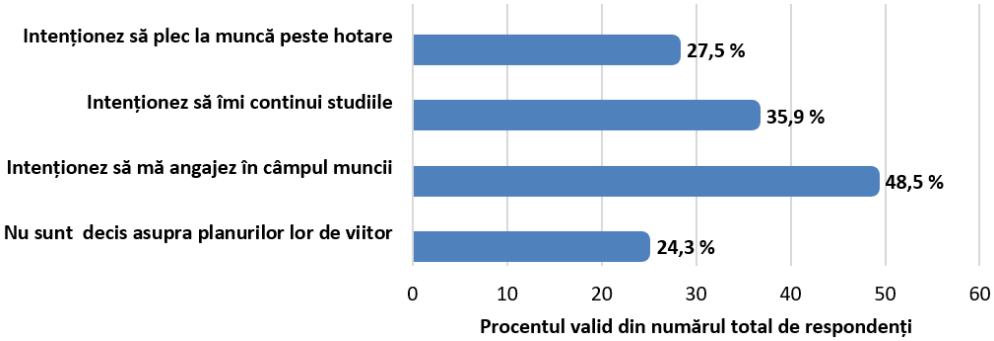

Figura 11. Intențiile elevilor după finalizarea studiilor.
Sursa: elaborat de autor în baza răspunsurilor elevilor, 1286 respondenți.

4. Discuții

Stagiile de practică ale elevilor desfășurate în cadrul unităților economice rămân a fi o platformă eficientă de formare profesională cu accent sporit pe dezvoltarea abilităților practice ale elevilor și formarea unor atitudini care să asigure o integrare mai rapidă a absolvenților în câmpul muncii. În acest sens este important ca stagiile de practică să fie desfășurate eficient și în acord cu prevederile curriculare. În cadrul cercetării urmare a examinării opiniilor elevilor vizavi de experiențele acestora acumulate în perioada desfășurării stagiilor de practică au fost identificate unele arii de îmbunătățire după cum urmează:

1. Pentru instituțiile de învățământ profesional tehnic:

- dezvoltarea și promovarea unor programe de mentorat care să ofere sprijin și îndrumare personalizată elevilor pe durata stagiilor lor de practică;
- pregătirea elevilor înainte de începerea stagiului de practică, inclusiv cu informații despre drepturile și obligațiile lor, regulamentele companiei și aspectele specifice ale mediului de lucru;
- diversificarea oportunităților de învățare și provocări pentru elevi în funcție de nevoile și interesele lor individuale;

- orientarea și informarea elevilor înainte de începerea stagiului de practică, cu subiecte ce țin de aspecte precum cunoștințele tehnice esențiale, așteptările companiei și strategiile de gestionare a timpului.

2. Pentru unitățile economice:

- implementarea unui sistem de feedback structurat și regulat pentru a evalua performanța și progresul elevilor în timpul stagiului de practică. Aceasta ar oferi elevilor oportunități mai clare pentru dezvoltare și îmbunătățire a competențelor profesionale;
- promovarea unui mediu de lucru sigur și incluziv care să ofere elevilor oportunități de dezvoltare și valorificare a potențialului lor;
- pregătirea și formarea adecvată a conducătorul de practică pentru a oferi îndrumare și suport corespunzător elevilor. Dezvoltarea unor programe de formare și mentorat pentru aceștia ar putea fi benefică pentru îmbunătățirea calității îndrumării elevilor în cadrul stagiilor de practică;
- asigurarea condițiilor pentru dezvoltarea abilităților tehnice ale elevilor, dezvoltării abilităților de comunicare;
- îmbunătățirea accesului la resurse și tehnologii moderne prin investirea în modernizarea și actualizarea resurselor și tehnologiilor disponibile pentru a oferi elevilor experiențe practice relevante și actualizate;
- crearea unui mediu de stagiu receptiv și incluziv care să faciliteze adaptarea elevilor și să promoveze comunicarea deschisă și colaborarea între aceștia și colegii de echipă;
- furnizarea de resurse și suport suplimentar pentru a depăși lipsa de experiență și alte provocări tehnice ale elevilor.

5. Concluzii

Stagiile de practică ale elevilor din învățământul profesional tehnic reprezintă o primă experiență a acestora de a face cunoștință cu piața muncii și de a conștientiza relevanța cunoștințelor dobândite, precum și a demonstra abilitățile practice și desigur de a-și forma atitudini corespunzătoare care să asigure elevilor o integrare mai ușoară în câmpul muncii.

Conform rezultatelor obținute în cadrul cercetării constatăm că în viziunea elevilor, stagiile de practică sunt relevante, pe parcursul lor elevii își dezvoltă abilitățile practice au oportunitatea de a se manifesta și a se orienta mai eficient în cariera lor profesională.

Remarcăm faptul că urmare a realizării stagiilor de practică circa 66,6 % din respondenți au menționat că iau în considerare oportunitatea de a se angaja în cadrul unității economice în care și-au desfășurat stagiul de practică.

În concluzie menționăm că stagiile de practică ale elevilor din învățământul profesional tehnic contribuie semnificativ în procesul de orientare și ghidare în carieră a elevilor și oferă premise pentru ulterioara lor angajare în câmpul muncii.

Mulțumiri: Lucrarea de față a fost elaborată în baza experienței dobândită în cadrul proiectului „Soluții pentru Tineri”, implementat de Centrul pentru Educație Antreprenorială și Asistență în Afaceri, în parteneriat cu Ministerul Educației și Cercetării și Agenția Națională pentru Ocuparea Forței de Muncă, finanțat de Agenția Austriacă pentru Dezvoltare cu fonduri din Cooperarea Austriacă pentru Dezvoltare. Autorii aduc sincere mulțumiri participanților implicați în realizarea cercetării.

Conflicts of Interest: The authors declare no conflict of interest.

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AFROCENTRIC PEDAGOGY APPROACH IN THE CURRICULUM OF EDUCATIONAL SYSTEM RENEWAL IN AFRICA: A CASE OF SOUTH AFRICA

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Abstract. The purpose of this paper is to conceptualize in greater detail the educational system approach that is being imposed into African countries, South Africa as a case in point. Over the past years, Sub-Saharan countries have and still experience indoctrinated educational system in which the content is mimicked from purported hegemonic states such UK, USA and other western counties inter alia. The problem of education retrogrades from the prior independence of African countries in the early 1960s wherein, the colonial masters organized and silently played a crucial role in shaping the formation of education in Africa; and not much has changed in terms of education since then. A particular concern is that the system of education might have designed to impoverish African people and perpetuate dependency to the western nations. Hence, at the core center of the educational system is the curriculum which seem to be inevitable and requires an alteration, particularly in South Africa. Therefore, the outlook of this paper is to critique and interrogate the system of education in South Africa looking at the socio-economic development and a continuous alteration in respect of the curriculum. The paper shows that for the realization of African renaissance, ideals of Africa Agenda 2063 and accelerated development, the system of education must be transformed and be Africanized to benefit the people of Africa. The paper uses literature-based approach as a methodological framework in order to analyze the status quo of education in South Africa. The paper concludes and recommends that the transformation of current educational system requires an alteration to the inclusive of indigenous knowledge to vigorously respond to socio-economic woes in Africa. Furthermore, the paper advocates for indigenous knowledge consideration in the incessant curriculum renewal.

Keywords: *Curriculum, Educational Systems, Indigenous knowledge, South Africa.*

Rezumat. Scopul acestei lucrări este de a conceptualiza în detalii abordarea sistemului educațional care se impune în țările africane, Africa de Sud drept exemplu. În ultimii ani, țările sub-sahariene au și încă experimentează un sistem educațional îndoctrinat în care conținutul este imitat din pretinse state hegemonice, cum ar fi Marea Britanie, SUA și altele.

Problema educației retrogradează de la independența anterioară a țărilor africane la începutul anilor 1960, în care stăpânii coloniali s-au organizat și au jucat în tăcere un rol crucial în formarea educației în Africa și nu s-au schimbat multe de atunci în ceea ce privește educația. În centrul sistemului educațional se află curriculumul care necesită o modificare, în special în Africa de Sud. Prin urmare, perspectiva acestei lucrări este de a critica și interoga sistemul de educație din Africa de Sud privind dezvoltarea socio-economică și modificarea continuă a curriculum-ului. Lucrarea arată că pentru renașterea africană, a idealurilor Agendei Africii 2063 și a dezvoltării accelerate, sistemul de educație trebuie transformat și africanizat pentru a aduce beneficii cetățenilor din Africa. Lucrarea folosește abordarea bazată pe literatură drept cadru metodologic pentru analiza status quo-ului educației în Africa de Sud. În concluzie se recomandă transformarea sistemului educațional actual, care necesită o modificare a incluziunii cunoștințelor indigene pentru a răspunde energic la problemele socio-economice din Africa. În plus, lucrarea pledează pentru luarea în considerare a cunoștințelor indigene în reînnoirea neîncetată a curriculum-ului.

Cuvinte cheie: *Curriculum, Sisteme educaționale, Cunoștințe indigene, Africa de Sud.*

1. Introduction

The post-colonial Africa is also alleged to be a neo-colonial Africa in a plethora of educational systems that is pragmatically a conundrum. This means that the post-colonial Africa is in rhetoric because major decision that seeks to influence the developmental direction are taken from outside of African civilizations, most in particular Europe and western nations [1]. The tragedy is that the future of Africa is discussed in its absence by the first world countries. Regrettably, the calamity of a neo-colonial project is gaining momentum by day in education, silencing the interest of the Africans. Of a particular concern is that the system of education might have designed to impoverish African people and perpetuate dependency to the western nations. The project in education appears to have hegemony over every sphere of the modern economy and the society in particular [1]. Hence, that raises the debating points that focus on its reflections and discussions around the issues of education in a post-colonial South Africa.

Clearly, South African education does not teach people to be inventors instead it channels them to memorize and lacking Afrocentric innovation. Hence, at the core center of the educational system is the curriculum that requires an alteration. Accordingly, it appears that the current education imparts young and emerging academics and scholars with the information that ensemble with the western states. On the same trajectory, the norms, values, culture, ethics and indigenous pedagogy are being exterminated and circumvented because of the education that is being taught at the educational institutions of higher learning [2, 3]. The paper submits that the indigenous knowledge should be incorporated to the existing curricula to harmonize with the pragmatic conditions of the African people and be pertinent to the needs of the people.

The paper concurs with [3, 4] that not only the western education system is a panacea for impartation of knowledge in area of unique and different capacity and capabilities. However, it is pivotal that knowledge, in any way, should not exist in isolation because, if they do, it will alienate certain knowledge and philosophies from various perspectives. If knowledge of a particular field is in isolation, then that would not be constituted as "knowledge"; thus, knowledge constitutes the amalgamation of both western and indigenous knowledge in education [4]. As a result, if there is a monopoly of education considered and

applied ubiquitously irrespective of practices and capacity of a specific area then that calls for compromises. Moreover, the writings of ancient scholars are still relevant today that local knowledge, the rituals, tradition, and inheritance rights disappear particularly since the inception of the western modern education [5]. An outlook that knowledge cultivates in a form of interaction between the individual and the environment; that is the surrounded cultural and natural settings which are imperative to the educational development of knowledge [5].

2. Materials and Methods

This paper used a literature-based methodology. Which means that the paper is purely conceptual and also adopted a qualitative approach. This type of a methodology was long used by philosophers in an attempt to describe and understand the developments of the time. The paper relied on an examination of literature and materials from secondary sources. The secondary sources provided secondary data obtained from regulatory and policy papers, academic books, journal articles and relevant reading materials which were deemed necessary to achieve the purpose of the paper [6]. It used a thematic analysis, wherein themes were identified and developed and further interpretation and meaning of the themes were provided for better understanding.

3. Literature Review

3.1. Interrogating the Current State of Curriculum in South Africa

There is nothing on the already existing literature or educational system that teaches young people the primary imperatives of self-development in terms of education and edification of knowledge just like the elders, [7] divulged the notion. Instead, young people learn how to absorb the taboos from their families that are taught using western ideology of education and culture. Yet, alienating the western approach of education as a panacea instead of converging with the indigenous knowledge could primarily persist the inability to meet the needs of the state and that is to circumvent the educational construct [7]. The challenges of the current curriculum are precisely due to globalization and democracy which does not do any justice to the woes and providing proper and quality education to the constituency. Meanwhile, it could be argued that the curriculum developers and teachers continue to fail learners and students thereof. However, it becomes a challenge when students write what they have observed through indigenous teachings from their communities. Conversely, teachers and lecturers antagonize the curriculum instead of converging with the needs and aspirations of the learners in their respective academic, social and personal context [7]. What exacerbates the current predicaments of the curriculum is what the teachers and lecturers impart to the students with the knowledge that is limited and scant to the classroom and the lecture halls, hence there is always a scope to guide and channel the journey of teaching and learning [7, 8]. When interrogating the status quo of the curriculum in South Africa, one can vividly note that, it mutes the indigenous knowledge and gives all the privileges and encomium to the "Western-European" perceptions [8].

For the past recent decades across Sub-Saharan and all the regions of Africa, indigenous knowledge has been successfully muted [8]. Accordingly, that is exacerbated by the contemporary educational system that does not enhance and transform the current state of educational development in Africa, particularly South Africa [8]. The pride of Africa resides in its indigenous use of resources, languages, and education [8]. Hence, the indigenous knowledge in Africa is used to define aesthetic, identity, symbolic, spirituality and all other

social norms and values that relates to the people given their geographical areas. Within that context, the social norms portray the language, culture, taboos, dance and music, riddles, rituals, and the indigenous knowledge that African people possess [9]. Be that as it may, the indigenous knowledge system endures the historical imbalances in the current dispensation of democracy and further circumvented in the current state of educational system across African countries [9]. Which means, there is nothing if not little in the current educational system that teaches people about the indigenous science, health, technology, and trading to name the few. The modern or conventional educational system undermines the African people about their origin, knowledge, and history. The adage that "for a nation without history shall perish" seems to be a reality in the current juncture most specifically in South Africa, wherein unemployment is skyrocketing, poverty seems to be the way of life, economy is at its lowest phase of recession and other socio-economic issues are unabatedly escalating on daily basis. All these challenges that South Africa is experiencing are merely because of the educational system that is adopted form the west which its curriculum does not respond to the needs of the African people [9, 10]. It is therefore proven that the indigenous knowledge can contribute to developing and re-shaping the educational system that its curriculum can speak and respond to the dilemmas of the country [11]. Furthermore, if indigenous knowledge can be considered in the curriculum development, then there can be a retain and redeeming of the splendor of African typicality of education and knowledge that can possibly deal with the socio-economic conundrums [11].

One can argue that the western epistemology and pedagogy have created and lay down the rules through educational system dominance. Considering that echoed dictum, the knowledge system consumption and production portray western domination [12]. That is to portray that the supremacy of what was the imperialists and now parading and masquerading as modern western knowledge is rooting deep into African states and education. The latter dictum and sentiments are shared by [13] who confirms the supremacy of western curriculum in the post-colonial Africa whom in words uttered that, "it is everywhere, dominating the disciplinary and interdisciplinary discourse and department, paradigms and publications, academics, politics and practices". The dictions of [13] as corroborated by [14] are still perceived as the key words for highlighting the skewed educational system that hammer the development of developing countries; wherein universities and research institutions are still guided and embedded by the ideologies of the western curriculum. Consequently, the universities and research institutions never cease to surprise the African countries with the knowledge they absorb and produce which is controlled by the same western hegemony [15]. Even though the libraries attempt to include indigenous knowledge and traditional heritage of Africa, most particularly in South Africa, such is not sufficient because those are just symbolling not contents. In fact, very scant intellectuals and academics are interested in pursuing indigenous knowledge research and devote themselves to the process [15].

When South African became a democratic country 30 years ago, the immediate mandate for the newly elected government was to transform and shape the system of education that would be salvage to the challenges confronting the South Africans in particular. Instead, from the primary and secondary educational perspective, it adopted the western curriculum in the name of Outcomes Based Education (OBE), the National Curriculum Statement (NCS) and now absorbed Curriculum Assessment and Policy Statement (CAPS). All these curriculums were mimicked from the western countries to try and reform the system of education. That was deliberately and intentionally done to overlook the true identity of

Africans. However, not everything is wrong with the western curricula, however, there are certain vacuums that must be installed with a sense and essence of indigenous knowledge science to properly fit in a specific context of South Africa. Consequently, the educational system to date is failing young and old in South Africa because they are in dire milieu of poverty and inequality. Meanwhile, [15] has vehemently lambasted the formal education that provides teachers with the training that makes them be part of the "elite strata" who's their acquired knowledge and skills set them apart from the native communities and yet their upbringing was purely indigenous like any other pupil who grew up in an African community. The paper seeks to incorporate in the current system of education, the indigenous economy, such that all the indigenous people can partake vigorously, meaningfully, and equally in the economy.

It could be noted that the education white paper 3, was a program aimed to transform the educational system of higher learning that was manufactured and adopted in the year 1997. The white paper acknowledges the key conundrums that are manifested in the institutions of higher learning in South Africa. These incorporate among others the redress of the imbalances of the past, the need to respond to new social woes, respond to the realities and available opportunities and respond to the national crisis. The national plan for higher education of 2001 focused on the de-racialization, achieving unity and diversity, being comprehensive, producing the graduates who are equal to the task of social and economic development of the country, installing research ingredient in higher learning and restructure higher educational system [15]. These are aspects that one would wish to see being executed to their full capacity. The provoking question that one is reluctant to ask, but must be asked anyway is, to what extent have these objectives being accomplished? In other words, what went wrong that the government policies and frameworks failed to materialize the objectives of the national plan? Perhaps this is the same nest filled with elements of success and failures in it. Hence, the paper seeks to do away with such a nest and bring a new nest with a sense of indigenous knowledge that would be responsive to socio-economic dilemmas. For that reason, [15] argue that the urgency with the South African curricula is of paramount importance and that it can no longer be postponed.

3.2. Colonial Educational System and Indigenous Knowledge Integration

The paper disproves the notion that African continent was 'tabula rasa' before the inception of western systems and had no origin. The discourse on indigenous knowledge has provoked the thoughts of the most Africa leaders particularly in South Africa over the recent years [15]. In South Africa, the indigenous knowledge is what informs the indigenous communities when it comes to the learning about indigenous pedagogy or education wherein the indigenous knowledge becomes a focal point of learning the basic principles of human development [15]. Paradoxically, the indigenous teachings are swept under the red carpet of western teachings. The colonial goons and its associate of apartheid system or administration have confidently disregarded and undermined the indigenous knowledge describing it as unscientific, ungodly, full of evil and diabolical, illogical system and anti-development to name the few [15]. Albeit the Global Knowledge Conference that took place in 1997 in Toronto that has put forward the ideals of indigenous knowledge which are to learn, preserve and share the indigenous knowledge became a pipedream. Hence, scant attention and little has been done in Sub-Saharan Africa to guarantee the maximum utilization of the indigenous teachings for a common goal. Equally, Africa endures to be in dire conditions of under

development and suffers from western doctrines under the so called "democracy" which is limping like a crippled old person [16]. Conspicuously, South Africa in particular persist times without number to languish in the pool of poverty in most (if) not all the aspects of the economy under the democratic dispensation.

The term "indigenous" has been vilified and slandered particularly under the new modern society and the beginning of formal western education. This knowledge (indigenous) is afforded low prestige because it belongs to a specific racial or ethnic group of African people and is perceived to be lacking the necessary cultural capital [17]. To this end, the curriculum which is the product of colonizing the mindset of African people has been adopted and persists in schools and further developed and perpetuated in the universities and colleges across the world. Therefore, the paper argues that the western curriculum must be reformed to allow Africans to have and resuscitate their old-fashioned way of education and learning because that is what defines them. One can explicitly note that very few if not many Africans are conscious that they are in cultural, economic, social and political bondage [17]. All of these are primarily due to what the curriculum and the content encapsulate which is not to provide a leeway for African people to know who they are and what they are. Be that as it may be, neocolonial cultural dependency is a peril to the autonomy of African psychology and sovereignty [17]. On the similar stance, African people continue suffering the intellectual poverty of the western curriculum and lacking the knowledge of self-consciousness [17].

It could be avowed that the mindsets of African people are still indoctrinated with the racial content of the curriculum. Similarly, [18] denotes that racialized curriculum is a new form of imperialism, a neocolonial apparatus of manipulation to take control of knowledge production in the world. Incontrovertibly, the western education has flourished in the Sub-Saharan countries to hide and distort the indigenous knowledge in the dustbin of history. In that, the modernity of western syllabus since the independence of African states in 1960s has not provided a long-term solution to socio-economic woes in a manner in which African people would have hoped for [18, 19]. To date, most of Sub-Saharan countries still experience myriad dilemma ranging from, sluggish economic development, low life expectancy and triple challenges, i.e., poverty, inequality and unemployment [18]. At the core center of Africa's under development, it is a nest of western education and its philosophies, which is designed and shaped to bring wealth to the western communities at the expense of African countries. Moreover, the conspiracy theories from the west have failed to at least incorporate some of the ideals of indigenous knowledge in the mist of its content; failed to provide a creative panacea to ameliorate the Africa's development particularly South Africa and must be rejected with the contempt they deserve. For that reason, students in South Africa took it to the streets to demand amongst other quality and decolonized education.

For a state that does not take care of young people would be deemed as a failed state. Students across the universities and colleges, specifically in South Africa stood up and fight to the bitter end and became the martyrs of the struggle to get free education for the poor and the missing-middle. Amongst others, students also included in their memorandum of demands the quest to get quality and decolonized education [19]. Students wanted education that they can relate to; that can be able to transform their communities into a better area; that can respond to social and economic needs. Many of the students to date [20] feel life is discombobulating, full of anarchy and devoid of meaning. Young people are not able to describe their moods and their affiliation to the society around them [19]. This is primarily because of the system of education that has imprisoned and "arrested" the minds of the

society young and old to reject their own self and abscond from the indigenous pedagogy [19]. The paper submits that the indigenous teachings and system is the only ingredient to add value and give a meaning to African people through education and transformation of the curriculum. Since indigenous knowledge rises from real-life experiences of African people, its incorporation into the existing curriculum in schools, Universities and colleges would motivate, inspire and broaden their intellectual capacity of knowledge and milieu around them [19]. Hence, indigenous knowledge is the knowledge that one has before entering the classroom and performing the academic activities [19]. The paper also extends to establish and explore in an African context, the doctrines of Pan Africanism which are collective self-reliance, economic growth and self-sustaining development. These doctrines would be materialized through teaching and learning of the indigenous knowledge so that the conceptualization and robust discussion could have and bring sound positive impact to the students, learners and the society at large; alternatively respond to the societal needs.

3.3. The Difference Between Academic Knowledge and Indigenous Knowledge

The paper refers to [19] in respect of the indigenous knowledge and conventional science or academic knowledge. Conventional science is generated through rules, policies, standards and planned procedures while indigenous knowledge is generated from community members [19]. It therefore, worth noting that indigenous knowledge derives or elicited from the existing wealth of community wisdom and information, local utilization of the resources and the creative art from the members of the community. While academic knowledge seems to bank on principles, theories and laws for the purpose of education. Moreover, [19] also makes a distinction that academic knowledge pays attention to the individualism and narcissism as it disregards and kill students and learners through the failure of academic activities such as tests and assignments. Opposite to the latter point, indigenous knowledge pays attention to the cooperative communalism, socialism as it pursues to include all the people in the community [20]. Academic knowledge is found in literature and packages with labels such as chemistry, economics, accounting and biology to name the few. Meanwhile, indigenous knowledge is not found in packages, it is passed on orally from generation to generation. Be that as it may, the paper seeks to acknowledge and document the indigenous knowledge to the existing curriculum so that it does not disappear.

3.4. The Significance of Indigenous Knowledge in Education

The valuable insights of indigenous knowledge could be a vehicle towards inclusive education and spearhead the educational transformation in the country [20]. Its insights are necessary for the efficient use of resources, land and spiritual relationships with nature. Teachers can execute any of the insights from the indigenous knowledge into a teaching space [20]. In that way, students and learners could be taught how to sustain life, protect the environment and not exploit it with technological elements. The consumption of indigenous knowledge in the learning process is essential to teach children about sustainability of human life and nature using indigenous methods and that this information could be passed along to the next generation [21]. Notwithstanding the values, principles, morals, traditional rights and ethics of the aboriginal people in South Africa who are popularly known as the Khoisan people in the current democracy [21, 22]. This will assist leaners and students to fathom how to protect the rights, water, land and the ecological system amongst others.

Despite the decades of African independence, to these end scholars, intellectuals and academics have not succeeded in transforming the continent to establish its original

methodological processes and theoretical structure for the source of indigenous knowledge and sustainable development [22]. Moreover, the government is quick to provide the resource to the universities, schools and colleges to enhance the educational system. But scant attention is being given to indigenous knowledge despite the contributions by the National Research Foundation (NRF) [22]. The paper, therefore, provides a thesis statement that in order to provide a panacea to the socio-economic challenges the indigenous knowledge must be included in the current curriculum to be relevant to the needs of the people, Africans in particular. The primary problem is that the current education is inherited from imperialists and colonial masters depending on who colonized a particular country and their way of learning and teaching is different from African countries [22, 23]. This is exacerbated by globalization and perpetuated by the strong ties between African countries and their former colonizers [24]. Due to globalization, African countries do not invest much in indigenous knowledge because they are trying to keep up with the western standards of education for the purposes of ratings. This is done at the expense of the intelligence of the people and subjects them to succumb to education that they do not know. Meanwhile, [24] implies that another problem of Africa in terms of education is that both research and academic tasks are still executed in western languages such as English, Portuguese and French, which neglect the indigenous knowledge research, methods and its ideals. Not even at least "Keswahili" as indigenous language of Africa is recognized a medium of communication in Africa is given much attention. The paper explored the distinction between the academic knowledge and indigenous knowledge to strengthen its propositional statement.

4. Results and Discussion

In line with the discourse provided above, it is pivotal to amalgamate what exists in respect of education and knowledge in concomitant with the indigenous practices. Likewise, the inclusion of both western and indigenous knowledges would mean power and critical analysis of the mainstream knowledge [25]. The convergent of western and indigenous knowledge would also mean muting effects and omissions negative social and economic repercussions [25]. The pertinent of this paper would be incomplete without quoting one of the martyrs of fighting for decolonizing the mind of the black man "Steve Biko" who alluded those developing countries are subjected to all oppression by western countries through institutionalized machinery, laws that restrict it, heavy work conditions, poor payments, very difficult living conditions and most importantly poor education [26]. That is sustained by [26] who implies that a black man from developing country is castrated from his origin and history and that has resulted into the extermination of indigenous ideals. Accordingly, the western cosmology that is institutionalized to the educational system has alienated indigenous knowledge that gave rise to the conditions of schizophrenic to the African people [27].

5. Conclusion

The predicament in traversing through finding the relevant epistemology in educational system and a better approach for the unabated socio-economic issues is of no trivial in South Africa. However, the driving dominance of western epistemology and ideology in an Afrocentric substratum seems to be the ambiguity and ambivalence in dealing with issues of educational curriculum. Thus, the ambivalence derives from either considering African content of education as an approach by those advocating for western epistemology approach. Hence, in South Africa there is a call for decolonization of education as a recommended panacea in the educational spectrum. There could be a nuance between the

western ideology and pedagogy of African content looking at the context nature of African capabilities and indigenous knowledge. That is why African pedagogy approach can be discovered as "heavens" only if the system of education is to be designed and structured to accommodate indigenous knowledge and capabilities to ameliorate the afflictions that the people endure on daily basis and in respect of the issues faced by Africans. The paper therefore, suggests that knowledge that is acquired before entering the classroom is indigenous knowledge which the native Africans have and are not taught in modern education. It is not a problem to integrate the two pedagogies for better education and impartation of knowledge in developing countries of Africa. In fact, the paper does not call for phasing out western approach of education but recommends the integration of the two which could work well for economic development and rendering services across the globe.

Conflicts of Interest: Authors declare no conflict of interest.

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MOBILE APPLICATIONS - IMPORTANT ADDITIONAL EDUCATIONAL SOURCE FOR STUDYING CHEMISTRY

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Abstract. The article proposes a brief description of some mobile applications useful both for people who are starting to study chemistry, but also for students. The purpose of the publication is to direct the attention of teaching staff towards this type of tools that can be useful and diversify the student's contact with the discipline of chemistry. There were analyzed 13 mobile applications oriented for different levels of studying chemistry. The opinions expressed by users are mostly positive and express a high degree of satisfaction.

Keywords: *chemistry, smartphone, app, play market.*

Abstract. În articol se propune o scurtă descriere a unor aplicații mobile utile atât pentru persoanele care încep a studia chimia, dar și pentru studenți. Publicația are drept scop de a orienta atenţia cadrelor didactice spre acest tip de instrumente care pot fi utile și diversifică contactul studentului cu disciplina chimia. Au fost analizate 13 aplicații mobile orientate pentru diferite nivele de studiere a chimiei. Opiniile expuse de utilizatori în majoritatea sa sunt pozitive şi exprimă gradul înalt de satisfacției.

Cuvinte cheie: *chimie, smartfon, aplicație, play market.*

1. Introduction

The last 20 years have been marked by essential changes in education, these being caused by the wide use of information technologies, starting with kindergartens and ending with universities. The phenomenon is primarily caused by the essential reduction in the price of equipment and software, which allowed their mass use. Currently, over 95% of the population of the Republic of Moldova and especially the young generation use mobile phones for communication in various forms.

The versatility of smartphones allows operative access to information resources, individual or group communication with other members of the educational process, participation in various types of online tests, etc. At the same time, the possibilities offered by the smartphone can cause addiction to the gadget and cause addictive behavior [1-4]. With all the possible problems caused by excessive use, smartphones make learning activities

more meaningful, transform the learning process into a more attractive form, propose educational information in a more interesting aspect by selecting visual images, improve the quality of the training process , makes the lesson more dynamic. The beneficial aspect of applying these devices in student-centered learning at all stages of education has been noted by a number of researchers [5-7]. At the moment we have at our disposal a multitude of applications that could be used in the teaching-learning-evaluation process, relying on the fact that both the teaching staff and the students have digital competence. In this publication we present possibilities for using smartphones in and outside of chemistry classes, namely applications in the field of general, inorganic, organic and analytical chemistry.

2. Materials and methods

Mobile applications from Google Play Market (Google's app store) served as the research object for studying chemistry (free or paid) proposed to different categories of interested individuals - students, teachers. However, the total number of applications in the field of chemistry proposed by the market could not be determined. Their selection was based on some topics that were of interest to the authors. Another selection criterion was the number of downloads and the average score. The graphic aspect and the textual content were analyzed as additional material in the study of chemistry for different interested groups.

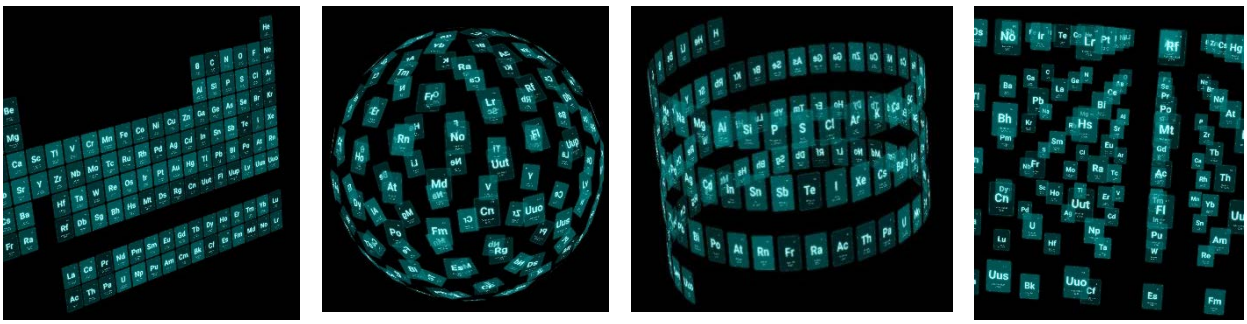
3. Results

We will start the presentation with the Periodic Table of the elements and the useful information presented by it.

Application ***Periodic Table.***

The periodic table of D.I. Mendeleev became the most important milestone in the development of atomic-molecular science. Thanks to her, the existence of chemical elements unknown to science was predicted, their position relative to those known in the table and their properties were established. Later, many elements were discovered and fell into the places that Mendeleev predicted in his table. The periodic system made it possible to form and develop a modern concept of the chemical element, to establish the correlation between the properties of simple and compound substances. The periodic system allowed predicting the existence of some chemical elements not discovered for the moment, describing some chemical properties of the transuranic elements.

This application was developed by Aloask Technologies and it allows us to view the Periodic Table of the elements, a characterization of the element (color, density, melting/boiling point, discoverer). The Periodic Table can be viewed as a table, sphere, helix, grid.



A B C D

Figure 1. The *Periodic Table* of chemical elements presented in different forms (A – table, B – sphere, C – helix, D – grid) [8].

The Pro version of the application contains 2 additional compartments: Test and Advanced features of chemical elements. Since the proposed information is relatively simplistic, the application can be recommended for people who are starting to study chemistry. The rating of application is 4.4 and it has been downloaded more than 10 thousand times [8]. Let's analyze another application that facilitates learning on the topic "Periodic Table", namely *Periodic Table 2020*.

Periodic Table 2024 Pro.

Periodic Table 2024 Pro is very useful both for students and teachers [9]. The application provides extensive information about chemical elements: molar mass, Latin/English name, year of discovery, density, melting/boiling temperature, valence, ionization potential, atomic radius, electronegativity/electroconductivity value, emission spectrum image, specific resistance, type the crystalline network and its parameters, the spread in nature/the human body.

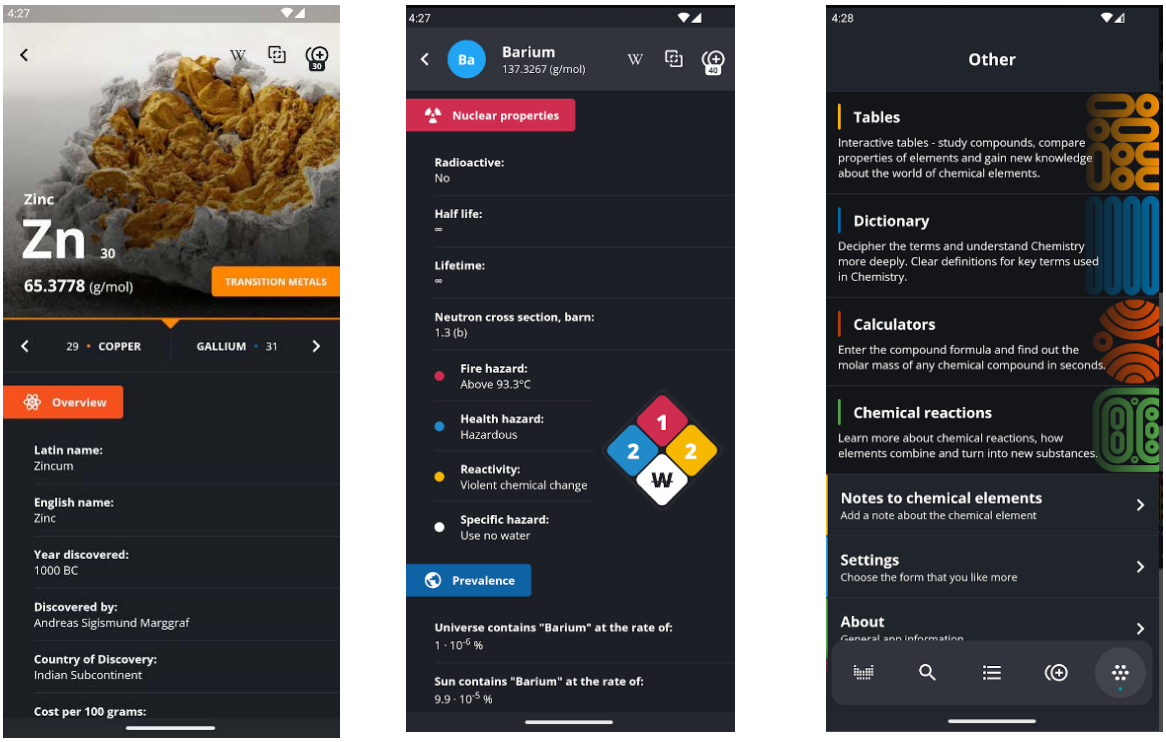


Figure 2. Images from the *Periodic Table 2024 Pro* application [9].

The rating of application is 4.8 and it has been downloaded more than 100 thousand times.

Virtual Orbitals 3D Chemistry. According to modern concepts, the electron has a dual nature and has both the properties of a wave and a particle, therefore, to describe its behavior, one cannot use the usual characteristics, such as speed and trajectory of movement. To describe the state of an electron in an atom, the concepts of quantum mechanics are used - a physical theory that establishes the laws of motion of microparticles. According to quantum mechanical concepts, an electron does not have a definite trajectory of motion and can be located in any part of the space around the nucleus, but with different probabilities. Each orbital corresponds to a region of space of a certain size, shape and orientation, equivalent to the concept of an electron cloud. The *Virtual Orbitals 3D Chemistry* application can be used for the graphic visualization of the electronic orbitals of some atoms. The application allows visualization in 3D of electronic orbitals *s, p, d, f,* p_x, p_y, p_z, d_{xy},

d_{yz}, d_{xz}, d_{x2-y2}, d_{z2} and the spatial electronic structure for a series of atoms – He, Be, C, O, Ne, Mg, Ar, Ca, Ti, Cr, Fe, Zn [10, 11]. The visualization is not static, it is possible to rotate the orbitals in different directions in relation to the *xyz* axes, which greatly simplifies the understanding of the location of the orbitals in space and in relation to each other.

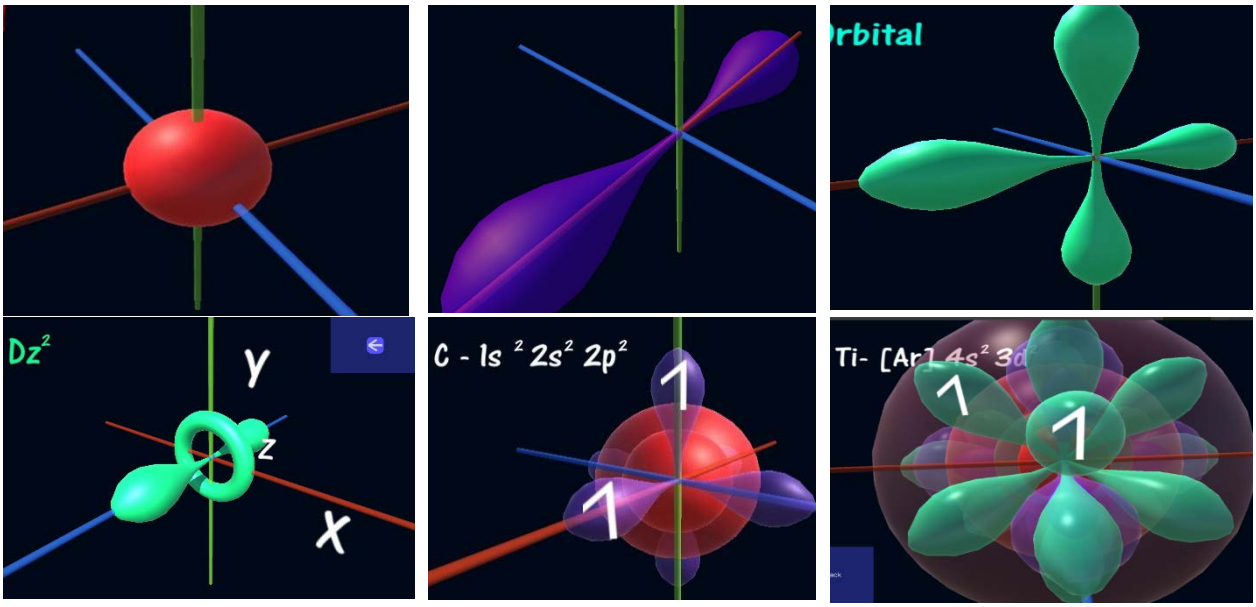


Figure 3. Images from Virtual Orbitals 3D Chemistry [11].

User reviews are mostly positive. The application is appreciated for its simplified use, grading of examples according to difficulty, and the possibility of viewing from different angles. At the same time, some users believe that with all the beautiful aspects, there is also room for improvement - to improve the animation, to offer the possibility of viewing the atomic orbitals on the inner layers for atoms with several electron shells, the visualization of all electrons (not only the valence ones). The rating of application is 4.4 and it has been downloaded more than 100 thousand times.

The following application ***Atom Phys*** allows us to deepen our knowledge in the field of the structure of the atom. The *Atom Phys* application [12] consists of the following compartments: test, modeling of atoms, writing nuclear reactions.

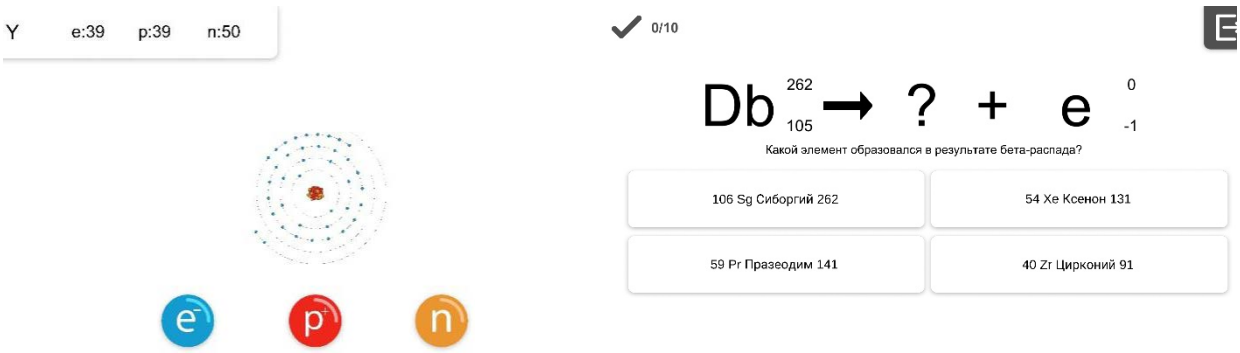


Figure 4. Images from the *Atom Phys* application [12].

The proposed visualization facilitates the study of the topics „Structure of the atom", „Radioactive fission", „Electronic formulas of atoms of chemical elements" by „building" different atoms from protons, neutrons electrons and checking the possibility of the existence

of the given atom; offers the opportunity to recap and test the knowledge of the electronic formulas of the atoms of chemical elements, the realization of α and β type fissions.

Users who have used the application in the fund have left positive opinions. Users are satisfied with the possibility to visualize the "construction" of different atoms, the visualization of the atom structure, the positioning of electrons, etc. The rating of application is 3.9 and it has been downloaded more than 10 thousand times.

Software for drawing structures is an essential tool to visualize and represent chemical substances in a digital format. These programs essentially simplify the creation, manipulation and analysis of the molecular structure of the analyzed compounds. Here's an explanation of their use:

1. Molecular Visualization: Software for drawing structures of molecules allows chemists to generate different representations of chemical compounds. Chemists can input the atoms and bonds of a compound and visualize its structure in different formats: ball-and-stick models, space-filling models, or wireframe models.

2. Drawing and Editing Molecules: The program offers a simplified user interface, which allows drawing and subsequent editing of the obtained structures. The obtained structure can be supplemented with atoms, groups of atoms, functional groups, molecular fragments; the angles between the links can be changed.

3. Molecular Formula Generation: Enter the qualitative and quantitative composition of the compound (empirical formula) and the software generates the molecular formula. This option is extremely useful for compounds with a complex structure.

4. Isomer Generation: The software allows the generation of isomers based on the formulas of the proposed chemical compounds.

5. Structural Analysis: The software allows to determine the molecular mass of substances, to estimate chemical properties and stoichiometric parameters.

One of the programs that facilitates the process of graphical presentation of chemical compounds is *KingDraw*.

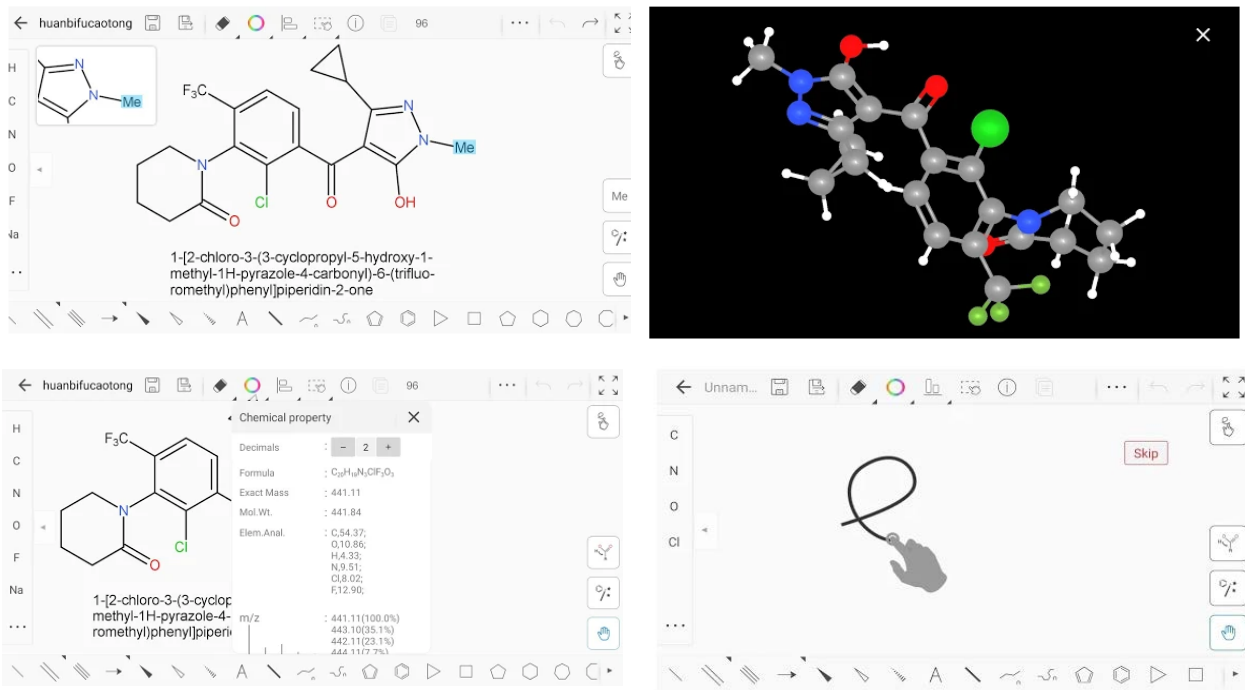


Figure 5. Images from the *KingDraw* application [13].

KingDraw is a chemical drawing editor that allows users to sketch the structure of molecules and the equations of reactions involving organic compounds [13] is possible to visualize the structures in 3D, to name the chemical compounds according to the IUPAC nomenclature, to predict the properties of the drawn compounds. The application has a serious database and can be considered as a semi-professional tool. Possibly the only shortcoming from my point of view – it is a bit difficult to work with small objects on the smartphone screen.

Users who have used the application in the fund have left good opinions. The rating of application is 4.3 and it has been downloaded more than 500 thousand times.

One of the applications that provides useful theoretical information in the field of general, inorganic and organic chemistry is *Chemistry Lab*.

Chemistry Lab. The application has an attractive design and graphics and is divided into 2 sections: General Chemisty and Organic Chemistry [14]. The General Chemisty section consists of Introduction, Atomic Structure, Periodic Table, Ionic Bonding, Covalent Bonding, Chemical Reactions, Moles, Solutions, Acids and Bases, Gases, Thermodynamics, Kinetics, Electrochemistry, Nuclear, Organic, Trivia. Each compartment consists of questions on the corresponding topic with the possibility of choosing the answer from 2 variants. The proposed testing is oriented for an average level of knowledge. In the Organic Chemisty chapter, the mechanism of different chemical reactions with different classes of compounds is explained.

Figure 6. Images from the *Chemistry Lab* application [14].

The majority of users positively appreciated the possibilities of the application: „the application is extremely useful, it is simple, interesting, interactive and is very good for forming interest in chemistry as a discipline". The rating of application is 4.1 and it has been downloaded more than 500 thousand times.

The application is extremely useful, it is simple, interesting, interactive and is very good for forming interest in chemistry as a discipline. Our actions in this area can be simplified with the application *Chemistry Calculator*.

Solution Calculator Lite. The *Solution Calculator Lite* application is a useful tool for: calculating the concentration of the solution (in mM, M, μM, nM, g/ml, g/l) knowing the

volume of the solution and the molar mass of the substance; calculating the volume of the solution with the known initial concentration required to obtain a more diluted solution; calculates the molar masses of chemical elements; provides detailed general information about 118 chemical elements [15].

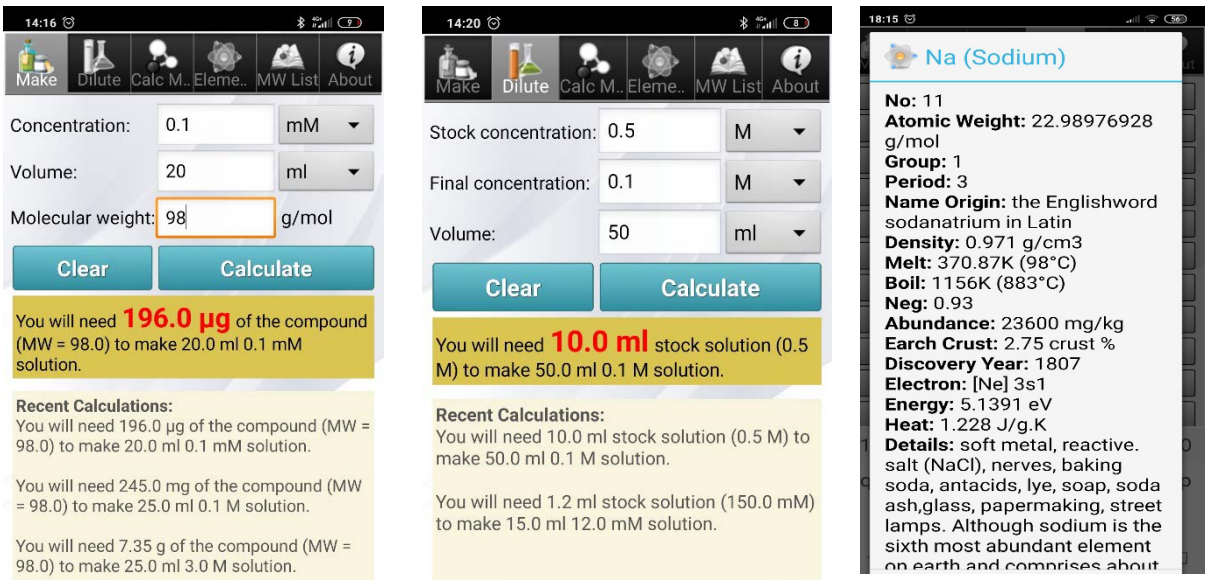


Figure 7. Images from the *Solution Calculator Lite* application [15].

The rating of application is 4.5 and it has been downloaded more than 100 thousand times.

Another extremely useful application, especially for experimental calculations in physical chemistry and colloidal chemistry, is *Chemistry Calculator*, the name of which does not quite optimally express their purpose.

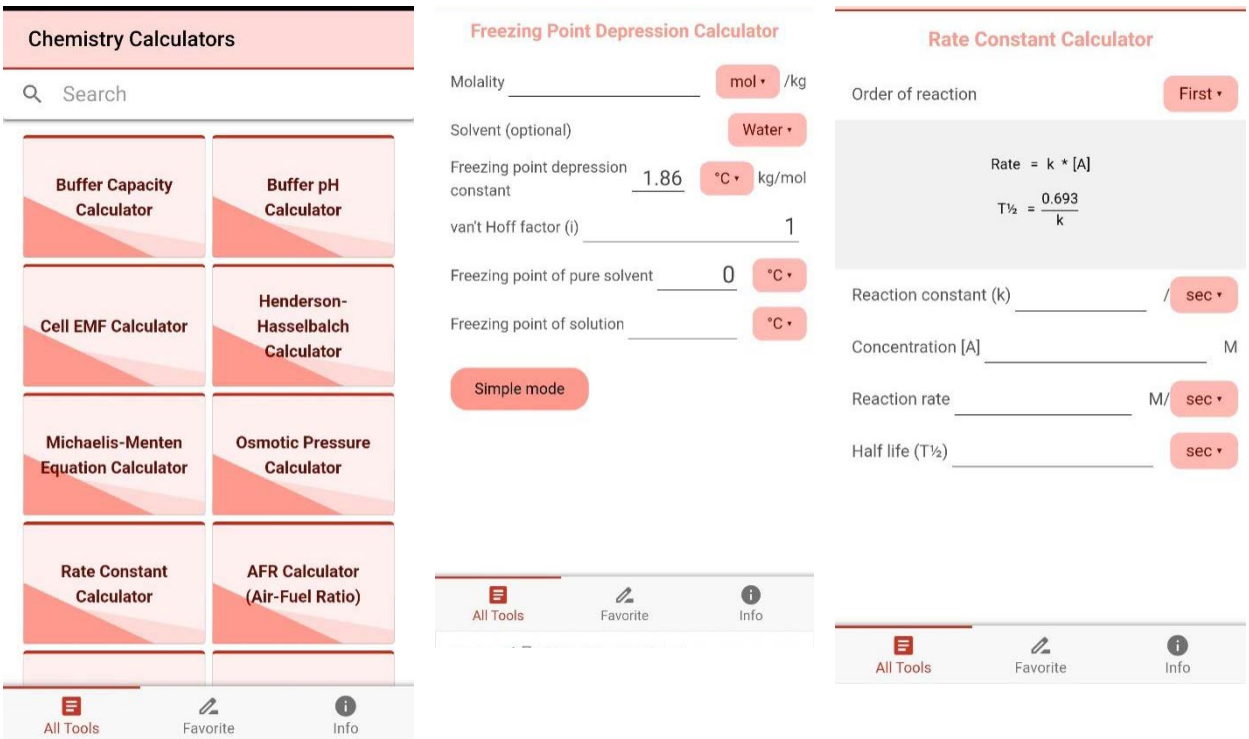


Figure 8. Images from the *Chemistry Calculator* application [16].

Chemistry Calculator. The given application contains an enormous number of tools intended for students and researchers [16]. Having a simplistic design, the application proposes calculations of 75 different parameters. We name only some of them: Buffer Capacity, Buffer pH, Cell EMF, Osmotic Pressure, Rate Constant, Arrhenius Equation, Entropy, Gibbs Free Energy, Surface Tension, etc.

The application essentially simplifies the calculations and is useful for students and researchers related to the discipline of physical chemistry, colloidal chemistry, electrochemistry.

The rating of application is 3.6 and it has been downloaded more than 10 thousand times. The low rating can be explained by the fact that the application was downloaded by random people.

Chemical nomenclature is an important field of chemistry that deals with the naming and classification of chemical substances. The nomenclature of chemical compounds follows certain rules established by international standardization organizations such as the International Union of Pure and Applied Chemistry (IUPAC). These rules establish standardized ways of naming organic and inorganic compounds, as well as other classes of chemicals. The application proposed below in a simplified form allows understanding the principles of naming chemical compounds.

IUPAC Nomenclature Chemistry. The application is very useful for studying organic chemistry and consists of the following sections: Iupac Nomenclature, Organic Reaction Notes, Iupac Practice. The Iupac Nomenclature department proposes, in order to study the way of naming organic compounds according to the IUPAC nomenclature, different variants of knowledge testing on the topic studied. Organic Reaction Notes proposes to describe the methods of obtaining, the chemical properties of organic compounds with the indication of the mechanism of interaction. Iupac Practice proposes a test of the acquired knowledge.

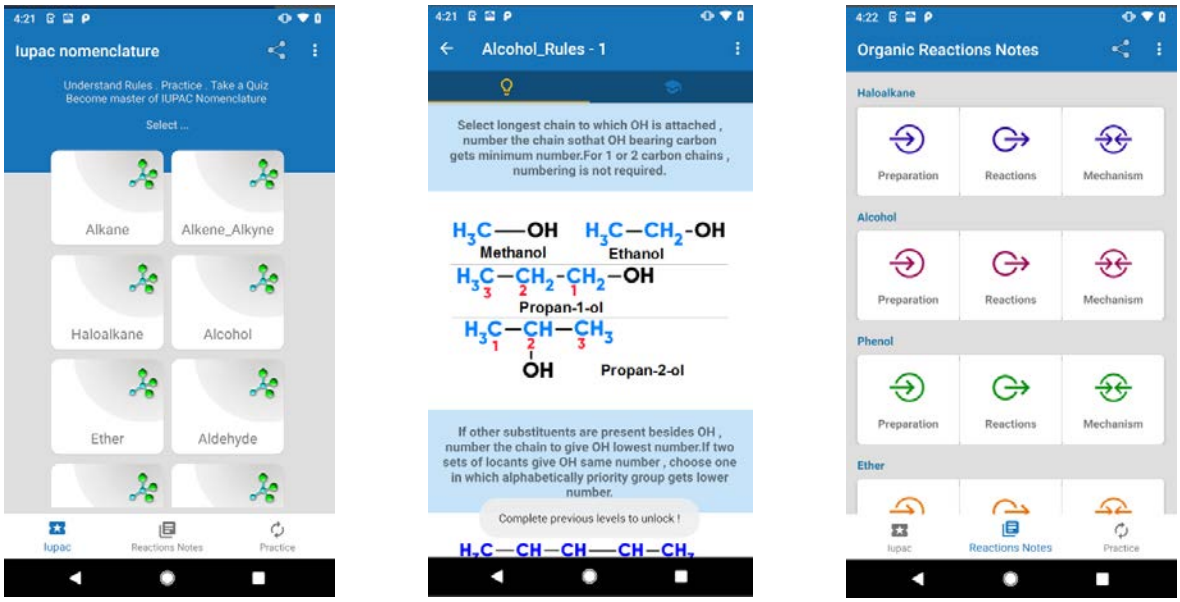


Figure 9. Images from the *IUPAC Nomenclature Chemistry* application [17].

The rating of application is 4.4 and it has been downloaded more than 100 thousand times.

The following three applications are useful in the field of simplified acquisition of theoretical material in different fields - inorganic, organic, instrumental chemistry, etc.

Organic Chemistry Formula Book. The application is useful for X-XII high school students and includes a vast theoretical material from inorganic and organic chemistry and includes the chapters: Periodic Table, mole concept, equivalent atomic and molecular weight, atomic structure, radioactivity, chemical bonding, solid state - unit cell, solid state - impurity and

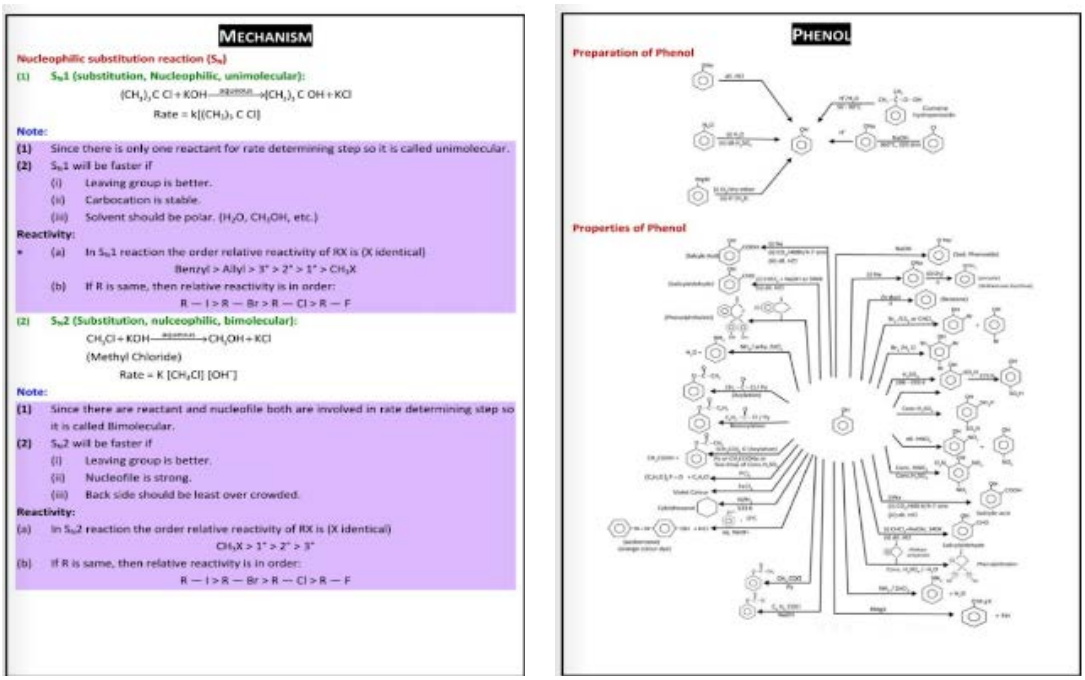


Figure 10. Images from the *Organic Chemistry Formula Book* application [18].

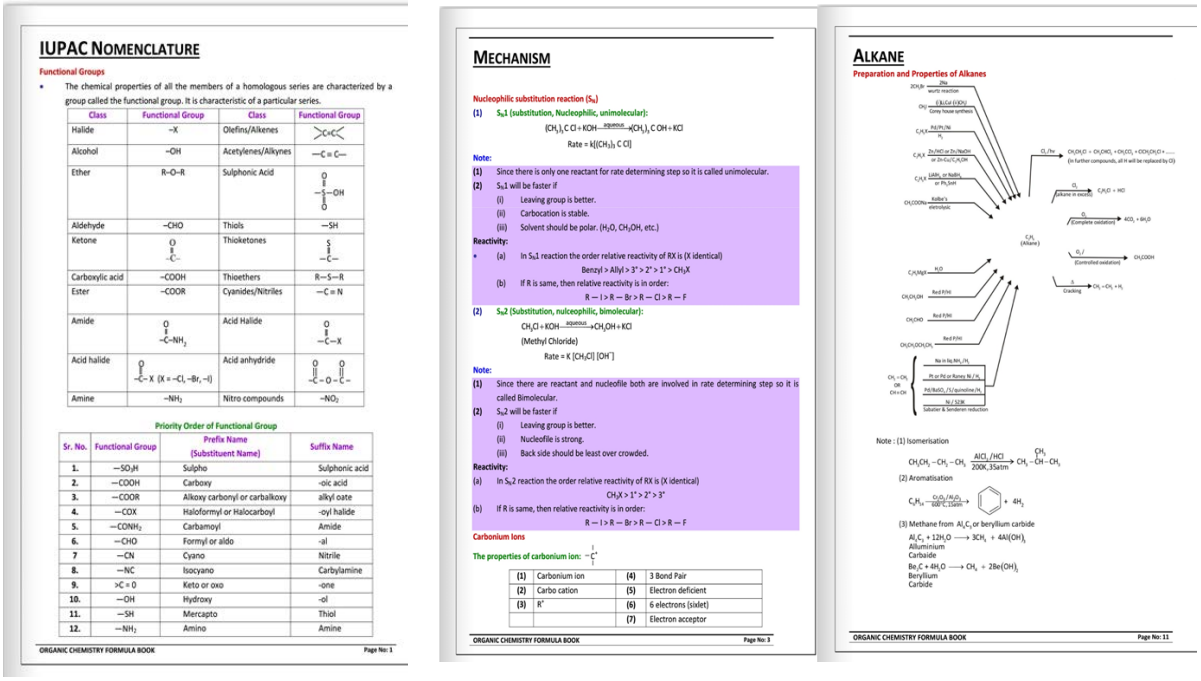


Figure 11. Images from the *Organic Chemistry Formula 2019* application [19].

vacancy, electrochemistry, gas laws, kinetic theory of gases, theory of dilute solution, chemical kinetics, titration, chemical equilibrium, ionic equilibrium and solubility product, thermochemistry, coordination compounds, Werner's theory, hydrogen, alkali metals, boron, carbon, nitrogen, phosphorus, oxygen, sulfur, halogen, hydrochloric acid, nobel gases, d-bock transition elements, f-block, important minerals, qualitative analysis, IUPAC nomenclature,

electronic effects and application, isomerism, alkane, alkene, alkyne, benzene, haloalkane or alkyl halide, haloarene or aryl halide, alcohol, ether, phenol, nitrobenzene, amine, aniline, aldehyde and ketone, carboxylic acid, general formula of organic compounds, IUPAC name of some organic compounds, etc. [18].

The rating of application is 4.0 and it has been downloaded more than 50 thousand times.

Organic Chemistry Formula 2019. The application is useful for recapitulating the matter of organic chemistry and offers information in the following sections: IUPAC nomenclature, mechanisms of chemical reactions, qualitative and quantitative analysis, chemical properties and methods of obtaining alkanes, alkenes, alkynes, alcohols, phenol ethers, aldehydes and ketones, acids carboxylic and their derivatives, nitro compounds, amines, benzene, polymers [19].

The rating of application is 4.2 and it has been downloaded more than 30 thousand times.

Electro Chemistry. The *Electro Chemistry* application is a manual application, in which the theoretical material related in more than 50 topics in the field of electrochemistry is presented in an accessible form. The information is presented in a clear and concise form [20].

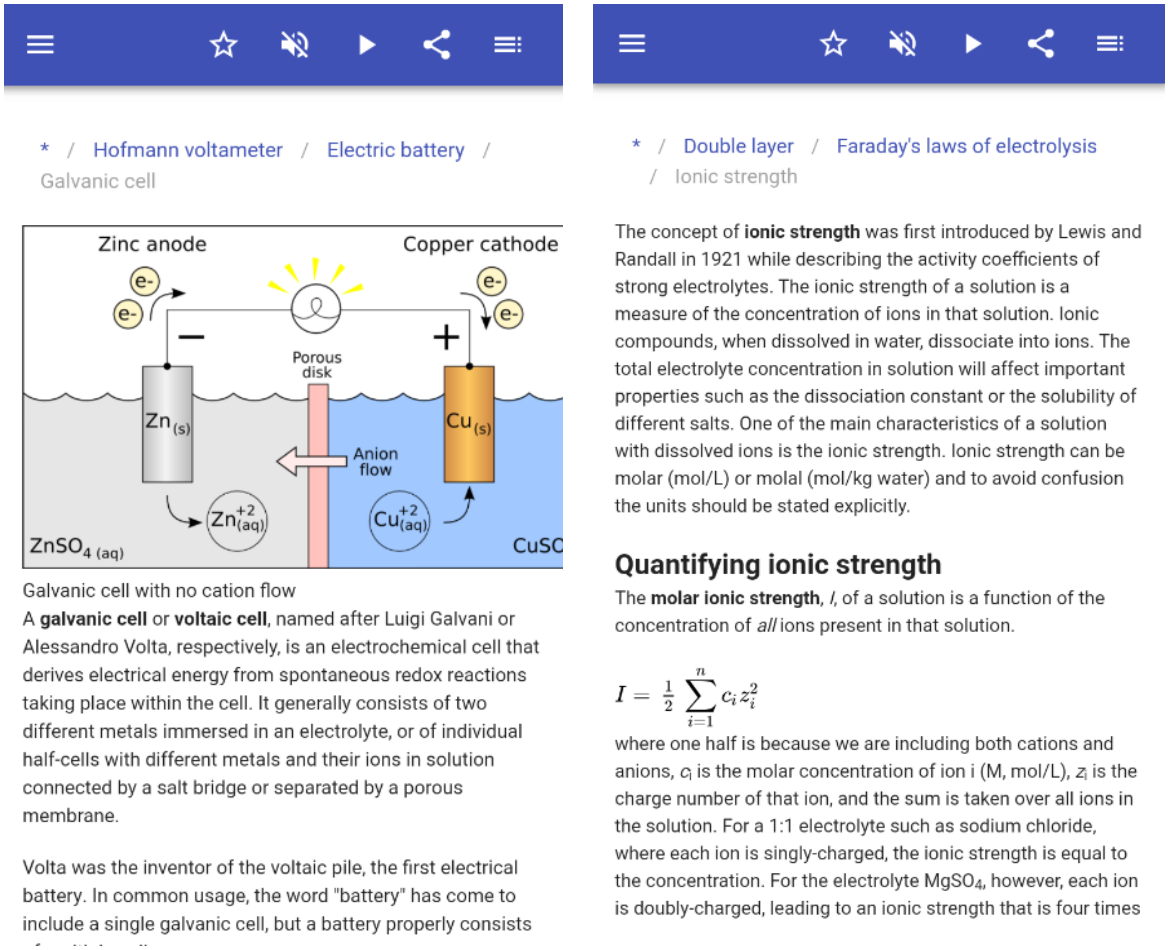


Figure 12. Images from the *Electrochemistry* application [20].

The application is useful for students studying electrochemistry. The rating of application is 4.5 and it has been downloaded more than 50 thousand times.

Analytical Chemistry. Application *Analytical Chemistry* is made up of 35 sections, which describe in detail the theoretical information in the most essential fields of analytical

chemistry – aqueous solutions and chemical equilibrium, the gravimetric method of analysis, acid-base titration, standard electrode potentials, molecular absorption spectrometry, gas chromatography, high-performance liquid chromatography, etc. [21].

The application is extremely useful to chemical students specializing in the field of analytical chemistry. The information presented allows the recapitulation of the theoretical and practical aspects of the studied field.

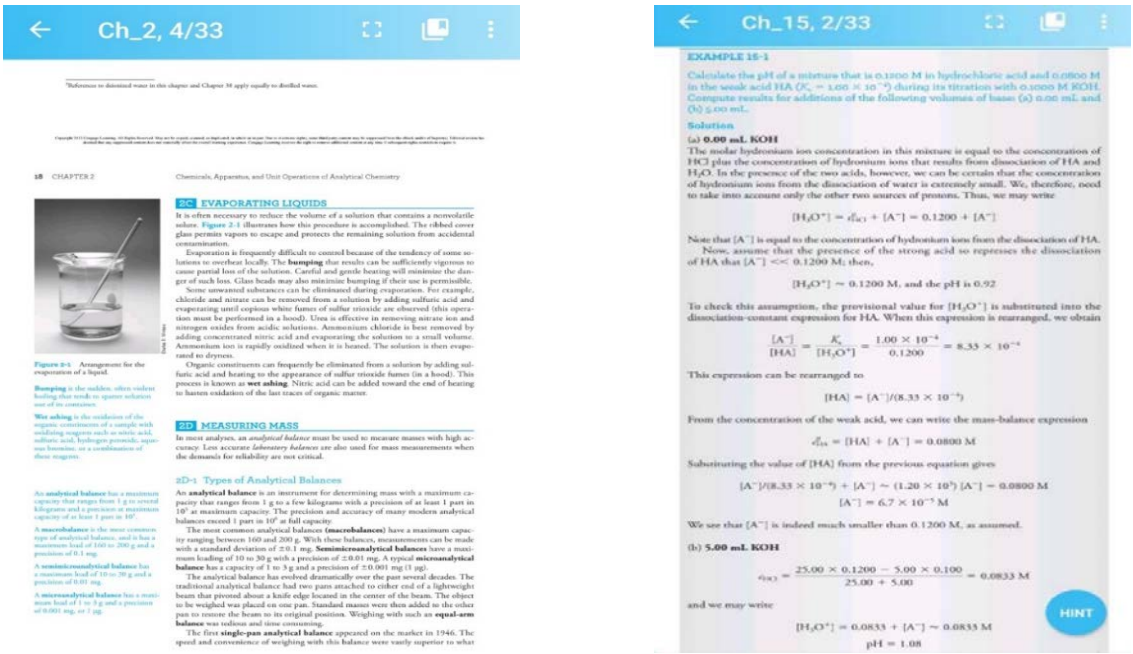


Figure 13. Images from the *Analytical Chemistry* application [21].

The application presents important theoretical support for students studying analytical chemistry and instrumental methods of analysis. The rating of application is 4.3 and it has been downloaded more than 20 thousand times.

3. Discussion

Mobile applications have become increasingly important in the process of studying chemistry due to their multiple benefits. Here are some reasons why using mobile apps is important in studying chemistry: accessibility - mobile apps enable access to information and learning resources anywhere and anytime, making it easier for students to supplement or strengthen their chemistry knowledge; interactivity - many mobile apps offer interactive lessons, games and simulations that help students reinforce their knowledge through hands-on activities; customization - mobile applications can be customized to suit the individual needs of students, providing them with a learning environment adapted to their own pace; time efficiency - by using mobile apps, students can save time and effort when searching for information or answers to their chemistry related questions; various resources - in addition to traditional lessons and materials, mobile applications offer a wide range of additional resources such as video tutorials, practice tests and topic guides. The application of mobile applications in the process of studying chemistry brings a diverse set of advantages that facilitate the acquisition of knowledge and their consolidation through innovative and interactive methods.

4. Conclusion

It is indisputable that the development of the Internet, information and communication technology has affected almost every aspect of teaching and learning. New technologies open up additional opportunities and motivate for training, giving teachers, students and pupils the opportunity to improve themselves. One of the possible additional means of training - mobile applications - can be recommended by teachers as an additional source of learning.

Conflicts of Interest: The authors declare no conflict of interest.

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AN APPRAISAL OF THE CAPACITY OF NATIONAL COUNTER TERRORISM STRATEGY TO PREVENT AND COMBAT TERRORISM IN NIGERIA

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Abstract. The standing policy adopted by Nigerian states to fight against terrorism is known as the National Counter Terrorism Strategy (NACTEST). This tactic has five pillars, namely: to forestall, to secure, to identify, to prepare, and to implement. Most of the literature engages on reasons for the emergency of terrorism, the effect of terrorism, or the strategy adopted by the terrorist to perpetrate their heinous activities. However, little attempt has been made to evaluate the efficacy of Nigeria's strategy against terrorism, especially NACTEST. Based on this backdrop, this paper is an attempt to examine the performance of Nigeria in identifying terrorist plans and its preparations to thwart them. These are two major and critical pillars of the NACTEST document (to identify and prepare). The paper adopts secondary methods of data gathering and content analysis for analyzing both primary and secondary data as a source of information gathering and content analysis methods for analyzing the generated data. The paper also adopted protracted social conflict theory to analyze the reasons for terrorism and the methods adopted by the Nigerian government to address those motivating factors. It was discovered that the Nigerian government has been able to prevent attacks by terrorists by identifying some sources of terrorist funding in Nigeria. However, it was discovered that, as far as the capacity of the government is concerned, security agencies still lack the necessary capacity to efficiently explore and detect terrorist attacks before they occur. The paper recommends more engagement of civilians and community stakeholders in fighting against terrorism in Nigeria.

Key words: *capacity, counter terrorism, prevention, terrorism, strategy.*

Rezumat. Politica permanentă adoptată de statele nigeriene pentru a lupta împotriva terorismului este cunoscută sub numele de Strategia Națională de Combatere a Terorismului (NACTEST). Această tactică are cinci piloni și anume: a preveni, a asigura, a identifica, a pregăti și a implementa. Cea mai mare parte a literaturii se angajează pe motivele urgenței terorismului, efectul terorismului sau strategia adoptată de terorist pentru a-și perpetua activitățile odioase. Cu toate acestea, au fost făcute puține încercări de a evalua eficacitatea strategiei Nigeriei împotriva terorismului, în special NACTEST. Această lucrare este o

încercare de a examina performanța Nigeriei în identificarea planurilor teroriste și a pregătirilor sale pentru a le contracara, doi piloni majori și critici ai documentului NACTEST (de identificare și pregătire). Sunt aplicate metode secundare de colectare a datelor și analiză de conținut pentru analizarea datelor primare și secundare ca sursă de colectare a informațiilor și metode de analiză a conținutului pentru analiza datelor generate. Lucrarea a adoptat, de asemenea, teoria conflictului social prelungit pentru a analiza motivele terorismului și metodele adoptate de guvernul nigerian pentru a aborda acești factori motivatori. S-a constatat, că guvernul nigerian a reușit să prevină atacurile teroriștilor prin identificarea unor surse de finanțare a terorismului în Nigeria. Cu toate acestea, agențiile de securitate încă nu dispun de capacitatea necesară de a detecta eficient atacurile teroriste înainte de a se produce. Lucrarea recomandă mai multă implicare a civililor și a părților interesate ale comunității în lupta împotriva terorismului în Nigeria.

Cuvinte cheie: *capacitate, combatere a terorismului, prevenire, terorism, strategie.*

1. Introduction

Terrorism has been a part of man's history dating back to antiquity for political and social reasons. This is because, long before the French Revolution, there had been philosophical and theological debates over the rightness or wrongness of killing political opponents. This discourse can be found in the works of Plato (429–347 BC) and Aristotle (384–322 BC), two ancient Greek philosophers. Both argued that tyranny is a perversion and thus addressed the issue and morality of tyrannicide (the killing of a despotic or evil ruler) in the republic and politics, respectively. Of equal importance to note is the fact that tyrannicide and other acts of political killing have also been glorified in the works of ancient poets and playwrights such as Harmodios and Aristogeiton. Cicero even noted in his De Officiis that tyrants normally come to a violent end. History actually shows that the Romans celebrated this. Thus, it is worth noting that the modern-day foremost promoter of terrorism was Juan de Mariana. Mariana was a Spanish Jesuit scholar who wrote a book, De Regis Institutions, but the book was later banned in France [1].

However, some scholars have argued that we should better identify the French Revolution and the Terror Reign of Jacobin (1792–1794) as the real dates for the beginning of the modern use of the word "terrorism." In this context, the term "terrorism" was associated with the abuse of office and power rather than overthrow attempts. According to the revolutionary leader, Robespierre, terror was seen as "nothing but justice, severe and inflexible," and hence, "it is therefore an emanation of virtue" and of vital necessity for forging a new society [2]. Since then, there has been no consensus on the actual meaning of the term "terrorism" because there are varying contexts for its common use. Right from the era of the French Revolution, the usage of the term "revolution" has been excessively enlarged to include ferocious rebels who revolted against the government; violent activities of social movements like nationalists, labor unions, or anarchists who demand the liberation of foreign occupation; and violent activism of left-wing groups. The term was also used to encompass all forms of war, including, but not limited to, guerrilla warfare and commando tactics. Moreso, on some occasions, political suppression has been categorized as part of terrorism. In recent years, religious manifestation and activism have been equally deemed and labeled terrorism [3]. Furthermore, depending on whose definition of terrorism one is considering - whether British, American, Israeli, or Arab - the definition of terrorism is sometimes related to and colored by ethno-character.

Terrorism today has its origins in the twentieth century as well. The September 11, 2001, attacks are another turning point in the development of terrorist acts around the world. There has never been a time when terrorism would emerge and there would not be equal counter-terrorism efforts. The recent act of terrorism elicited critical responses from both the affected states and the global community. Nigeria, as one of the affected states by terrorism, has devised strategic plans against terrorism, called NACTEST. The strategy consists of five pillars, namely, “to forestall, to secure, to identify, to prepare, and to implement." Out of these five pillars, this paper is interested in evaluating the two major pillars, which are to identify and to prepare. These two pillars are more about soft power than military engagement.

The third pillar (to identify) has some specific objectives. Studying these objectives would give us a better understanding of the extent to which Nigeria has achieved its goals of combating terrorism in Nigeria. These objectives are: the government's ability to effectively investigate, detect, and disrupt terrorist threats; a significant decrease in the frequency of terrorist attacks; identification of the terrorists' funding sources and activities; a significant reduction in the terrorists' ability to raise money; and the ability for neighborhood members, customary and religious groups, and groups from civil society to effectively work together. The fourth pillar’s (to prepare) objective is the ability of first responders, security agencies, and stakeholder organizations to respond to and effectively recover from numerous types of terrorist attacks. The last pillar’s (implementation) objective is to ensure that different components act collectively and cooperatively to address a complicated threat.

The paper adopts Protracted Social Conflict (PSC) as a theoretical framework. The PSC argues that any dislocation or disconnection between the state and any of the groups within the state is likely to promote tense conflicts. After this introduction, the next discourse is on methodology, followed by a theoretical framework. The subsequent segment of this paper deals with results and discussion of findings, while the last segment of the paper is on conclusion and recommendations.

2. Methodology

This paper adopts secondary methods of data gathering. The paper secures information from secondary data by consulting available books, journals, documentaries, newspapers, and internet sources on the subject matter. The secondary data generated was analyzed by adopting the content analysis method.

Theoretical framework

This paper adopts Protracted Social Conflict (PSC), which was propounded by Edward Azar [4]. PCS traces prolonged armed disputes between social groupings to desperate needs for basic things like security, social recognition, and acceptance. It also covers equitable involvement in the political and economic spheres. PSC theory studies the interactions between players inside a state, such as tribes, communities, and ethnic groups and rejects making a distinction between domestic and international politics. Therefore, a state's function in the internal interactions of its fellow statesmen is to either appease or irritate them and this in turn would determine whether conflict would be prevented or promoted [4].

Protracted Social conflict theory places emphasis on the intra-state relationships of major actors. Azar was reported to have developed four major variables to explain PSC [5]. The first variable is "communal content." This variable identifies the groups involved, which are racial, religious, ethnic, and cultural groups. Any disarticulation or disjunction between the state and any of these groups is likely to promote tense conflicts. For Azar, most of Africa's states are disarticulated, and this menace is linked to the colonial legacy [5]. The second

variable identified is the "deprivation of human needs." Azar argues that grievances are mostly the by-product of needs' deprivation, which is expressed collectively [5]. Any failure by the state to address and redress these grievances could lead to protracted social conflicts. The third variable, according to Azar, is "governance and the state role [5]." He argues that since the state is expected to protect the lives and properties of citizens in any state where there is protracted social conflict, this signifies the weakness, incompetence, and fragility of such a state. Such states could also be referred to as parochial and authoritarian states that fail to provide for and satisfy basic human needs [5]. Thus, protracted social conflict ensues when a state has limited political capacity due to rigid or fragile authority structures that prevent states from responding to the needs of various components within the state.

The fourth variable is "international linkages". Azar linked protracted social conflict to the international economic system, which makes some countries dependent on others. He believes that the state is influenced by events around the globe, whether regional or international. The pattern of connections within the international system has a significant impact on how domestic social and political institutions are formed, and this influence even influences how the state plays its role in society [5]. Drawing from Azar's work, Agara and Ajisebiyawo trace protracted social conflict to a group's past experience, fear, and belief; it could also be experience from other states since there is linkage in the international system. Also, actions by antagonistic groups are often considered threatening [4]. This reduces the room for tolerance and flexibility, while proposals for resolution are often misconstrued, giving rebels more chances to ventilate their anger [4].

The theory of protracted social conflict is considered appropriate for the study since it would provide us with an adequate understanding of why terrorism exists in Nigeria. Communal content and deprivation of human needs assumptions shall apprise us of why there are protracted conflicts in the north-eastern part of Nigeria and give reasons why Nigeria's Counter Terrorism Strategy (NACTEST) has not yet finally put an end to terrorism in Nigeria despite international support and the federal government and state governments' concerted efforts. It is quite noted that prolonged social conflict emphasizes issues of identity. Thus, it could be said that, for conflict to be controlled, there is a need to identify the needs and identities of the conflicting parties.

3. Results and Discussion

As explained above, the third pillar of NACTEST is called 'to identify'. This pillar consists of notable objectives. This study has evaluated each of these objectives as follows:

a. A significant decrease in the number of terrorist incidents

Based on reports from the residents of the affected areas in the North East and media reports, one can argue that there was a considerable reduction in the gravity of the attacks and even in their frequency [6]. More so, before NACTEST, Boko Haram was occupying some territories, especially Sambisa Forest. However, today, terrorists can no longer use the forest as their hideout. The frequency of terrorist attacks decreased drastically after the adoption of NACTEST. Therefore, we can infer that this objective was achieved to a greater extent based on the facts presented above.

b. A substantial decrease in the terrorists' capacity for gathering money, particularly the discovery of their funding sources and revenue-generating operations

Though the sources of funding for Boko Haram are unclear, as the United Nations Security Council rightly argued [7], However, from the literature, we discovered that the

Nigerian government has been able to identify some sources of terrorist funding in Nigeria. This includes ransom kidnappings, bank vandalism, fraud, dues for membership, outside money or supporters, microfinance, and illegal trafficking [8]. Other scholars also corroborate the above report [9]. They equally mention the sources of Boko Haram's finances, which include membership dues, loans to members, assistance from friends both domestically and abroad, and various black market activities including drug trafficking, people trafficking, weapons sales, burglaries with guns, abduction, and other sources that are undependable, such as tax collection in regions thought to be within their jurisdiction and the management of farms around Lake Chad.

Out of these seven sources mentioned by Jason, only five were sustainable after Boko Haram was tagged as a terrorist group [8]. For instance, microfinance was established during the time of Yusuf, the founder of Boko Haram, and survived for a while after his demise. Secondly, membership fees were also launched by Muhammadu Yusuf, but this scheme survived for a while after his demise. However, with little or no efforts from the Nigerian government, these were no longer the sources of funding for the terrorists because of the heavy attacks on the group in 2009 and the demise of the group leader. On microfinance, it is expected that the Nigerian government will be able to freeze terrorists' financial assets. However, this was not done during the period under study. Though there is the Financial Action Task Force (FATF), which is saddled with this responsibility, we also discovered that Nigeria has some other legal frameworks and the right institutions in place to seize any assets held by Boko Haram if they are located. Additionally, Nigeria has enacted a number of rules governing its financial sector and prohibiting the sponsorship of terrorist groups. Yet terrorists' accounts were not frozen [10]. Some scholars have brought up some possible reasons for this. First, out of concern for potential Boko Haram reprisals, Nigerian banks would be hesitant to submit suspicious transaction reports (STRs), which would enable them to locate potential Boko Haram cash. The fact that Boko Haram doesn't seem to rely on the official banking sector is the second and most significant element [8].

To curb terrorist funds that were being raised through kidnapping and armed robbery, the government adopted the "follow the money and arrest" policy. Using this strategy, most of the arrests were made before NACTEST. According to Jason, the Nigerian government was able to partially halt financing for Boko Haram by apprehending well-known sympathizers [8]. Sheik Muhiddeen Abdullahi, an Islamic charity director supported by Saudi Arabia and a Muslim businessman from Sudan, was detained at the beginning of 2004. He was apprehended after his transactions with a Boko Haram middleman totaled millions [11]. Mohammed Ashafa was also detained in 2006 for soliciting people to fly to Niger to undergo training from an Algerian Salifist organization and for accepting money from two Al-Qaeda agents in Pakistan [8]. The accusations made by the Nigerian government as well as the world community that Al-Qaeda was one of Boko Haram's financiers in Nigeria were validated by these arrests [8].

Additional actions included the detention of well-known arms dealer Mohammed Zakaria, who supplied information that resulted in the February 2011 assassination of Alhaji Salisu Damaturu, another supporter of Boko Haram. Mohammed Ali Ndume, a senator from Borno State, and Saidu Pindar, a former ambassador to Sao Tome and Principe, were exposed as Boko Haram's financial backers following the group's 2011 arrest of members. November 2011 saw the arrest of Ndume, who was accused of providing funding to Boko Haram. A Boko Haram spokesperson was detained in 2012 after claiming that governors of Kano State,

Ibrahim Shekaru, and Bauchi State, Isa Yuguda, were providing terrorists with a monthly payment [8]. Through these arrests, the government was able to curtail terrorist funding. The recent report of the National Inherent Risk Assessment (NIRA) in 2022 captures some other efforts that were not captured by the 2016 reports. The misuse of official financial sectors to fund terrorism has been uncovered by this study; these findings were not included in the 2016 NRA, and they may point to the increasing complexity of some terrorist groups' TF abilities. TF has been conducted using Bureau de Change (BDCs), Point of Sale Machines (POS), wire transfers, and Designated Financial Businesses and Professions (DNFBPs) [12].

Another policy put in place by the Nigerian government was the strategy of closing livestock markets to stop financing Boko Haram [13]. The selling of stolen livestock by Boko Haram as a method of financial support was discovered throughout northern Nigeria as a result of the organization's exploitation of financial intelligence by the Nigerian government. To stop this financing source, the Nigerian government responded by closing many livestock markets in northeastern Nigeria at the beginning of 2016. [13].

To deal with all other sources of terrorist funding, strengthening security in the affected area was equally identified as a remedy. It was discovered that some terrorists' sources of funding, like external money from admirers, extortion, hostage captures, the financial institution burglaries, and illegal trafficking were all triumphs because there was a security crisis in the affected areas [8]. This objective of NACTEST believes that external funding and illicit trafficking would be impossible for the terrorists if there was adequate security since they depend on man-to-man financial transactions rather than making use of existing financial institutions [8]. Thus, strengthening security was then used as a strategy to curb bank robbery and kidnapping for ransom. Closely related to the above strategy was the fact that terrorists were no longer allowed to occupy any territory. Since this was done, terrorists' ability to launch operations has decreased, while kidnappings and bank robberies have also decreased [14].

However, some scholars have equally identified some shortcomings in the actions of the government in decimating terrorist finances. For instance, on the issue of kidnapping for ransom, they believed that the government should discourage paying ransom as this would discourage terrorists from taking action [15]. They argued that this strategy has been tested by the USA and Britain. In Maghrib, terrorists prefer to kidnap citizens of other European countries rather than Britain and the USA. This is because other European countries always prefer to pay ransom rather than risk the lives of their loved ones [16]. Recently, the Nigerian government has criminalized paying ransom to kidnappers or terrorists, as was done in the USA and Britain [17]. Hence, this objective of NACTEST faced some challenges in curbing terrorist finance. These challenges include, but are not limited to, a lack of institutional and techno-scientific instruments, the problem of the political elite, who are beneficiaries of terrorism, and the challenges of uncoordinated CT strategies. Other challenges are the There is no political appetite on the part of the pertinent parties to deal with TF's challenges and its structural circumstances that rendered the Combating the Financing of Terrorism (CFT) policies ineffective [9]. Despite all these challenges, we can categorically say that there is a reduction in terrorist financing, going by the above discourse.

c. Establishing the necessary infrastructure to efficiently look into, identify, and neutralize terrorist threats

As far as capacity is concerned, security agencies still lack the requisite capacity to effectively investigate and detect terrorist attacks [18]. The FATF Report corroborates this

view that "law enforcement and regulatory agencies, security and intelligence services, and the judiciary lack the requisite capacity to effectively address the challenge of terrorism and terrorism financing" [19]." Ability to detect relies on capacity to investigate, and from reports so far, Nigerian security and even the MJTF lack capacity to independently investigate suspected attacks. The Stars and telegraph papers provide relevant information in this regard: there were two surveillance drones owned by the Nigerian government. But still, the ability of the Nigerian government to conduct efficient monitoring is lacking [20,21]. According to a former US military commander, the US taught the Nigerian air force to operate a surveillance drone, but they only purchased two, and we don't know if the other one is still in service [20,21].

Therefore, Nigeria becomes dependent on outside help for photographic intelligence. As a result, US satellites, mounted surveillance aircraft, and surveillance drones have monitored the activities of Boko Haram combatants, especially their practice facilities. Additionally, it was stated that Israel, China, and France agreed to exchange information and satellite photos, and the UK government is promising to deploy a surveillance plane [22]. At the time of writing this report, these promises have yet to be fulfilled, despite the fact that they were made in 2014. In assessing this objective, we could conclude that it has not yet been achieved. The implication of this is that it is most likely to constrain the performance of Nigerian forces in combating terrorism in Nigeria.

d. Government's effective leverage on the capacity of community representatives, traditional and religious institutions, and civil society organizations

The Nigerian government has tried to leverage the capacity of community representatives to combat terrorism in Nigeria. This could be deduced from the speech of the chairman of the Counter Terrorism Center, Rear Admiral Yaminu Musa, at the United Nations High Level Conference on Counter Terrorism, which was held in New York between June 28 and 29, 2018. He reported that "the policy framework adopts a "whole-of-government" and a "whole-of-society approach" [23]. He explained further that "it encourages the active participation of ministries, departments, and agencies of government, as well as critical stakeholders from different sectors of civil society, such as religious actors, youths, teachers, women, law enforcement, the media, and community-based organizations" [23].

We discovered that students and teachers were also carried along in this revolution to discourage them from becoming radicalized. Musa also gave an account of these concerted efforts being made by Nigeria in his report [23]. He laments that students were urged to plan conferences and seminars to talk about the reasons behind extremism and violence, come up with strategies for combating it both online and on campus, and establish connections with young people all over the world in networks dedicated to doing just that [23]. Still on youth, Nigeria has also enacted the "Not Too Young to Run Bill," with the intention of eliminating age constraints for youthful aspirants. It is the government's belief that youth involvement and upward trajectory will lessen the likelihood of being a target of extremist acts [23]. More so, the chairman reported efforts that have been made that have led to kick-starting a community-based preventive program with youths and community leaders. These efforts are also being facilitated with the support of the UNDP Office in Abuja.

In a special report of the United States Institute of Peace, as reported by [24], there are a series of programs that were organized by the government and NGOs to sensitize the general public on security. Based on these facts, we can say that the above objective is followed and achieved by the Nigerian government to a considerable extent.

4. Assessment of fourth pillar of NACTEST "to Prepare"

This pillar is more about the ability of the government, stakeholder organizations and security agencies to swiftly respond to terrorist attacks and to successfully recuperating from a range of terrorist incidents

In assessing this objective, we have discovered that the National Emergency Management Agency (NEMA) spearheaded the government's response to a crisis in terms of humanitarian assistance, intervention, planning, and recovery. It has also been at the forefront of humanitarian relief provision since the onset of the Boko Haram saga. NEMA has been in charge of overseeing the diverse IDP camps, distributing philanthropic aid in the form of things both edible and non-food, enrolling and supervising IDPs, and reacting quickly to crisis situations via ambulances and other paramedics [25,26]. NEMA and its state counterparts, State Emergency Management Agencies (SEMAs), have also collaborated with other humanitarian organizations to provide assistance to IDPs both in formally recognized camps and in host communities, where the majority of IDPs reside [25,27]. In addition to the role played by the Federal Government through NEMA, state governments, particularly in Borno, Adamawa, and Yobe States, have equally played critical roles in the care of IDPs. They provided lodging, food, non-food equipment, and pharmaceuticals, as well as leading advocacy for assistance in coping with the insurrection and its impacts on a domestic and international level. In reaction to this activism, various non-governmental organizations (NGOs) have made contributions to supplying much-needed humanitarian assistance to the insurrection's survivors in partnerships with Global Development Partners (GDP) and state governments [27].

Other international bodies that have collaborated with Local collaborators in Nigeria to assist the government in providing humanitarian relief are the United Nations' Humanitarian Country Team (HCT), Water, Sanitation, and Hygiene (WASH), Non-Food Items (NFI), Camp Coordination and Camp Management (CCCM), and The Buhari Plan (BP), which consists of Strategic Response Plans (SRPs), Humanitarian Response Plans (HRPs), Joint Humanitarian Action Plans (JHAPs), and the North East Development Commission (NEDC). As a result of these efforts, annual plans for relief efforts have been designed and deployed mostly in collaboration with local, state, and federal governments [25,27].

The Presidential Initiative for the North East (PINE) is another initiative formulated by Nigeria's government. The ex-president of Nigeria, Dr. Goodluck Jonatan, instructed his National Security Adviser (NSA), Sambo Dasuki, to take the helm of a significant project to create a Marshal Plan for the economic recovery of the Northeast when the Boko Haram insurgency ends in order to respond tactfully and strategically to the insurrection's national security concerns [28]. A short-term fiscal intervention policy was also included in the mandate, allowing the federal authorities to use economic tools to deal with the insurgency's fundamental problems. The Presidential Initiative for the North East (PINE) was launched in 2011 by the Office of the National Security Adviser (ONSA) for the purpose of investigating the reasons behind the insurgence and its impacts. Two additional studies were conducted in 2012 and 2013 for the same purpose. One of them was conducted by ONSA, while the other was done in collaboration with the European Union (EU) [29].

The research conducted by ONSA during that period was handled by ONSA's Economic Team in the North East. The aforementioned study served as the foundation for the development of the North East Economic Transformation Initiative (NEETI), which the Directorate of Economic Intelligence (DEI) oversaw [30]. Not too long after, the "Soft approach

to Counter Terrorism" was implemented in order to tackle the North East's underlying economic issues. The President unveiled the economic intervention agenda in 2014 as a consequence of this endeavor. [30]. The bottom-up approach of the initiative was disclosed. It was tasked with cultivating regional contributions through contributions from North East governors, the public and private sectors, and individual stakeholders. The action plan also sought to organize worldwide community involvement and contributions via global development partners of Nigeria as well as other global groups that are non-governmental [31]. Several federal government agencies, departments, and ministries' programs focusing on the Northeast economy eventually crystallized into PINE in 2014. These agencies include, but are not limited to, the Federal Initiative for the North East (FINE), the Federal Ministry of Finance (FMF), and the National Planning Commission (NPC), which launched the Special Planning Initiative for the North East (SPINE) [27,31].

Another state-level initiative addressing the North East's recovery is the North East Economic Summit Group (NEESG). The six Executive Governors of the North East Region met in Gombe, Gombe State, on the 3rd and 4th of December 2013 for the second North East economic conference [32]. The first meeting took place on the 6th and 7th of December 2012 in Bauchi, Bauchi State. ONSA's work influenced the President's decision to attend the said 2nd North East Summit Group, and it was at the summit that the PINE was announced [27]. Another significant outcome of the 2nd Summit was the determination of the region's representatives at the pinnacle of politics to draft a state-level development plan akin to the "Marshall Plan". In response to that, governors formed individual state development plan committees and charged them with swift action. This plan's development took place from January to August of 2014. A thorough discussion with important parties was conducted as part of the preparation. Officials from the federal and state governments, the organized private sector, Nigeria's international development partners, and youth and women's groups from the Northeast were among the stakeholders [27]. During this period, important and helpful contributions were given for the scheme's development. Additionally, the procedure allowed the committee to interact with the budget and planning officers, who had been allowed to depart the area to assist the committee. The strategy was named the "North East States Transformation Strategy" (NESTS) [31]. The NESTS was created to provide affected states with strategic information and representation before the federal government. From its inception, the NESTS Plan was thus incorporated into the Federal Government's regional planning effort [27,31].

The Victims' Support Fund (VSF) was likewise established during President Jonathan's tenure. The then-federal government investigated supplementary funding sources for the much-needed recovery efforts to encourage backing for the government's initiatives to provide assistance to the increasing number of insurgent casualties. As a result, the former President, Goodluck Jonathan, established the Victims Support Fund, led by General T.Y. Danjuma (Rtd.), on July 16, 2014 [33]. It was saddled with the following responsibilities: to pinpoint sources and methods of generating long-term financial support to assist victims of the Boko Haram insurrection; to devise effective fund-raising schemes; and to identify individuals, societies, infrastructure, and valuable property that have been impacted by terrorists [27].

From the report of PCNI [27], we discovered that the VSF sponsored the Nigeria Foundation for the Support of Terrorist Victims (NFSTV) as a voluntary action that serves as the committee's execution arm, with excellent committee members serving on its team [34].

On July 31, 2014, during the formal fundraising occasion, the committee received commitments of over 50 billion naira, of which over 20 billion have been returned thus far. As part of the Federal Governent's Strategic Response Plan, the Committee is cooperating closely with other collaborators; through its foundation, it has planned many relief efforts to aid those who have survived the onslaught by the insurgents [27].

In addition, on May 7, 2014, during the World Economic Forum Africa (WEFA) in Abuja, Nigeria, the Federal Government of Nigeria established "The Safe Schools Initiative (SSI)" as part of the immediate interventions in the Northeast. Together with a group of influential Nigerian entrepreneurs, the UN Special Representative for Education Worldwide was involved in this [27]. The SSI wants to keep numerous schools throughout the nation safe. from future attacks and kidnappings, beginning with schools in the Northeast. On July 9, 2014, past President Goodluck Jonathan inaugurated a steering committee for the initiative, and the North East Schools Students Transfer Programme was successfully launched [27,35].

Still on the recovery objective, Buhari's government also put in place its strategy for recovery and stabilization. It was also reported that the findings of the Recovery and Peace Building Assessment (RPBA) were incorporated into the Nigerian government's master plan for rebuilding the North East [36]. The Buhari Plan and the RPBA have been transformed into the North East Nigeria Recovery and Stabilization Program (RSP), which was expected to operationalize the RPBA's findings and translate them into an efficient and successful implementation for rehabilitation and peacebuilding across economic, social, and infrastructural facilities, including restoration, recovery, and reconstruction. The program also includes an institutional structure for recovery program execution, coordination, quality control, supervision, and appraisal, as well as a financing mobilization plan [35].

This research corroborates the general as7essment of scholars that the achievement of this objective was somehow low. For instance, Steven [31] argues that, so far, no government entity in Nigeria has managed the emergency effectively. He contends that the President's Initiative for the North East (PINE) and a related plan were not effective. The plan lacked prioritization, budget, sequencing, or even ownership for operationalization [36]. Likewise, the North East States Transformation Strategy (NESTS) achieved little or nothing because it was established at a time when President Jonathan and many of these northern governors were not from the same political parties. Apart from that, the PINE and NESTS plans were both desk studies without data or public consultation [37]. Though some early 2017 military gains and improved security in some parts of northeastern Nigeria have spurred a greater focus on conflict stabilization measures, Yet, the so-called Buhari Plan, which outlines its post-conflict recovery priorities in the northeast, which could range from emergency assistance to stabilization and early recovery, was ineffective.

This is because the recovery policy put in place by the Nigerian government was not all-encompassing. An evaluation of Nigeria's counterterrorism strategy and post-conflict rehabilitation plans revealed that these plans lacked consideration for the psychological wellness of kids impacted by terrorism in the country [38]. This lack of assistance is a result of the Nigerian government's insufficient readiness to combat terrorism and the absence of a legislative framework to address the emotional requirements of children who have experienced violence [38]. Because of corruption, children seldom have access to the little services provided, which are reactive rather than proactive [39]. If the mental health needs of those impacted by the trauma of terrorism are not met, peacebuilding efforts may backfire and fail to bring about a lasting peace. More so, traditional cultural systems do not support

the mental health needs of children. For instance, any child who is sexually harassed will have a psychological problem due to stigma [38].

According to Saskia [18], Nigeria's recovery and peacebuilding program is overstretched, under-resourced, and corruption-plagued. As the military struggled to consolidate its gains, civilians in many parts of the northeast faced threats from both insurgents and government officials. Another challenge was rampant corruption and ineffective coordination, which have hampered the government's response to the crisis. In other words, elites in various agencies and levels of government (federal, state, and local) illegally benefited from the continuation of the crisis [18]. Therefore, major recovery programs were only made possible by international donors. These recovery exercises were handled by the Lake Chad Basin Commission and the African Union Commission. They adopted a regional stabilization strategy that highlighted short-, medium-, and long-term programs for stabilization, resilience, and recovery needs [40]. These programs did not only aim at strengthening local conflict prevention and mitigation systems but also at restoring local governance and basic services. The programs were equally aimed at fostering social cohesion and ensuring the reintegration of former combatants [38].

With these reports and the analysis above, we can conclude that this objective was not achieved to a large extent. Therefore, the government needed to really work on this area.

5. Conclusion and Recommendation

According to a study, all hands should be on deck while combating terrorism in both wealthy and developing nations. The National Counter Terrorism Strategy (NACTEST) is the long-standing anti-terrorism policy that Nigerian governments have embraced. The five pillars of this method are to forestall, secure, identify, prepare, and implement. The majority of the literature discusses the causes of the terrorist situation, the effects of terrorism, or the tactics used by terrorists to carry out their horrific acts. Nonetheless, not much work has been done to assess the effectiveness of Nigeria's counterterrorism policy, particularly NACTEST. In light of this, this paper has assessed Nigeria's effectiveness in following the two essential and main pillars of NACTEST.

It has been discovered that Nigeria, to a large extent, has worked to prevent many attacks by terrorists, but there are still areas where government efforts have not yet yielded the expected results. It is observed that there was a significant decrease in the gravity of the attacks and even in their frequency during the period under review. We also discovered that the Nigerian government has been able to identify some sources of terrorist funding in Nigeria. Though the Nigerian government has tried to leverage the capacity of community representatives to combat terrorism in Nigeria, some scholars have rated the government's efforts low on decimating terrorist finances. Moreso, it was discovered that, as far as the capacity of the government is concerned, security agencies still lack the capacity needed to look into and identify terrorist attacks before they occur. Thus, there is a need for the government to do more, especially in the area of soft targets.

Similarly, on the fourth pillar, which is to prepare, the government has also tried to This pillar is more about the ability of the government, safety apparatus, and participant organizations to swiftly respond to terrorist attacks and to efficiently emerge from a range of terrorist incidents. We have discovered that the National Emergency Management Agency (NEMA) spearheaded the government's response to a crisis in terms of humanitarian assistance, intervention, planning, and recovery. However, NEMA works in collaboration with

other agencies, both government and private-based agencies. It is recommended that the government employ sophisticated technologies for tracking terrorists to forestall their attacks before executing them. This, no doubt, will reduce the number of casualties and increase people's confidence in both the military and government.

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THE PERSPECTIVES FOR THE DEVELOPMENT OF SCIENCE IN THE SOCIETY

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Abstract. The world has never been so open to scientific research and technological development as it is today, nor has human competence evolved so rapidly in directions not previously appreciated. The pace of discoveries is faster, although there are scientific fields in which goals are achieved more slowly and with considerable collective effort. However, we find that the successes achieved in the field of science have had an enormous impact on people's mentality and as a consequence have formed the belief that reflects science as a dominant factor in contemporary society. A philosophical reflection on the process of scientific development reveals that for a long time, the physical sciences have been dominant, and in recent years we are witnessing a fulminating development of biology (genetics), which has not only economic implications but also the ethical implications of a major importance. At the same time, the contemporary society of information and knowledge attests to obvious factors of a unique phenomenon called integrative science. It is projected at the integrative frontier of the astrophysics field that combines the processes of the universe constitution as a quantum system (processes that go beyond the theory of quantum mechanics, but also the theory of super lathes) and the processes of life, mind and consciousness. Integrative science proposes a new understanding of reality, even the one considered today purely structural. We hope that integrative science theories will reflect the reality that includes Consciousness as a fundamental factor of Existence.

Keywords: *quantum mechanics, biology, development, integrative science, consciousness.*

Rezumat. Lumea nu a fost niciodată atât de deschisă pentru cercetarea științifică și dezvoltarea tehnologică ca în prezent și nici competența umană nu a mai evoluat atât de rapid spre direcții care nu erau apreciate anterior. Ritmul descoperirilor este mai accelerat, deși, există domenii științifice în cadrul cărora obiectivele se realizează mai lent și cu eforturi colective considerabile. Cu toate acestea, constatăm că succesele obținute în domeniul științei au avut un impact enorm asupra mentalității oamenilor și ca consecință au format convingerea care reflectă știința ca factor dominant în societatea contemporană. O reflecție filosofică asupra procesului de dezvoltare a științei ne relevă faptul că timp îndelungat științele fizice au fost dominante, iar în ultimii ani asistăm la o dezvoltare fulminantă a biologiei (geneticii), care are nu numai implicații economice, dar și implicații etice de o

importanță majoră. Totodată, societatea contemporană a informației și cunoașterii atestă factori indicativi a unui fenomen inedit numit știința integrativă. Aceasta se proiectează la frontiera integratoare a domeniului astrofizic care îmbină procese de constituire a universului ca sistem cuantic (procese ce se plasează dincolo de teoria mecanicii cuantice, dar și de teoria superstrungurilor) și a proceselor vieții, minții și conștiinței. Știința integratoare propune o nouă înțelegere a realității, chiar și a aceleia considerată astăzi pur structurală. Sperăm că teoriile științei integrative vor reflecta asupra realității care include Conștiința ca factor fundamental al Existenței.

Cuvinte-cheie: *mecanică cuantică, biologie, dezvoltare, știință integrativă, conștiință.*

1. Introduction

The twentieth century embodies the essential elements like science and technology as integral parts of human activity. Their nature is determined by the social goals pursued, by the degree of organization of the society, and by the specifics of the promoted policy. The social climate, the complex issues in science and the requirements for the establishment of the digital society require that in the process of evolution, we focus on the development of creative activities, as well as on capitalizing on the results of this activity.

In the first decades of the 21st century, scientific research has proven to be a fundamental component of the knowledge-based economy and society. More than ever, science has become one of the fundamental driving forces behind economic and social progress, and it is a key factor in improving the quality of life. In the last decade, science accentuated its systemic character and raised the degree of the interdisciplinary approach, and assimilation of intrepid behaviour to research teams in research institutions and universities. In this context, the relations of research with education and production in the form of partnerships and collaboration projects have been intensified. This Research-Development and Innovation environment can be improved if measures are taken at the government level, which means intensifying and economically implementing intellectual property rights, as well as developing quality standards. In the 21st century, there is a belief that Western economies will thrive only through the effective commercialization of ideas, intellectual creations and innovations.

Achieving this goal involves placing scientific research at the centre of society's attention, creating among people the belief that society is the basis for solving all problems, including economic and social ones. Society's understanding of science as an essential factor of society involves not only the "popularization of science", but also the presentation of scientific achievements in an accessible form for those outside the community of scientists, their understanding of the concept, and the scientific model about our world.

The development of science has led to the expansion of the fields in which man enters through knowledge and dominates through his actions. Science is the foundation of culture, which aims to study the laws governing phenomena, based on which scientific predictions can be released. Science differs from the simple accumulation of facts in that its principles must be based on general principles and laws. For example, ”Science among the ancient Egyptians and Babylonians presented a collection of practical observations and recommendations, but this was not a science because it was not aimed at identifying the general laws”[1]. The dominance in the cultures of these societies of canonized styles of thinking and traditions oriented towards the reproduction of the existing forms and methods of activity, imposed serious limitations on the predictive possibilities of knowledge,

preventing the stereotypes of social experience already formed. The knowledge in oriental cultures was exposed in the form of prescriptions for practices and did not acquire the status of knowledge about the processes of nature, which occur according to objective laws.

2. The specifics of the development of science in antiquity and in the Renaissance

The transition to scientific knowledge imposed the need for a new type of civilization and culture. One such civilization, which created the premises for the first steps towards science, was the democracy of ancient Greece. ”The traditional culture took place in Greece and the social life embodied the spirit of competitiveness in which everyone competed with each other, manifesting activism and initiative” [2]. In the Greek state, the priority of an opinion was imposed by demonstration, which was later transferred to mathematical science. Mathematics occupied an important place in Greek culture, being the concern of many philosophers such as Thales, Anaximander, Pythagoras, Plato, and Aristotle. This science was "based on reasoning - a scientific activity over which the Greeks had a special predilection" [2., p. 53]. Mathematical reasoning reached its peak of development with Alexandrian Euclid (3rd century BC), who wrote 13 books known as the "Elements" in which all the mathematical knowledge accumulated in Greece in the last three centuries was summed up in one system. The oldest treatise on algebra "Arithmetic" was written by Diophanes (b. 210 BC), who is considered the "father of algebra." It is also known the Aristotle's "Physics" (390-321 BC), which argued that the movement is induced by the attempt of each object to reach its natural state of equilibrium. Archimedes of Syracuse (287-212 BC) established the mathematical laws of lever motion and the laws of hydrostatics. He was the author of numerous inventions: field irrigation machines, lever systems and pulleys for lifting weights and weight-throwing machines used in Syracuse’s war of defence.

All these can be appreciated as incipient theoretical models obtained by applying mathematical proof. However, until the formation of the natural sciences as a distinct field of knowledge remained a step: the fusion of mathematical description with empirical research. The ancient science was not able to accomplish this last step. The cause, as most researchers claim, was slavery - the cheap labour of slaves that did not create the necessary incentives for the development of technology and scientific knowledge [3, p. 29]. Another condition for the establishment of science is related to the specificity of the meaning of the basic category - "nature". In ancient Greece, the universal "nature" was expressed by the categories of "physis" and " outer space ". "Physis" meant the special qualitative specificity of each thing and each essence, involved in the work. Knowledge was aimed at revealing the qualitative essence of things that have meaning, purpose and function. The outer space was a perfect finality, and "its eternal motion presented itself as an eternal reproduction of harmony" [4, p. 71]. That is why the knowledge that implies empirical research, i.e. the placement of work in artificial, unnatural conditions was conceived by the Greeks as a violation of harmony.

Thus, the knowledge of outer space can be reached only through mental contemplation, appreciated as the main way of searching for the truth. The ancient Greeks opposed the knowledge of the nature of "physis" to the knowledge of "techne" (artificial). Mechanics in antiquity was not considered a knowledge of nature but was attributed to the artificial, created by human hands. If Archimedes’s experiences and mechanics are appreciated as knowledge of the laws of nature, then in the ancient world they were attributed to "techne", and the experience was not conceived as a way of knowing nature.

The natural sciences, which are based on the experimental method, appeared at the same time as technogenic civilization. The foundation of this culture was formed in the Renaissance when a new understanding of man and human activity was established [5]. During this period, the traditional Christian teaching regarding the divine creation acquired a new meaning. The man himself became a creator on a smaller scale compared to God, and the man's activity was oriented towards the recognition of its rational origins (laws) and the confirmation of the conscious harmony of nature in the human arts. It was during the Renaissance that the old meanings of the notions of “space” - as a qualitative system of places and “time” - were replaced by a succession of qualitatively distinct moments with qualitatively homogeneous “time” and “space”.

The fact that the new representations about space and time developed during the Renaissance in the most diverse fields is significant: in philosophy (N. Cuzanus and G. Bruno’s conception about the infinity of the Universe); in science (N. Copernic’s heliocentric system that erases the boundary between the earthly and the heavenly realm); in the representative art, where the conception of painting appeared in the dominant form of spatial organization, from the linear perspective of the homogeneous Euclidean space. All these created premises for the affirmation of the empirical method and the fusion of the theoretical (mathematical) description of nature with its experimental research. In many respects, the researchers of this period prepared the radical turning point in science, later made by G. Galilei and I. Newton, crowned with the creation of mechanics as the first scientific theory of nature.

3. The development of modern and contemporary science

G. Galilei was the first researcher who, against the peripatetics, dogmatically supported the supremacy of Aristotle's physics and against the Christian tradition, did not comment on the Bible, but with the help of a telescope he tracked the motion of celestial bodies and confirmed N. Copernic's "heliocentric" theory. Starting with G. Galilei, science lost its speculative character, influencing and subsequently determining technical and technological progress.

Fr. Bacon - the English philosopher is considered the first theorist of science who in his work "New Atlantis" claimed that "Science means power". In this way, he expressed his confidence in the limitless possibilities of science. In such conditions, when the scientific factor is considered decisive for all forms of human activity, I. Newton mathematically founded the explanation of the natural phenomena in his work "Mathematical Principles of the Philosophy of Nature". He used the analogies between mental experiences and the models of mechanical constructions to represent the forces of interaction between celestial bodies. Thus, the law of universal gravitation was obtained, by comparing J. Kepler's laws and the mathematical expressions gained through the mental experience on the mechanical analogue model, which characterized the motion of a ball under the influence of centrifugal force.

The theoretical sciences of nature, which were established in the Modern Age became an undoubted value of civilization. At the end of the eighteenth century and the beginning of the nineteenth century science increasingly participated in the formation of the conception of the world, claiming to achieve true knowledge about the world. It is in this historical period that the intensive process of the interaction of science and technology began, the permanent and systemic introduction of the results of science in production, thus revealing its pragmatic value.

In the eighteenth century, the Marquis de Condorcet (1743-1794) in his work "History of the Progress of the Human Spirit" argued that "the rationalist progress should infallibly lead mankind to happiness" [6, p. 48]. Later, the French physicist Andre Marie Ampere presented a classification of scientific disciplines, including cybernetics as a new science, which deals with “the study of the methods of command and management of society” [7, p. 68]. He considered that this science would contribute to the formation of a society in which the citizens would be carefree and enjoy themselves in peace. Later this brilliant prediction was confirmed by the evolution of cybernetics in the twentieth century, by its strong gnoseological and praxiological value.

In the current conditions, when we have an informational "explosion", man can no longer aspire to many sides, as it was during the Renaissance or even the Modern age. The age of personalities who "knew everything and something above" [8, p. 67] was in the past. The contemporary man can no longer comprehend even the knowledge accumulated over a century.

The development of science-based on previous achievements and the challenge of scientific knowledge of the nineteenth century took place in the twentieth century. The second law of thermodynamics, the increase of entropy and the idea that the fundamental laws of nature include the "arrow of time" were discovered by R. Clausius in the first half of the nineteenth century. Also, during this time, Ch. Darwin supported by convincing evidence the evolutionary conception of biological species, and J. C. Maxwell demonstrated mathematically (M. Faradey's idea) the propagation of the electromagnetic field in the form of waves. Later, in the second half of the nineteenth century, H. A. Lorentz formulated the law of the contraction of objects moving at a speed close to that of light, H. Becquerel discovered the natural radioactivity, and J. J. Thomson introduced the atomic model (plum pudding), followed by E. Rutherford's planetary atomic model and N. Bohr's quantum atomic model.

The twentieth century began with some scientific discoveries that have called into question a series of previously developed knowledge: the indivisibility of the atom, the reality of the ether, phlogiston, and caloric, but also the recognition of some new sciences such as genetics and cybernetics. At the same time, in this century, theories were established that produced profound changes and scientific debates.

The theory of special relativity developed by A. Einstein in 1905 states that the speed of light is constant, but the absolute time and space (independent of the reference system) in Newtonian theory are replaced by the global time and space depending on the reference system (the law of transformation of Lorentz). An even more striking thing in this theory is that the inert mass, which is an invariant in Newtonian dynamics, is completely converted into energy. In the second theory - general relativity published in 1915, A. Einstein argued that the inertial-gravitational structure is determined by the matter-energy content of space-time. This theory incorporated the legitimacy of mechanical, electromagnetic, and gravitational processes, leaving out atomic and nuclear processes, "outlining the problem of unitary laws of the field, which would explain both micro and macro physical processes" [9].

Quantum theory, in turn, caused another scientific "explosion". This theory formulated by M. Planck in 1900 argued that energy is transferred from a hot object to the environment only in finite quantities called quanta. Subsequently, through the efforts of researchers such as N. Bohr, W. Heisenberg, E. Schrodinger and P. Dirac, the quantum theory will become the foundation of the new mechanics, as comprehensive as Newtonian theory, in the sense that

it can be applied to the problems related to phenomena and processes of the microcosm. With M. Planck's quantum theory, contemporary science moved to a new stage of development, which requires a deeper way of research and a special understanding of reality [10].

At present, many researchers claim that quantum mechanics includes a large number of paradoxes. [11, p. 102]. In this context, quantum mechanics is difficult to understand because it refers to a microcosmic reality, space and time being on a very small scale. At the same time, our senses have evolved through natural selection and provide us with knowledge about the microcosmic world, and this has allowed the species to survive. The dominant laws of quantum mechanics are probabilistic, in the sense that they cannot accurately predict the behaviour of the particle, but it can be argued with a higher or lower probability that it is at a certain time in a certain place.

Today, scientists describe the universe using two fundamental theories - the theory of general relativity and quantum mechanics, which are the great achievements of the first half of the twentieth century. Unfortunately, “these two theories are incompatible” [3, p. 116]. Much of the efforts of physicists are geared towards developing a theory that includes both gravity and quantum theory. With the help of the four fundamental forces (electric, magnetic, strong, weak), physicists can describe the full range of known physical processes. Gravitational and electromagnetic forces are long-range forces because their effect is felt at great distances, while the weak and strong forces act at very short distances. These fundamental forces seem to act independently of each other, and physicists are trying to formulate a single theory that encompasses them all. The theories that would succeed in achieving this goal would be called unification theory. A. Einstein was convinced that the gravitational and electromagnetic forces could be unified. It is known that the scientist dedicated his last years to this unsuccessful research, which aimed to unify the theory of fields, the general theory of relativity with Maxwell's theory of electromagnetism. Some current models managed to unify strong interactions with weak and electromagnetic keys but failed to incorporate the gravitational force, and this limits the possibilities of explaining reality [5]. The twentieth-century science would be "incomplete" without specifying another feature, which relates to the technical approach of scientific discoveries, by reducing the period of their implementation in industry. The intense interaction between industry and science has generated an accelerated evolution in the field of basic scientific research and has imposed a rapid pace of technical progress. In this sense, we would mention those that had a decisive impact on existence: new motion systems (car, naval, aerial), space exploration, radio and television (today digital and three-dimensional television), modern means of global communication, calculation systems (from J. Napier, B. Pascal, G. Leibnitz, A. Turing and B. Gates). Information and communication technologies (ICT) have become an integral part of our economic, everyday, and social life. The development of computers and communications has led to the explosion of information on a global scale.

The discovery of vaccines and antibiotics has brought a higher degree of comfort and health. However, the consequences of the Chornobyl catastrophe, genetic manipulation and cloning have tarnished the image of science. This has contributed to the secrecy of research results related to the remote propagation of energy through radio waves; the possibility of capturing and retransmitting high-intensity energy by psychotronic means; the discovery of radiation in the living molecule and its representation as a miniature emission and reception station, whose emissions are beyond the five senses and appear to be outside the measurable electromagnetic spectrum. In this situation, M. Berthelot’s arguments that "science today

demands, simultaneously, the material, the intellectual and the moral direction of society" became even more relevant [12, p. 34].

The validity and importance of these ideas became important in terms of the impact of new technologies on society. Even if there was a long optimistic period, today it has been understood that the problems of science, thinking and psyche cannot be satisfactorily explained by the current science. The sceptical element about the value of scientific truth manifests itself in an increasingly visible form today, arguing that science has reached its limits. Under these conditions, several developed countries are making considerable efforts to further develop scientific research.

The problem related to the unitary character of science remains unresolved even at the beginning of the third millennium. The reflections of the philosophy of science on the evolution of science show that it went through a complex path from the paradigm that supported the primacy of matter to the primacy of energy and then to the one of information-knowledge, and most recently to the paradigm of digital technologies. For a long time in science, the emphasis was on the quantitative, measurable aspect. Subsequently, it turned out that the use of only structural information deduced directly from measurements, observations, and experiments is insufficient.

At present it has been understood that the great problems of contemporary science are tangent to the problems of consciousness: a) of physics, to explain the transition from deep existence to space, time and matter in the universe; b) of biology, to explain life; c) of information science, regarding the relationship between intelligent robots and consciousness, in general, between intelligence and consciousness; d) of cosmology, to clarify the dependence of the universe on a fundamental consciousness, but also on the nature of the last layer of reality.

These problems have had a structural (synergetic) approach, which involves the description through the mathematical models. However, for deeper knowledge, it is necessary to capture the phenomenological meaning, which at the contemporary stage was considered a fundamental process of nature, irreducible to physical, measurable phenomena, and this phenomenological meaning being a phenomenon outside the structural science. Structural science has already reached the frontier that requires its transformation into an integrative science, i.e. a science that combines the structural and the phenomenological into a whole.

The concept of integrative science was developed by M. Kafatos, who would have methods and a mathematical language appropriate to the structural-phenomenological processes of reality. According to Kafatos, the integrative science "will have an integrative mathematics, which through the theory of categories extended from the structural field to the phenomenological structural categories and the structural-phenomenological phenomenological functions could represent the theories of physical and informational reality" [13, p. 84]. J. G. Taylor, another British researcher, proposed a way to build a link between the phenomenal experience and the neurobiological structure of the brain. The study of mental processes and consciousness today leads to quantum phenomena and experimental phenomena [5]. The transition from structural science to integrative science represents the frontier of contemporary science, and the latter supports the thesis that "structural science is insufficient to explain all existence including life, mind and consciousness". Integrative science involves a mixture of physics and information science connected to other areas of reality. This is because life itself is an integrative process and the brain is a complex system, a device with integrative functions.

4. Perspectives on the development of science at the current stage

From the comparative analysis of predictions on the future of science, we highlight the following areas that will play an important role in the evolution of science and technology in the XXI century: science and information technology, genetic technology, materials technology, environmental science, and brain science.

Information science and technology is the fastest evolving field with the most obvious involvement in the social and economic field. Some factors allow us to conclude that today we are only at the beginning of the evolutionary process of this field. The development of information science and technology is determined by the intensification of communication due to the opening to the general public of the global network – the internet, based on personal computers that facilitate real-time connection between people and allow access to information of any kind. Replacing copper with fibre optics has led to the transformation of every phone into a video phone.

The effects of the development of science and information technology are spectacular, and in the conditions of the global pandemic with SARS-CoV-2, when a large volume of work is done from home, the use of these technological innovations has been accelerated. At the same time, the effects of the development of information science and technology have had a considerable impact on education. They have optimized and created conditions for the development of the educational and instructive process in the online form.

Another direction of development of science and information technology is related to artificial intelligence. Currently, two levels of Artificial Intelligence have been highlighted: a) the lower level (weak) - ensures the development of non-biological processes that involve the management of production processes, understanding and synthesis of natural language; b) the higher level (strong) - offers the possibility to have intelligent reactions similar to humans. The trends in developing artificial intelligence software that provides similar reactions to humans have achieved some success. This is because there is enough research and scanning of the human brain, and there are real-time observations of human neural networks. Mathematical models have been devised that simulate dozens of regions of the brain, including the cerebellum, in which the largest number of neurons are concentrated. However, there are differences between the human brain and the computer (robots) in the sense that the human brain is prone to make mistakes, it forgets and makes errors. The process of human thinking is non-algorithmic and operates mainly with images, while the computer (robot) is an algorithmic machine, and if the software is correct then it does not make mistakes and does not forget. The processes of thinking have the form of reasoning, which is subject to logical rules, while human emotions and feelings are not governed by logical rules and cannot be simulated by the computer (robot).

At the present stage, there is important research in the study of the process of thinking, but it cannot be stated that the mechanism of human thinking is fully known, moreover, it cannot be stated that the mechanism of thinking generating new knowledge is known. Research for collective intelligence and environmental management activities is intensified. These do not aim at "mastering nature", but the integration of man in the environment through interaction with the technical environment.

Genetic technology is another field of research that determines the specificity of the evolution of science and technology at the current stage. At the end of the twentieth century, the human genome was deciphered and the relationship between genes and their effects was elucidated, which facilitated the knowledge of the biological basis of man. The successful

effects of this research have made possible genetic changes for medical purposes related to the cure of hereditary diseases. Other directions of application of genetic research are related to plant changes, which aim to cultivate plants resistant to harmful factors and increase their production. Even if progress and beneficial effects have been made, not only ethical but also existential dangers persist in this field, determined by the possible human cloning, which will cause dangerous consequences for the entire human species.

Material technology is another direction of scientific research. For millennia, the materials have been active factors in the development of human civilizations. Research in the field of materials technology has opened up perspectives whose results are unpredictable. They can favour and help man to fit into the environment, as well as his exclusion from nature. At the present stage, the progress in this field is presented by the production of the so-called aerogels-elastic, reliable, hydrophobic materials, with a conductivity close to zero. Airgels are remarkably remarkable thermal insulators and are used in various fields as cosmonautics and as absorbers in ecological catastrophes. The nanoparticles, which allow the programming of material properties, are another success in the field of materials technologies. Due to the structure of nanoparticles when introduced into other materials, they change their characteristics: some metals can be transformed into semiconductors and optical materials. One direction in the nano field is the creation of nanostructural materials, which are used in the electronics industry. Materials technology also includes research in the direction of producing biological materials, obtained by imitating natural processes. This is how silks are obtained with a resistance comparable to the spider's web, cotton with exceptional elasticity and resistance.

Regarding the field of research and development of energy technology, it has a priority direction oriented towards the replacement of standard resources, which use the burning of fossil fuels, with alternative, recoverable energies, nuclear energy, photovoltaic energy, and wind energy. Regarding nuclear energy, there are currently two known ways of production: by fission and by cold nuclear fusion (non-polluting and inexhaustible source). The latest research has stated that energy will not be able to be produced by nuclear fusion in the next 50 years. The use of nuclear technology by fission is followed by a series of problems related to the insufficiency of the uranium source, the safety of the operation of nuclear power plants, and the storage of waste that remains radioactive for many years to come.

One solution to a problem in this direction would be the fast-neutron regenerative nuclear reactors. In this case, the problem of world peace arises, because when most countries have such regenerative nuclear reactors, they could at any time become sources of fuel for nuclear bombs. Wind technology does not present prospects for solving the energy problem on the globe, because there are not so many windy areas to cover the energy needs. An analogous situation also relates to the conversion of solar energy into electricity. There are currently no economically efficient technologies for providing the energy needed in the 21st century. Research on the conversion of solar energy claims that this direction can only be developed through nanotechnologies. This will allow people to provide cheaper, smarter, cleaner and easier materials, which ensure conversion. In this way, not only a cheaper energy source will be obtained, but it will also be possible to create an ecosystem.

The scientific studies and conclusions drawn in the field of ecology have led to the establishment of ecological movements, which have voiced the dangers that can cause the inappropriate exploitation of the natural environment: the spread of cancer and uncontrollable genetic mutations, the reduced immune capacity of the human body, the

greenhouse effects which lead to thinning of the ozone layer, the negative effects of the environment on brain function. The only solution to overcome the situation is to use resources without harming nature and future generations. This involves processes related to the use of green technologies with zero waste. Greater attention needs to be paid to recycling and remanufacturing processes.

Many scientists believe that the last frontier of science today is to explain how the brain, mind and consciousness act [14]. Recently, research has been conducted and knowledge about the brain has been accumulated, which has established connections between human performance not only with brain biochemistry but also with the genetic factors. It is claimed that 60% of mental functions are genetically determined. However, it is incomplete to understand how the brain works, because today it is not known what the decision-making mechanism is. It is difficult to identify the types of behaviour of neurons and establish their connection with decision-making or a certain cognitive activity is, for now, impossible. The complications are determined by the fact that the adoption of a decision is preceded by the analysis of several alternatives of neural correlations. At the present stage, the science of mind and consciousness has reached a common frontier with quantum physics. The mind and consciousness cannot be explained without the involvement of quantum physics, and the latter will not be able to move forward without considering the necessity of explaining what consciousness is. The phenomenological information and the active information generating the quantum world unite these sciences.

Research in the field of brain science will evaluate brain functions in the direction of monitoring [15]. The functions of the brain are both specific-individual and general-universal. This assumes that certain locations in the brain are involved that perform certain things that then integrate into complex functions such as memory and logical analysis. It will be sufficient to identify the location where a potential disaggregation could occur, and the source of that disaggregation, to correct it. Mental simulation technology has been developed based on brain imaging that highlights the correlation between active brain areas and the experimental finding that neural networks evolve throughout life. This allows the brain to reshape its activity and improve its cognitive capacity. It was found that the human brain has a remarkable intellectual plasticity, which is manifested by the ability to reshape the neural networks, to reprogram their activity. At present, the limits of action of mental simulation technology are not known.

It is argued that it will be possible to create the possibility of a complete remodelling of brain circuits so that an existing brain function can be improved or a lost brain function can be restored. In this way, it will be possible to treat several diseases related to neuronal degeneration, ageing, and memory loss.

5. Conclusions

The analysis of the evolution of scientific research will allow the highlighting of other potential achievements soon: the development of digital technologies, the production of new superconducting materials, the developments in biocybernetics and genetic engineering to combat interdisciplinary diseases such as psycho-neurological, cardiovascular and cancer. All these allow us to argue that after two millennia of science, the adventure of knowledge, in search of the truth, has a chance to continue. G. Galilei stated that "all truths are easy to understand as soon as they have been discovered, but the problem is to discover them". The only way to discover is through research. W. von Braun defined "research as what I do when

I don't know what I'm doing" Research is a search followed by a set of pertinent questions for which answers are to be formulated and the most creative quality of a researcher is the ability to ask appropriate questions.

Current advances in science and technology are happening too fast compared to our ability to understand. If a few centuries ago science had an insignificant influence, today, science and technology are present everywhere. Even if they are not well understood, their importance is recognized. Especially when they are so obvious, such as the media, computers, transportation, and medicine. Deciphering the human genome at the end of the twentieth century will undoubtedly have many economic, social and ethical consequences. This discovery will give impetus to the development of scientific multiple fields.

The use of scientific and technological discoveries allows the prediction of radical changes in human nature, redefining it not only psychologically, biophysically and biochemically, but also improving the human being by prolonging his life and quality. In this context, the question of the ethical aspect of science becomes extraordinarily important. If science is defined as pure and selfless research, which aims to obtain objective knowledge, then the final verdict is that science is good for humanity. Its value can be challenged only by the technical-scientific "applications", which raise major problems such as weapons, nuclear waste, genetic manipulation, and excessive automation. Some researchers argue that the path of science is undoubtedly an advantage for humanity. However, questions about evaluating the effects that science can have on the way we feel, think, or behave with our fellow human beings arise.

The problems we face could go beyond the economic logic of scientific efficiency. It is less important if we have faster cars or more sophisticated electronic utilities. It would be essential to know what kind of society and what way of life we tend to, to understand the specifics of global evolution in which science has a major role.

The dangers to which humanity is exposed start from the fact that day by day, a weak correlation between human creativity and moral precepts is sketched. The more correctly the future effects of science and technology will be understood, the more important will be the active role of man in their evolution. It will be necessary to place the results of their development in an ethical and social context. This could even involve redefining what is human and what is humanism. Man as a human being has not only instincts and intelligence but must also manifest a conscience, personal censorship, being able to understand and become aware of the consequences of certain actions, being responsible and controlling their instincts, and actions according to their moral actions.

The man can give all his actions a moral and constructive meaning for himself and his fellows. He was endowed with consciousness not to be destructive to the world around him, but to contribute to the improvement of the way of life. He should do good. Our belief is that man must establish a purpose in life by which to give a moral, constructive meaning to his actions. It is unfortunate that, in the current conditions, it seems that this sense has been somewhat lost. It is found that as science and technology develop, the immorality and the sleep of reason become more and more overwhelming. If reason and morality generate harmony, then the sunset of the light of reason gives rise to chaos. Therefore, we must be aware of our purpose, that is, to use our intelligence for our great, noble purposes, that is, to use morally the reason we possess, and for this, we should be aware of our lives.

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GOVERNMENT OF THE PEOPLE, BY THE PEOPLE, AND FOR THE PEOPLE: STAKEHOLDER'S ENGAGEMENT IN SERVICE DELIVERY PLANNING IN SOUTH AFRICA

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Abstract. This article examines stakeholder involvement in service delivery planning within local government, focusing on Polokwane Local Municipality. Local governments' proximity to stakeholders through integrated development planning (IDP) enables a comprehensive understanding of their needs. Municipalities are legally required to ensure active stakeholder participation, reflecting a governance model of "government of the people, by the people, and for the people." Drawing on Patsy Healey's (1997) collaborative planning theory, the article uses a mixed methodology, including probability sampling of 80 respondents for questionnaires and purposive sampling of 3 respondents for semi-structured interviews. Findings reveal a significant deficit in service delivery due to inadequate stakeholder engagement, despite satisfactory legislative compliance. Challenges include demonstrations, resource constraints, service backlogs, inadequate monitoring and evaluation, and corruption. Recommendations emphasize prioritizing stakeholder involvement and enhancing institutional capacity to optimize resources, address poverty, and improve service delivery.

Keywords: *Stakeholder Engagement, Service Delivery, Planning, Consultation, Collaborative Planning, Decentralisation.*

Rezumat. Articolul examinează implicarea părților interesate în planificarea furnizării de servicii în cadrul guvernului local, concentrându-se pe municipalitatea locală Polokwane. Apropierea autorităților locale de părțile interesate prin planificarea integrată a dezvoltării (IDP) permite o înțelegere cuprinzătoare a nevoilor acestora. Municipalitățile sunt obligate prin lege să asigure participarea activă a părților interesate, reflectând un model de „guvernare a oamenilor, de către oameni și pentru oameni”. Bazându-se pe teoria de planificare colaborativă a lui Patsy Healey (1997), articolul folosește o metodologie mixtă, incluzând eșantionarea probabilă a 80 de respondenți pentru chestionare și eșantionarea

intenționată a 3 respondenți pentru interviurile semi-structurate. Constatările relevă un deficit semnificativ în furnizarea de servicii din cauza implicării inadecvate a părților interesate, în ciuda respectării satisfăcătoare a legislației. Provocările includ demonstrații, constrângeri de resurse, întârzieri de servicii, monitorizare și evaluare inadecvate, precum și corupție. Recomandările subliniază necesitatea implicării părților interesate și creșterea capacității instituționale de a optimiza resursele, de a aborda sărăcia și de a îmbunătăți furnizarea de servicii.

Cuvinte cheie: *Implicarea părților interesate, Furnizare de servicii, Planificare, Consultare, Planificare colaborativă, Descentralizare.*

1. Introduction

The local government encounters a significant level of complexity and is confronted with multiple challenges that require attention and resolution [1]. Stakeholder engagement in service delivery planning is paramount to ensure the achievement of the required level of service delivery standards. Including stakeholders in service delivery planning has been identified as a crucial aspect of the integrated development planning (IDP) process. One could argue that stakeholders are inadequately afforded opportunities to engage in the IDP process. Ensuring the active engagement and participation of stakeholders in the formulation of plans and policies holds substantial importance for local governing bodies [2]. Based on the scholarly research conducted by [3], the scope of public engagement within the context of local government in South Africa is constrained by specific factors. The proposition is further supported by [4] which identified and explained the various constraints within the field. One of the main limitations pertains to the apprehensions raised regarding the management of internally displaced people (IDP), which can be attributed to the substantial scale of urban areas. The significant magnitude of this event leads to a state of fatigue and disengagement among the general population, commonly referred to as participation fatigue.

The topic of public involvement in municipalities is a significant challenge, particularly when it pertains to effectively engaging stakeholders in the decision-making process [4]. The existing arrangements of IDP representatives appear to demonstrate a lack of effectiveness in promoting substantial stakeholder engagement. Individuals who do not possess land ownership or secure jobs frequently face multifarious challenges.

Furthermore, as evidenced by [5], indigenous administrative entities in the South African context face significant challenges in their efforts to implement the IDP and effectively deliver vital services to their constituents. According to [6] there is evidence indicating a significant lack of effectiveness in the planning and implementation of IDP efforts in rural regions. Because of this deficiency, there is a noticeable scarcity of sustainable services in the areas. There have been documented occurrences of service delivery demonstrations in different areas of the country [5]. The ongoing demonstrations have been driven by the widespread dissatisfaction and increasing irritation felt by the local population. Recently, there has been a notable emergence of social dissatisfaction accompanied by corresponding political difficulties. In a scholarly inquiry carried out by [7], it was revealed that a majority of 51% of the respondents expressed the opinion that municipal administrations should improve their current protocols and systems regarding public participation. Implementing this approach would facilitate a more significant and efficient interaction with the general population [8].

Theoretical Framework- Collaborative Planning Theory

The article employed the conventional and persuasive framework of collaborative planning as proposed by Patsy Healey in her influential literature, Collaborative Planning: Shaping Places in Fragmented Societies (1997). Healey's original theory focused on the complex dynamics through which stakeholders in local communities exert their influence on the development of communal spaces and the definition of their shared interests. The influence is attained using communication, even if there may not be a common cultural background among the individuals involved [9,10]. Collaborative planning is a procedural framework that plays a crucial role in the formulation of public policies, making it an essential component of democratic governance in a particular jurisdiction [11]. Collaborative planning and practice play a crucial role in ensuring the necessary standard of service delivery [1].

The concept of collaborative planning in service delivery involves government entities actively engaging in harmonious cooperation with various stakeholders, utilising a range of strategies and approaches [12]. The distinction between the government's role and the participation of different societal entities in collaborative planning is often unclear [12,13]. Contrary to popular belief, it experiences a significant transformation and is constantly being challenged. In this scholarly study, the concept of collaborative planning is examined, highlighting its dualistic nature that includes both a societal facet and a governmental facet. Collaborative planning is a comprehensive and interactive approach that seeks to determine the best way to deliver services [14]. This theory exhibits alignment with specific aspects of South Africa's contemporary society.

The concept of collaborative planning has gained widespread acceptance among contemporary scholars and practitioners in the field of local governance. This consensus is supported by [15]. The concept of collaborative planning challenges the Lockean perspective that views individuals as isolated entities. Instead, it aligns with an Aristotelian understanding of humans as inherently social and political beings [14]. Collaborative planning is a planning theory that is widely praised for its suitability in community settings. It is known for prioritising the development of a fair and comprehensive institutional framework that promotes dialogue among various stakeholders, including both public and private entities [11]. Collaborative planning processes typically rely on representatives from established democratic institutions within a specific geographic area. These processes only involve individuals directly involved in the planning decision and do not occur outside of the established framework.

Given the current circumstances surrounding the diversity of lifestyles, the collaborative planning theory focuses on how local stakeholders can exert their influence over the spaces they share. The influence is observed in the communication process, where stakeholders express and define their shared interests and goals [10]. Collaborative planning is a new planning paradigm that is specifically designed to address the complex nature of modern society [16]. The approach effectively utilises consensus-building techniques to navigate and resolve conflicts among multiple stakeholders. To discover innovative ideas, achieve significant results, and develop the skills of the organisation, it encourages stakeholders to actively participate in a discussion that promotes fairness, empowerment, and the sharing of knowledge [16-18]. Policymakers could increase stakeholder engagement by promoting collaborative planning. The study is highly influenced by the theory of collaborative planning, which aligns well with the current legal frameworks of South Africa. The legal framework being discussed is the White Paper on Public Service Delivery

Transformation of 1997, which is based on the respected Batho Pele principles. The theoretical framework is based on the idea of actively engaging the stakeholders. The study suggests that local government authorities and municipalities should follow the collaborative planning theory, which emphasises the importance of involving stakeholders actively in the planning processes.

2. Materials and Methods

The article used convergent parallel research methods to examine stakeholder engagement and participation in service planning, focusing on Polokwane Local Municipality (PLM) as a case study. The article used a non-probability sampling technique to randomly select 80 respondents. Respondents were asked to complete a questionnaire with close-ended responses. In addition, the study also included 3 respondents who were selected through purposive sampling. These respondents were interviewed face-to-face using a semi-structured interview schedule. Prior to the collection of empirical data for this study, the researchers diligently sought and obtained an ethical clearance certificate [HS22/6/39] from the University of the Western Cape, specifically from the Humanities & Social Sciences Research Ethics Committee, on September 12th, 2022. The researcher (s) duly ascertained and ensured compliance with all requisite research ethics and integrity prerequisites. Furthermore, an informed consent was duly acquired from all individuals who participated in the study. The participants were furnished with a comprehensive elucidation of the purpose and goals of the study. The individuals involved in the study were additionally requested to peruse and affix their signature to the consent document, demonstrating their voluntary commitment to partake in the research endeavour. All the subjects participating in the study provided a completed informed consent prior to their involvement. This study used a combination of quantitative and qualitative data analysis methodologies. In this fashion, the empirical data acquired via open-ended questionnaires were subjected to analysis employing the software application Microsoft Excel. The data were subjected to analysis using descriptive statistical methods. Hence, the utilisation of bar graphs and pie charts was employed to effectively present and elucidate the findings. Conversely, the acquisition of qualitative data was facilitated by conducting face-to-face semi-structured interviews. These interviews were subsequently subjected to rigorous analysis using the thematic content analysis approach, with the aid of NVivo software for the transcription of interview recordings. The process of data collection and subsequent analysis was carried out until the point of saturation was achieved.

3. Results

3.1. Stakeholders Involved in Service Delivery Planning

- ***Ward Councillors***

Ward Councillors play a significant role as stakeholders within the municipality and society. Furthermore, councillors must effectively communicate with the municipality regarding the specific service delivery needs and obstacles that have an impact on the members of the community [19]. Ward councillors play a crucial role in the service delivery planning process by ensuring that their wards are included in the IDP [6,20]. Additionally, they are responsible for facilitating public involvement and consultation processes in the planning phase. Municipal councillors have several responsibilities [21,22]. These include acting as representatives of the community they serve, providing leadership in councils, acting as custodians and guardians of public finance, promoting a cooperative governance

ethos, providing effective oversight over the municipal executive and council officials, being accountable to local communities, reporting back to their constituencies on council matters, and being responsive to the communities they serve. The leadership role, duties, and responsibilities of councillors towards their communities in South Africa are defined and mandated by the municipal Code of Conduct for Councillors, among other legislative measures. The primary responsibility is to serve and represent all community members in the constituency, regardless of their political affiliation. It is important to avoid any situations that may give rise to a conflict of interest [23]. Ward councillors, in their role as elected representatives, are responsible for demonstrating leadership and ensuring accountability to their constituencies. The key responsibility of councillors is to establish and maintain accountability between the municipality and the individuals it serves [24].

- ***Ward Committee***

According to Article 6 of the South African Constitution (Act 108 of 1996), Ward Committees and their members have specific roles in local government. These roles include assessing and approving the budget and planning and developing the IDP. Ward committees need to collaborate with councillors and other community organisations to identify priority needs and ensure that these needs are included in the budget proposals and plans [25, p.45]. The establishment of ward committees by local municipalities in South Africa is in line with the provisions of the Constitution of the Republic of South Africa (1996). These committees serve as a mechanism to engage stakeholder communities in public affairs [26]. The ward committee serves to facilitate effective communication between the ward and the local council through the ward councillor [27]. Ward committees play a crucial role in ensuring that the electorate actively engages and has a say in the decision-making process of the council [25]. Individuals need to be integrated into the processes and structures that have an impact on their lives as ordinary citizens. Ward committees are widely seen as ineffective in promoting stakeholder participation in local government [25]. The lack of skills is a significant challenge faced by ward committees and municipalities across South Africa [26]. In certain instances, the ability of ward councillors to publicly justify the development decisions made by municipal councils was hindered due to their lack of understanding of the technical aspects involved. One criticism is that ward committee members often serve as mere extensions of political parties and may not adequately represent the diverse interests within communities [26,28]. The effectiveness of ward committees in facilitating communication between municipal councils and communities is hindered by inadequate municipal communication strategies and a lack of easily accessible information at the ward level [28]. Ward committees face various challenges, including financial and infrastructure limitations, limited understanding of local government laws and regulations, and interference from political entities [29]. The ward committee faces significant challenges that hinder its ability to hold the municipal council and councillors accountable.

- ***Municipal Council***

Council members have a significant role in the IDP process. Their role as mediators between the community and the council enables them to help find mutually acceptable resolutions to local government issues [30]. The IDP serves as more than just a decision-making mechanism [31]. It also considers the desires and preferences of its constituents. It is important for council members to actively participate in the process to ensure that the concerns and interests of their communities are adequately represented and considered. The

council has the responsibility to approve both the service delivery planning process and the IDP document [6]. Furthermore, it is recommended that the Municipal Council assumes control and assumes a prominent position in coordinating the comprehensive management of the service delivery planning process. Municipal councils in South African municipalities face challenges with unstable coalitions. The adoption of coalition governance in municipalities has resulted in instability and compromised service delivery [32]. This conclusion is supported by recent national trends and developments.

- ***Municipal Officials***

The process of IDP service delivery planning recognises municipal officials, including the accounting officer, as significant stakeholders [6]. The recognition is stipulated in the Municipal Finance Management Act (Act 56 of 2003). The responsibilities of the accounting officer, commonly known as the Municipal Manager, encompass the coordination and compilation of the Integrated Development Plan (IDP) document, as well as the supervision of its execution. The municipal manager must demonstrate complete objectivity and impartiality, like that of a judge [33]. They should refrain from aligning themselves with any specific political party within the municipal council. In the present situation, it appears highly challenging for municipal managers to remain apolitical due to the influence of political parties in making recommendations and influencing appointments within municipalities. When individuals choose not to prioritise loyalty to the administrative hierarchy in situations where unethical or illegal activity seems to be accepted, it becomes evident that this decision carries significant risks, leads to isolation, and incurs financial burdens [33]. Municipal officials in South Africa have a significant impact on advancing the development agenda of the national government and promoting the growth of democratic values within municipalities [34].

- ***Municipal Stakeholders***

The primary objective of the IDP process is to facilitate the discernment and elucidation of the requisites and inclinations of stakeholders and the community residing within a given municipality. This measure is undertaken to address and enhance the overall well-being of individuals impacted by said procedure [35]. The core focus of the IDP's needs identification approach lies in fostering community and stakeholder interaction and participation. According to the Constitution and the Municipal Systems Act, it is apparent that municipalities have a responsibility to promote the engagement and commitment of their stakeholders by implementing an effective participation mechanism [5]. Ensuring the participation of historically excluded groups is of utmost importance for the municipality to incorporate their specific needs and objectives into the planning and implementation of various projects and programmes [36]. The municipal stakeholder forums consist of various stakeholders, including Traditional Authorities, the Community, the Business Sector, Traditional Healers, Government Departments, the Education Sector, Non-Governmental Organisations, the Transport Sector, Financial Institutions, Farmers, Civic Organisations, and Religious Groups. The municipal stakeholders bear the task of ensuring social accountability within the municipality. Stakeholders possess a significant interest in the successful supply of services and development within the municipality. The stakeholders encompassed in this context comprise community members, municipalities, investors, suppliers, interest groups, non-governmental organisations, organisations, and traders [37].

- ***Provincial and national sector departments***

It is imperative that the efficacy of all governmental departments at both the national and provincial levels actively engage in the process of Integrated Development Planning (IDP). The IDP process necessitates a collaborative and synchronised endeavour including officials from many sectors, rather than being simply the duty of the municipality's planning department [30,31]. A significant obstacle encountered by municipalities everywhere pertains to the absence of integration between sectoral plans and programmes with the Integrated Development Plan (IDP) and respective departments. The absence of integration can be ascribed to multiple issues, with one of them being the incapacity to demonstrate the interconnections among different sector plans and departments [35]. The IDP should function as a comprehensive framework for provincial and national sector departments to effectively allocate resources at the local level. In the process of formulating their policies and strategies, municipalities must take into account the policies and programmes of sector departments [30]. Engaging in the Integrated Development Plan (IDP) process is crucial for sector departments to ensure effective coordination between their programmes and those of the municipalities, thereby serving their best interests. As to the White Paper on Local Government, the concept of development-oriented local government entails the active engagement of local authorities in partnership with local communities to ascertain sustainable solutions that address their requirements and enhance their overall well-being. The notion of development-oriented local government highlights the significance of public participation in the Integrated Development Plan (IDP) process, as it enhances the perceived legitimacy of development initiatives by fostering a sense of community ownership towards municipal programmes or projects [38].

- ***Traditional Leaders***

A traditional leader can be defined as a traditional monarch who possesses authority within the indigenous system of African governance [39]. There exists a variation in the interpretation of the word "traditional leadership" among researchers, with the consensus being that it refers to leadership structures prevalent in rural areas, characterised by the presence of hereditary leaders such as chiefs and monarchs [40]. The traditional leadership framework in South Africa is renowned for its proficiency and involvement in community Integrated Development Plan (IDP) processes, which hold significant potential for enhancing the welfare of the communities they cater to. This phenomenon is notably apparent in the realms of service provision and community advancement [35,41,42]. The inclusion of traditional leaders in the integrated development planning process enhances their significance as key stakeholders in service delivery planning. The inclusion of traditional leaders in the decision-making process regarding community services can potentially enhance service delivery. This is due to the involvement of certain traditional leaders in the governance and management of the local council, as mandated by the Municipal Structures Act 117 of 1998.

- ***Mass Media***

Mass media have emerged as a potent tool for ensuring the accountability of public officials with their behaviour while in office [43]. In the context of modern democratic systems, the government use mass media to engage citizens in the process of decision-making [44]. Hence, mass media can be regarded as a vehicle for ensuring public accountability. It is evident that in the current day, the media are increasingly being utilised

as a widely employed mechanism to ensure governmental authorities are held responsible on a global scale, particularly within the context of South Africa [45]. Furthermore, mass media have the potential to serve as both a catalyst for democracy and a tool for democratic governance. This is achieved through their ability to facilitate the monitoring and evaluation of good governance by promoting openness, accountability, and adherence to other fundamental principles [43]. The media, under their role, serve to bring to light instances of power abuse and eventually ensure that public authorities are held responsible for their conduct. The mass media serves the purpose of disseminating information regarding the actions and decisions of public authorities and governments, enabling the public to form their assessments and judgements [46]. New media contribute to the promotion of good governance within a democratic society. Even though mass media serve the purpose of promoting public accountability, they are not without obstacles. Furthermore, posits that profit-oriented media outlets occasionally engage in deceptive practices that mislead the general audience [44 p.49, 47, 48 p.28]. The media's function has evolved into a multifaceted, biased, and deceptive entity [49]. The behaviour exhibited by these individuals poses a threat to the burgeoning democracy and hinders the achievement of effective governance in South Africa.

3.2. Presentation of Quantitative Results

The primary aim of this research is to gain insight into the principal stakeholders engaged in the process of service delivery planning, with a specific focus on the Polokwane municipal area, utilising the Bloodriver village as a case study. It intends to investigate and comprehend the characteristics, functions, and extent of engagement of stakeholders in the service delivery planning process within the Polokwane municipal area. In the subsequent analysis, several questions or themes are examined.

3.2.1. Driver of the process of Stakeholder engagement in the service delivery planning

The participants in this section were asked, 'Who is driving the process of public participation in service delivery planning?' Thus, Figure 1 shows communities' knowledge and understanding of who is responsible for driving the process of public participation in service delivery planning.

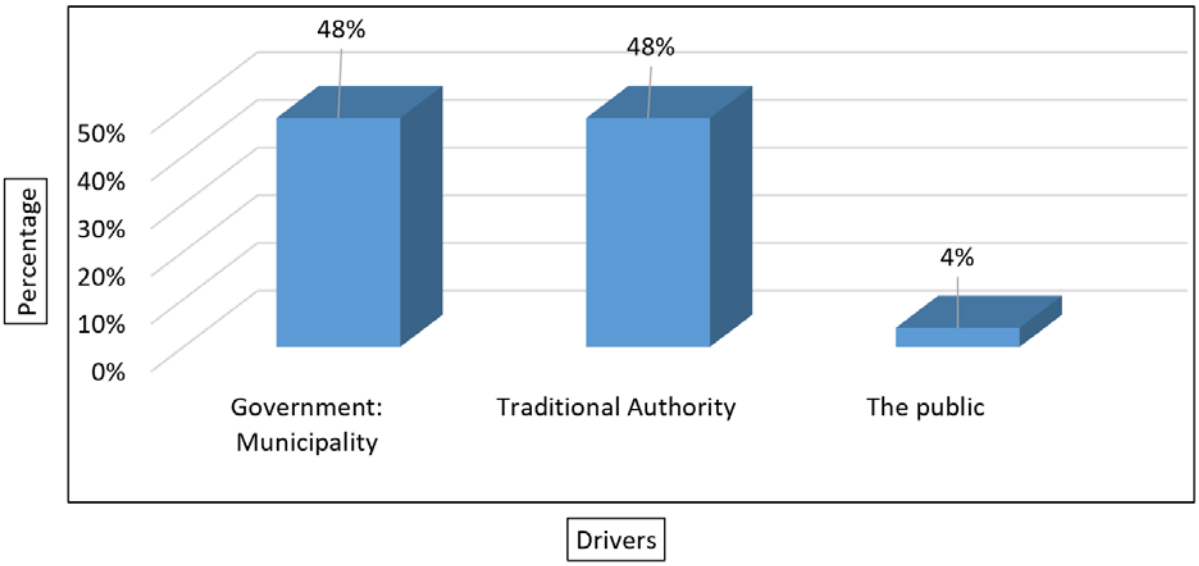

Figure 1. Driver of the process of stakeholder engagement in the service delivery planning.

Figure 1 above illustrates who was responsible for the public participation process in planning service delivery within the community. To this end, Figure 1 shows that most respondents, 48%, indicated that the government, i.e., the municipality, was responsible for facilitating public participation in service delivery planning. In addition, the following graph shows that another majority of respondents (48%) indicated that traditional authorities drive the process of public participation in service delivery planning, while the minority of respondents (4%) indicated that the public is responsible for ensuring public participation in service delivery planning. Therefore, community members do not know how to manage and direct public participation in service planning in their community. According to the study, participants were unable to accurately determine who they believed was responsible for planning services and instead relied on guesswork. The fact that a majority of 48% of the respondents felt that the traditional agency is responsible for service planning shows that there is still much work to be done in local government. The results from figure 1 show that the dispute between traditional authorities and local government officials has continued to intensify, as traditional leaders believe that they are leading the process of public participation in service delivery planning. The literature on service delivery argues that there is a conflict between traditional leaders and local councils. It can be argued that the struggle between traditional leaders and the local council undermines an agenda of where appropriate services should be delivered.

3.2.2. The effectiveness of public participation in service delivery planning

The participants in this section were asked if public participation was effective in service delivery planning. Thus, Figure 2 shows communities' knowledge and understanding of the effectiveness of public participation in service delivery planning.

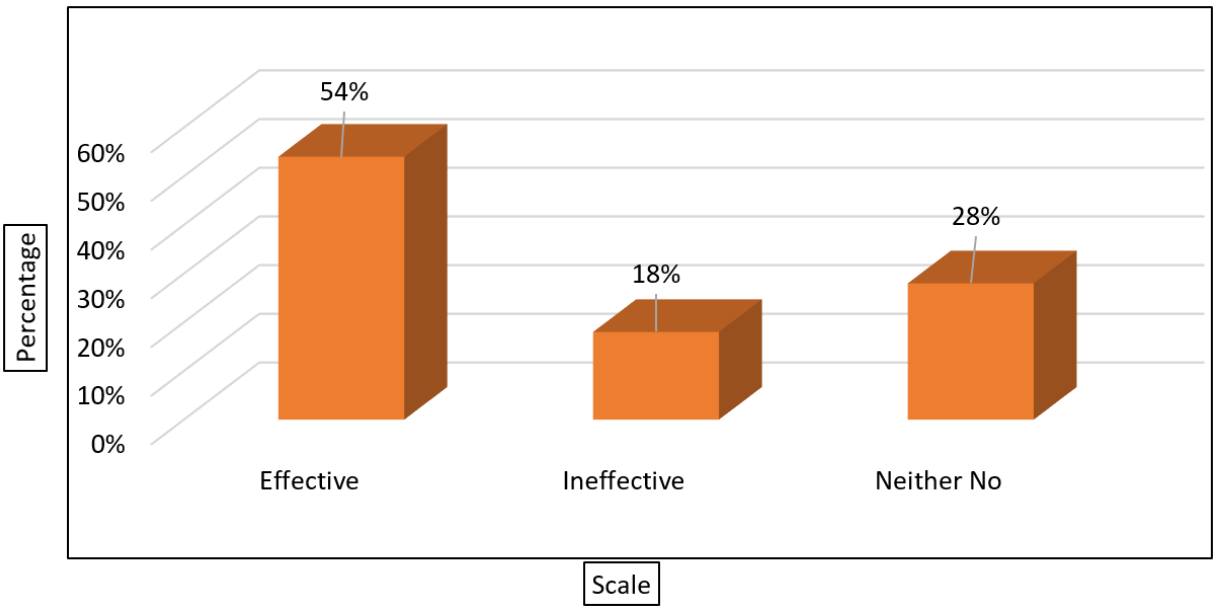

Figure 2. Effectiveness of public participation in service delivery planning.

Figure 2 above illustrates the efficacy of public participation in public service delivery planning. To this end, Figure 2 shows that most respondents, 54%, indicated that public participation is effective in planning service delivery. On the other hand, 28% of the respondents denied the effectiveness of public participation in service delivery, while the minority of 18% indicated that public participation is ineffective in service delivery planning.

The results in the figure below show that public participation is of utmost importance in a democratic country, as it gives people the opportunity to express their needs and concerns. Public participation strengthens and promotes people's engagement in matters that affect them. This enables the government to identify the services that citizens need. Service delivery is seen as an important factor in improving the quality of life and ensuring better access to socio-economic services. Citizen participation leads to a different way of knowing things. Things that were not known before, that were concealed or hidden, enter the public domain and become known to all stakeholders or relevant people for whom they were intended. As a result, the process of planning service delivery becomes easily feasible. Through citizen participation, resources are not wasted based on priorities set by the public.

3.2.3. The Status Quo of Public Participation in Service Delivery Planning

The participants in this section were asked what the status quo of public participation in service delivery planning was. Thus, Figure 3 shows communities' knowledge and understanding of the status quo of public participation in service delivery planning. Figure 3 shows that most respondents, 54%, said it was poor and 31% said it was very good. In contrast, 11% of the respondents indicated that the status quo of public participation in service delivery planning was very poor and only 1% indicated that it was very good, while 3% of respondents were not sure. Clearly, most respondents were not satisfied with public participation in service delivery planning. A limited number of participants expressed contentment with the level of public involvement in the planning of service delivery. It was emphasised that the local government should actively promote community engagement in service delivery planning, as this would enable them to effectively tackle the existing backlog in service provision within their society.

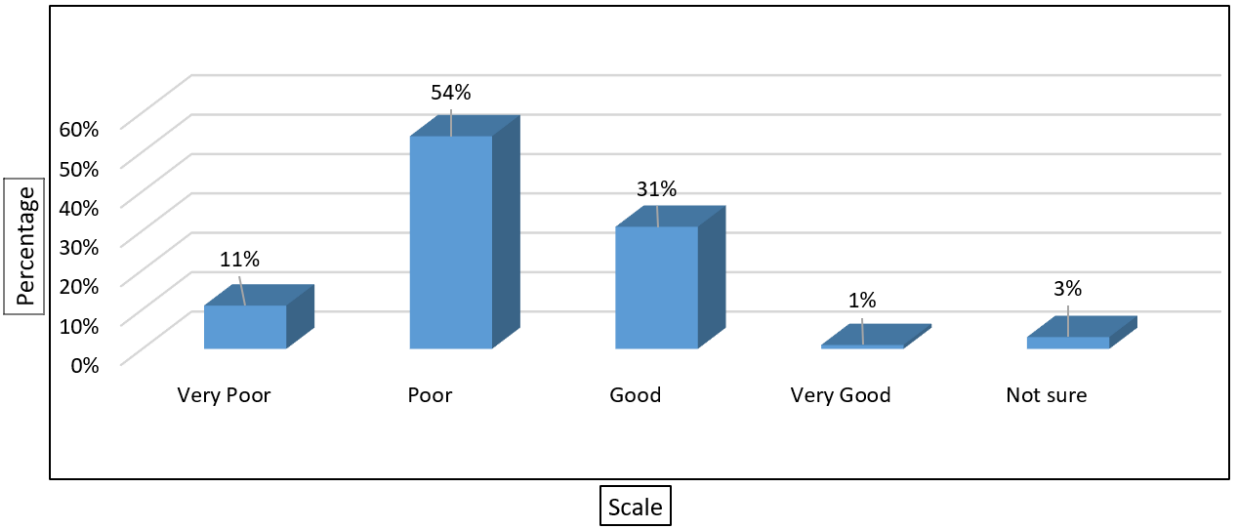

Figure 3. The Status Quo of public participation in service delivery planning.

Hence, the involvement of community members and other relevant stakeholders should not be overlooked, as it constitutes both a legal obligation and a fundamental democratic tenet that necessitates implementation.

3.2.4. Service delivery planning approach adopted by the municipality

The participants were asked what service delivery planning approach was being adopted by the municipality. Thus, Figure 4 shows communities' knowledge and understanding of the service delivery planning approach is being adopted by the municipality.

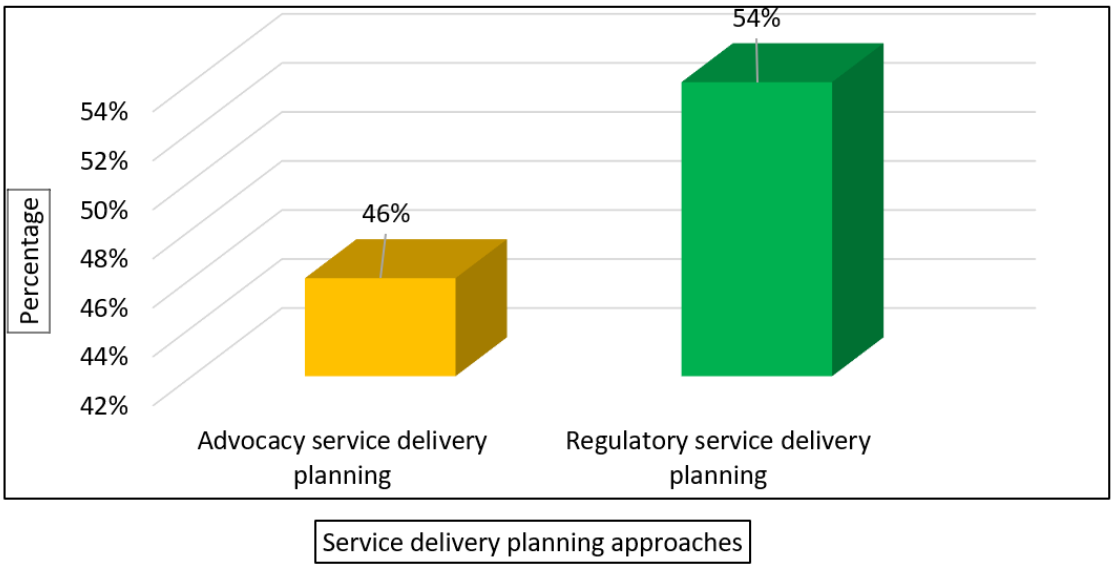

Figure 4. Service delivery planning approaches adopted by the municipality.

Figure 4 focuses on respondents' perceptions and understandings of the use of service delivery planning approaches that fall between advocacy planning and regulatory planning. Regulatory service delivery planning focuses on the optimal allocation of resources across all competing needs or uses within a society, while advocacy planning aims to mobilise and channel resources to new or neglected uses to achieve the legitimisation of new social goals or the comprehensive redirection of existing goals. To this end, Figure 4 shows that the respondents who believed that the community was in favour of service delivery planning comprised 46% whereas those who were in favour of service delivery planning through regulations represented 54%. From the results, it can be concluded that the regulatory planning of service delivery shifts the locus of decision-making from the public to technicians and thwarts the scope for policy deliberation to remedy past inequities. The PLM continues to struggle to uproot the top-down planning approach in municipal planning [50]. Thus, the municipality cannot foster a collaborative planning approach. The literature on planning argues that regulatory planning neither addresses public reason nor gives substance to democracy. It can also be inferred from the review of findings that service delivery planning by regulatory agencies does not return local government to the citizenry. It can thus be suggested that service delivery planning at the local level should be tempered with a dose of advocacy for improved service delivery and stakeholder consultation. In addition, the use of advocacy will help bridge the gap and reduce tensions between the public and service delivery planning. Decisions about what services are delivered should be practical at the core of the reasons for the existence of a citizen-centred local government. The inability to involve the various stakeholders in the planning and management of the city, despite the decentralisation of decision-making from the upper level of government, shows that decision-making has been centralised at the local government level.

3.3. Presentation of Qualitative Findings

The study's objective was also assessed using qualitative methods. The purpose of this study was to analyse the key stakeholders involved in the service delivery planning process through integrated development planning (IDP), to enhance service delivery in the Polokwane Municipal area. The purpose of this objective is to assess the level of awareness among key informants regarding the various stakeholders that should be engaged in the IDP process. To

test this objective, interviews were conducted with three key informants. The text effectively identified and appropriately presented common and distinctive themes. Thus, the analysis, presentation, and discussion of the qualitative information gathered from the key informants are included in this section. The outcomes are displayed below.

3.3.1. Fitting Public Participation in the Service Delivery Planning Process

The researchers asked the respondents how public participation fit in service delivery planning and the responses are shown below.

The key informant **A** indicated that:

"As we are aware that we are a local municipality and as such, we are guided by the Integrated Development Planning (IDP) document and is a legislated process which argues that for the IDP to be complete the municipality need to conduct a public participation process. Given that this IDP document is used to deliver services to the public it is of great concern that public participation process be conducted before service delivery planning is finalised through IDP. He further added that legislation allows the municipality to draft the IDP, but they must first take that draft to the public and inform the community on what the municipality is planning for them. The way public participation fits in service delivery planning is that it is legislated to say the municipality must consult the public". The key informant further indicated that "one of the mechanisms for involving communities in the municipal service delivery issues is the ward-based planning sessions that were held annually to try and foster genuine and active involvement of community member in the municipal affairs….in the ward-based planning that's where the municipality can consolidate the needs of the ward in the IDP."

The key informant **B** asserted that:

"Before the municipality can bring any services to the public, they must identify the stakeholders which are community members and then do a stakeholder consultation so that the intended beneficiaries are aware and give consent of service delivery planning and they will further communicate a comment resolution. Further indicated that the municipality cannot decide on developmental needs of the community without the community being first consulted and list their priority needs".

The key informant **C** indicated that:

"Public participation has a significant impact on how residents judge their local municipality." It has been proven that well-informed residents are more likely to be satisfied with municipal services and be supportive of its work. The informant further indicated that public participation in service delivery planning is facilitated by few legislations notably the Constitution of the Republic of South Africa, which section 152(1)(e) – obliges Municipalities to encourage the involvement of communities and community organisations in local government, and Section 195(3)- people's needs must be responded to, and the public must be encouraged to participate in policy-making. Section 4(2)(c) and (d) of Local Government Municipal Systems Act 32, of 2000 shows that the municipal has the duty to (c) encourage the involvement of the local municipality and (e) consult the community about the level quality, range and impact of municipal services provided by the municipality, either directly or through another service provider. "Section 5 of the local government municipal systems Act 32 of 2000 shows that the rights and duties of the community: are members of the community have a right to, through processes provide, contribute to the decision-making

processes and submit written or oral recommendations, representations and complaints to the Municipal Manager or structures".

Section 16(1) A municipality must inter alia, encourage and create conditions for the community to participate in the affairs of the municipality, including IDP, Performance management system, monitoring, and review of performance preparation of the budget, strategic decisions on municipal service delivery planning. Paragraph (b) municipality must contribute to the capacity building of the local community to participate in the affairs of the municipality and councillors and staff to foster community participation. Local Government Municipality Structures Act 117 of 1998; "A category B municipality with a ward participatory system, and executive committees or Executive Mayors must ...annually report on the involvement of communities and community organization in the affairs of the municipality. Section 72 states that the object of a ward committee is to enhance participatory democracy in local government and section 74 sets out functions and powers of ward committees". "A ward committee may make recommendations on any matter affecting its ward to the ward councilor through the ward councilor to the local municipality and further has such duties and powers as the local municipal may delegate to it".

The data above indicate that public participation in the service delivery planning fits as it is a legal obligation for communities to be involved and consulted. The data above further affirm that public participation within service delivery planning is not only conducted for legal compliance but because a municipality is for the people and with the people, better explained as "nothing for us without us". Literature also indicated that one way of promoting effective community participation is to embark on ward-based service delivery planning [30]. This process could culminate in the development of community-based service delivery planning.

3.3.2. Community as part of the Municipal Planning Committee

The researchers asked the respondents whether the community was part of the municipal planning committee and responses are shown below.

All key informants indicated that:

"Yes, the community is part of the municipal planning committee as they are one of the municipal stakeholders within the IDP, Budget and PMS Representative Forum. The community is part of the municipal planning committee as they first participate during consultation and planning for any projects that the municipality would need to implement. They are part of the municipal planning committee given they elected a councillor and a ward committee to represent them and normally ward consultations are undertaken in collaboration with the ward counsellor who's close to the community".

The data above indicate that PLM provides communities with opportunities to participate in municipal planning. Subsequently, the literature also indicated that one of the key activities towards the attainment of values is the engagement of the public in matters of local government to ensure the relevance and sustainability of development interventions [30]. This implies that public participation is not a once-off process, but rather a continuous process. Consultation should not only end during the identification and prioritisation of the need but also reporting back after every phase to the society is crucial and serves as a complete of communities being part of the municipal planning.

3.3.3. Community Member's Participation in the Municipal Planning

The researcher asked the interviewees how the community members get to participate in the municipal planning committee and responses are shown below.

All key informants asserted that:

"The community gets to participate in municipal planning through the IDP representative forum. In the IDP representative forum, the community is identified as one of the major stakeholders that must be involved in municipal planning. So, the IDP representative forum allows the community to participate in all five phases, which are Phase 1: Analysis, Phase 2: Strategies, Phase 3: Projects, Phase 4: Integration and lastly Phase 5: Approval. They participate in the integrated development planning process which is the core business of the municipal planning committee. The participation of communities in municipal planning is of doing needs prioritisation in terms of service delivery needs as it is the community who knows what constitutes development for themselves. Polokwane local municipality is 70% rural and 30% urban and given that the IDP is based on community needs and priorities. Communities must participate in identifying their most important needs. The IDP process encourages all stakeholders who reside and conduct business within a municipal area to participate in the preparation and implementation of the developmental plan."

The data above affirm that the community is part of municipal planning, although [51] argues that public participation in municipal planning remains a serious challenge despite that it is a legal requirement and not a privilege. The findings above also show that the municipality creates the conditions for the members of the society to have an interest in whatever the municipality is doing regarding service delivery planning. It is critically important for the municipality to involve the community members in the municipal planning processes to ensure that community members are allowed to be active participants in their own development initiatives [35]. The researchers are of the view that the municipality must promote section 14(4) of the Municipal Structures Act, which argues that local communities ought to be encouraged to participate in municipal affairs.

3.3.4. The Status of Public Participation in Polokwane Local Municipality

The researchers asked the key informants how they would describe the status of public participation in the PLM. The responses from the key informants are presented below.

All key informants indicated that:

"We are one of the best municipalities when it comes to conducting public participation process and our process is fair as it is supported by the fact that our IDP document has never been rejected ever since the inception of the integrated development planning process. Each year we ensure that public participation is followed, and communities are given a platform to raise their issues and concerns regarding the development that they want to see in their areas. Our credibility is further supported by the high rating we receive from the office of the National Treasury and Auditor General as when they assess our IDP document they confirm that our public participation article in the IDP document is conducted thoroughly and not only for the sake of compliance with regulation".

The above findings affirm that PLM creates a conducive environment for public participation and further ensures that no one is left behind. Literature also indicated that public participation in rural areas is still a serious challenge [51]. This finding shows that communities of the Polokwane municipal area are taking full control and charge of their development.

4. Discussion

The study accomplished its research purpose by assessing the extent of public participation in service delivery planning, examining the current state of public participation, and identifying the factors that motivate public engagement in service delivery planning. Most participants, approximately 54%, expressed the view that public participation plays a significant role in the effectiveness of service delivery planning. Based on the research findings, the involvement of stakeholders serves to enhance and foster individuals' active involvement in issues that have an impact on them. This facilitates the government's ability to discern the services that are required by the citizenry. The significance of service delivery is widely recognised in enhancing the overall quality of life and facilitating equitable access to socio-economic services. The involvement of stakeholders results in an alternative epistemological perspective. Previously undisclosed or secret information is disseminated to the public sphere, thus becoming accessible to all pertinent stakeholders or those for whom it was originally intended. Consequently, the process of strategising service delivery becomes readily achievable. The spatial proximity between municipalities and stakeholders signifies a mode of governance that embraces the fundamental idea of "Government of the people, by the people, and for the people." This implies that the delivery of services to the public is contingent upon the active involvement and decision-making of the public.

The principle of "Leaving No One Behind" in governance is crucial in the formulation and execution of service delivery planning via the IDP to achieve enhanced service delivery [35]. Therefore, the results of this survey reveal an unfavourable consequence, as they indicate that a majority of the participants (54%) voiced discontent with the current status of public involvement in the planning of service delivery. The discovery made in this study necessitates the adoption of collaborative planning theory and its associated principles by the municipality. Moreover, the participants were solely engaged in speculative conjecture regarding the identification of the individuals they believed to be accountable for orchestrating the provision of services. The data reveal that a significant majority of the respondents, comprising 48%, hold the belief that the responsibility for service planning lies with the conventional authority. This finding underscores the need for further efforts to be undertaken within the realm of local government. The study's findings have significant policy implications, suggesting that the potential for service delivery protests is heightened when stakeholders perceive dissatisfaction with their level of involvement in the planning process. Numerous municipalities have seen protests due to the disregard of constitutional obligations that advocate sustainable service delivery and meaningful engagement of stakeholders [35]. Ensuring stakeholder participation throughout the service delivery planning process is of paramount importance in establishing the credibility and resilience of the IDP [30]. The participation and involvement of stakeholders are of utmost importance in guaranteeing the fulfilment of precise service delivery requirements and preferences.

This study was limited to the specific areas governed by the regulations of the PLM. The study's findings have broader implications for other South African municipalities due to the prevalent issue of inadequate public participation across many municipalities. Numerous empirical and theoretical studies have been carried out in South Africa to examine the relationship between integrated development planning, service delivery planning, and public participation. Although the findings can be applied to other municipalities, it is crucial to recognise that each municipality encounters unique challenges in relation to the service delivery planning process. The applicability of the findings in this study to other

municipalities may be limited. One limitation observed in this study was the unfortunate passing of the Ward Councillor shortly before data collection. Additionally, the establishment of ward committees was not yet in place. Research funding was also a limiting factor, especially for travel to collect data.

5. Conclusions

The issue of promoting active stakeholder participation in service delivery planning remains a significant challenge in numerous municipalities across South Africa, including the PLM. The study acknowledges the existence of a gap between service delivery planning and public participation. Hence, it is imperative to conduct further research to bridge the existing disparity and enhance the knowledge of the public, civil society organisations, and local government professionals. Therefore, it would be beneficial for the PLM to prioritise stakeholders in their municipal planning efforts and actively engage them throughout the entirety of the service delivery planning process. The stages encompass the process of planning, implementing, and evaluating. Transparency and inclusivity should be prioritised in engaging stakeholders, with an emphasis on fostering interactive and deliberative participation. The municipality should also strive to augment its capacity for engaging stakeholders in the decision-making process. The engagement of stakeholders in matters pertaining to local government is a mandated legal requirement, and it is incumbent upon the municipality to establish a favourable atmosphere that facilitates well-informed decision-making processes that duly consider the interests and apprehensions of the broader public. The municipality ought to actively engage in a transparent and inclusive discourse with the wider society, while also extending invitations to pertinent stakeholders, to facilitate their participation in the process of prioritising demands. The implementation of development programmes should not proceed without the active involvement of stakeholders, as sustainable development can only be attained through stakeholder participation, which promotes a sense of ownership and self-sufficiency. The article additionally suggests that the PLM should proactively promote public engagement to resolve concerns pertaining to inadequate participation. This approach has the potential to effectively address service delivery protests and facilitate inclusive decision-making processes, including all relevant stakeholders. The selection of participants who accurately represent the target community is crucial, as is the inclusion of all relevant interests, including those that extend across national boundaries. The procedure needs to be characterised by impartiality and devoid of any political or financial influences. Early public engagement is essential in the policy-making process, with the inputs supplied by participants playing a significant role in shaping the subsequent decision-making process. The perception of the public towards the efficacy of their contributions and the provision of feedback on outcomes is of utmost importance. The principles of transparency and information dissemination are vital, and it is crucial to incorporate public engagement in all aspects of municipal activities, methods, and policies.

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UNPACKING THE PLACE OF ARCHAEOLOGY AND HERITAGE IN PANDEMIC STUDIES

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Abstract. Archaeology offers a 3.5 million-year-long scientific record of human and earlier hominine problem-solving and thus has the potential to research very deep into the past human solutions to pandemics and epidemics. Heritage on the other hand acts as a positive enabler for the complex, multi-vector challenges of today's world, such as cultural and environmental sustainability, economic inequalities, conflict resolution, social cohesion and the future of cities among others. In this way, the remote past has the capacity to educate the present world on how to cope with pandemic diseases and similar challenges in the contemporary era. Therefore, this essay seeks to open a discourse on the ways in which archaeology and heritage can contribute to the prevention and control of the present COVID-19 pandemic and similar others in the present and future. Therefore, the government and other agencies funding research pertaining to the discovery of the ways through which pandemics can be treated, controlled and prevented, need also to explore the option of archaeology and heritage studies, so as to trace the root causes of pandemic diseases. This will lead to the discovery of traditional means of treating, controlling and preventing pandemic outbreaks. This underscores the argument that almost everything that exists in the present day has some historical antecedence.

Keywords: *Archaeology, Heritage, Epidemics, Pandemics, Traditional remedy, Historical connection.*

Rezumat. Arheologia oferă o înregistrare științifică de 3,5 milioane de ani a rezolvării problemelor umane și anterioare ale hominilor și, prin urmare, are potențialul de a cerceta foarte profund soluțiile umane din trecut la pandemii și epidemii. Patrimoniul, pe de altă parte, acționează ca un factor pozitiv pentru provocările complexe, multi-vectorale ale lumii de astăzi, cum ar fi sustenabilitatea culturală și de mediu, inegalitățile economice, soluționarea conflictelor, coeziunea socială și viitorul orașelor, printre altele. În acest fel, trecutul îndepărtat are capacitatea de a educa lumea prezentă despre cum să facă față bolilor pandemice și provocărilor similare din epoca contemporană. Această lucrare încearcă să deschidă un discurs asupra modalităților în care arheologia și patrimoniul pot contribui la prevenirea și controlul actualei pandemii de COVID-19 și a altora similare în prezent și viitor. Prin urmare, guvernul și alte agenții care finanțează cercetările legate de descoperirea

modalităților prin care pandemiile pot fi tratate, controlate și prevenite, trebuie să exploreze, de asemenea, opțiunea studiilor de arheologie și patrimoniu pentru a urmări cauzele fundamentale ale bolilor pandemice. Acest lucru va conduce la descoperirea mijloacelor tradiționale de tratare, control și prevenire a focarelor pandemice. Studiul subliniază argumentul, că aproape tot ceea ce există în zilele noastre are antecedente istorice.

Cuvinte cheie: *arheologie, patrimoniu, epidemii, pandemii, remediu tradițional, legătură istorică.*

1. Introduction

Throughout the course of history, the intermittent outbreaks of pandemic diseases have had a profound impact on human societies, influencing their demographic structures, economic indicators, political landscapes, and social standings. One of the most noteworthy instances of such a transformative impact is the emergence of the Coronavirus (COVID-19) in late 2019. This virus, which originated in Wuhan, a relatively small city in Hebei Province, China, swiftly threw the global community into an unprecedented state of disarray. The COVID-19 pandemic is considered one of the most devastating in recorded history [1]. Recent updates from the World Health Organization (WHO) indicate that as of 4:22 pm CET on March 14, 2022, there were 456,797,217 confirmed cases globally, resulting in 6,043,094 deaths. The widespread effects of this pandemic have been felt in virtually all aspects of life, from public health and healthcare systems to global trade and international relations.

The aforementioned example serves as evidence that the occurrence of a pandemic leads to substantial shifts in the demographic landscape, economic metrics, and political and social dynamics of societies. Furthermore, the processes employed by humans to achieve various forms of civilization and cultural progress are significantly influenced during a pandemic outbreak. These effects can persist for an extended period, often spanning as long as a century.

In his publication titled "A Brief History of Pandemics (Pandemics Throughout History)," Huremović [2] underscores the profound and far-reaching impact that infectious disease outbreaks have exerted on societies and cultures throughout the course of human history. Despite the immense significance of these events, there has been a surprising lack of attention to them in behavioural social science and related medical fields such as psychiatry. This neglect is particularly perplexing when considering that pandemics stand amongst the most monumental catastrophes in human history. They have not only wrought devastation upon societies, influenced the outcomes of wars, and led to the extinction of entire populations, but have also paradoxically paved the way for substantial innovations and advancements in various domains, including medicine, public health, the economy, and political systems.

The recent sporadic occurrences of pandemics have sparked a significant surge of interest in the fields of humanities and social sciences. However, the majority of this research has primarily focused on examining the historical context, geographical spread, duration, and profound societal implications of these pandemics in the past [2]. Unfortunately, there has been a notable lack of substantial attention directed towards investigating the root causes of these pandemics.

Understanding the historical approaches of early human societies to pandemics can offer invaluable insights for contemporary scientists in devising more effective strategies for addressing future outbreaks. It is within the domain of archaeology, among other disciplines, to unravel the underlying causes of historical pandemics. Therefore, this paper seeks to

encourage archaeologists to actively delve into the investigation of the root causes of pandemics and epidemics, fostering intellectual engagement and contributing to our understanding of these complex phenomena.

2. Conceptual clarification

For us to meaningfully discuss the subject matter at hand it is paramount to have a good knowledge of what archaeology, heritage and pandemic entails.

2.1. Archaeology

Archaeology is a multifaceted discipline that serves as the gateway to understanding the rich tapestry of human history. It is the study of humanity and its past [3], delving into the lives of people in bygone eras. This field meticulously examines and interprets various aspects of ancient societies, including their daily activities, cultural practices, use of tools, technological advancements, and the intricacies of their superstitious and religious beliefs. By piecing together fragments of the past, archaeology offers a profound insight into how ancient humans expressed their cultural identities and beliefs, providing a window into their world. As a result, archaeology plays a vital role in unravelling the complexities of human history and shedding light on the diverse and dynamic nature of ancient societies.

As a means of reconstructing history, archaeology complements oral and written records, enriching our understanding of past human cultures. The data derived from archaeological findings are invaluable to scholars across various disciplines, supporting a wide array of arguments, including those related to human health and medicine. The material artefacts unearthed through archaeological investigations provide vital insights into early traditions, civilizations, and cultural accomplishments. These artefacts, ranging from everyday tools to monumental structures, paint a vivid picture of the societies that created them [4].

The fundamental aim of archaeology is to gain insight into the evolution and progression of human cultures and civilizations across diverse temporal and geographical contexts. This often entails the meticulous examination of specific cultures through the tangible remnants they have left behind. By scrutinizing these remnants, archaeologists are able to compare different cultures and establish connections between them [5]. This is achieved through the systematic surveying and excavation of sites to uncover cultural artefacts, followed by the thorough analysis and categorization of these artefacts, and the subsequent interpretation of their cultural and historical significance. Ultimately, through this comprehensive process, archaeologists seek to reconstruct past human cultural advancements and make these reconstructions accessible and engaging to the public.

The field of archaeology is characterized by its interdisciplinary nature, drawing on methodologies and research approaches from a wide range of other disciplines. In particular, many of the methods employed in laboratory analyses within archaeology have been adapted from the fields of geology, chemistry, and biological sciences [6]. This multidisciplinary approach not only enriches the precision and depth of archaeological investigations but also facilitates more thorough analyses of artefacts and sites, ultimately contributing to a more comprehensive understanding of the past.

The field of archaeology is quite diverse, encompassing a wide array of sub-disciplines, each focusing on different aspects of the past. These sub-disciplines include archaeozoology (the study of animal remains found at archaeological sites), archaeobotany (the study of plant remains), archaeoastronomy (the study of how ancient cultures understood the sky and

celestial bodies), aerial archaeology (the study of archaeological sites from the air), computational archaeology (using computer-based methods to analyse archaeological data), experimental archaeology (recreating and testing ancient techniques), environmental archaeology (studying the interaction between past human societies and the environment), geoarchaeology (the study of the earth's processes and how they affect archaeological sites), public archaeology (engaging with the public in archaeological research and preservation), ethnoarchaeology (studying modern societies to better understand past societies), urban archaeology (the study of ancient and historical cities), forensic archaeology (applying archaeological techniques to modern crime scenes), landscape archaeology (studying the ways in which people in the past have shaped and been shaped by the landscape), maritime archaeology (the study of human interaction with the sea), biblical archaeology (the study of archaeological sites and artefacts that are related to the Bible), settlement archaeology (the study of past human settlements), museum studies (the curation and presentation of archaeological findings), heritage studies (the management and interpretation of the cultural heritage), bioarchaeology (the study of human remains from archaeological sites), and battlefield archaeology (the study of past battlefields and military activity), among others. Each sub-discipline employs specific methodologies and focuses on particular types of evidence to uncover different facets of human history.

One of these sub-disciplines is bioarchaeology, which delves into the anatomical examination of human skeletal remains. This unique area of study empowers archaeologists to gain insights into various aspects of past populations, such as diseases, health, nutrition, migration, gender status, and kinship [7]. By meticulously analysing skeletal remains, bioarchaeologists are able to reveal detailed information about the physical features and health conditions of individuals from ancient societies. This in-depth analysis not only provides a window into the lives of these ancient people but also significantly contributes to the historical reconstruction of their societies. Through its diverse methodologies and interdisciplinary nature, archaeology continues to be an indispensable field of study, offering profound insights into the human past and playing a pivotal role in illuminating the complexities of ancient cultures and civilizations.

2.2. Heritage Studies

Heritage as it pertains to identity, transmission and collectiveness is as old as humanity itself [8]. The concept of cultural heritage has its roots in the Western world and has evolved in parallel with the broader changes of Western modernity. As defined by the International Council on Monuments and Sites (ICOMOS) in 2002, cultural heritage encompasses the tangible and intangible manifestations of community-developed ways of life that have been passed down through generations. This includes traditions, physical locations, objects, artistic expressions, and values. Cultural heritage serves as a repository of accumulated knowledge derived from human experiences and practices, encompassing spatial, social, and cultural elements often referred to as "memory." [9].

In the past, the concept of cultural heritage was primarily focused on monuments and significant works of art, with aesthetic and historical values serving as the main criteria for determining cultural significance. This meant that anything with high aesthetic value or a connection to an important person or historic event was regarded as having substantial cultural importance [10]. However, in the contemporary era, there has been a broadening of the criteria used to assess cultural heritage. In addition to aesthetic and historical values,

social values such as traditional practices and beliefs are now considered essential in determining the cultural significance of heritage sites. This expanded perspective allows for a more comprehensive understanding of cultural heritage, recognizing the importance of intangible elements in addition to tangible artefacts [10].

In 2008, the United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP) introduced a significant classification of heritage, distinguishing it into two main forms: 'tangible' and 'intangible' heritage. Tangible heritage specifically refers to the physical and material manifestations or symbols that represent the cultural expressions and traditions of societies that have inhabited or currently inhabit a particular area. This includes a diverse array of physical entities such as monuments, archaeological sites, traditional buildings, temples, historic cities, and various other physical manifestations that bear immense cultural and historical significance. These tangible elements serve as crucial links to the past and present, providing insight into the rich cultural heritage of the societies that created them [10].

Intangible heritage, as a concept, encompasses a diverse range of cultural elements including practices, representations, expressions, knowledge, and skills, as well as the tools, objects, artefacts, and cultural spaces that are associated with them. What makes these elements unique is that they are recognised and valued by communities, groups, and at times, individuals, as integral components of their cultural heritage. This intangible cultural heritage is not static; rather, it is transmitted from generation to generation and is constantly reinterpreted and reinvigorated by communities and groups in response to their environment, their interactions with nature, and their historical experiences. This continual recreation of intangible heritage provides these communities with a deep sense of identity and continuity, ultimately fostering respect for cultural diversity and human creativity [11].

The understanding of heritage has experienced a significant evolution, positioning itself as a crucial stakeholder capable of driving positive change in addressing the multifaceted challenges of our times. These challenges encompass a broad spectrum of issues, such as the sustainable utilisation of cultural and environmental resources, the mitigation of economic disparities, the resolution of conflicts, the promotion of social cohesion, and the guidance of urban development [8]. Furthermore, heritage now has the potential to critically examine and address contemporary problems related to human health, particularly in responding to the recurring and disruptive pandemic outbreaks that have a profound impact on the global community.

2.3. Pandemic

The term 'Pandemic' is derived from the Greek words pan, meaning 'all,' and demos, meaning 'the people' [12]. It refers to an epidemic that spreads worldwide or across a vast area, crossing borders of multiple countries and typically affecting a significant number of individuals [13]. The International Federation of Red Cross and Red Crescent Societies (2018) further defines a pandemic as an epidemic of an infectious disease that spreads through human populations across a large region, multiple continents, or globally.

Morens et al. [14] note that during the 17th and 18th centuries, the terms epidemic and pandemic were employed ambiguously and often interchangeably in various social and medical contexts. The first recorded instance of the term pandemic, in 1666, described "a *Pandemick*, or *Endemick*, or rather a *Vernacular* Disease (*a disease always reigning in a Country*)" (Harvey, 1666, p. 3). By 1828, epidemiologist and lexicographer Noah Webster, having experienced the influenza pandemic of 1789–1790, listed epidemic and pandemic as

synonymous in his first edition of *Webster's Dictionary*. Interestingly, Webster's dictionary mentions epidemic influenza but not pandemic influenza, suggesting that by the early 19th century, epidemic, when used as a noun, had become the accepted term for what today encompasses both an epidemic and a pandemic.

Pandemics are widespread outbreaks of infectious diseases that impact large populations, posing significant threats to public health and safety. These events can lead to a high number of fatalities, widespread illness, and substantial social and economic consequences. The global community is particularly concerned about the recurring emergence of pandemic diseases, including new strains of severe acute respiratory syndrome (SARS), Middle East respiratory syndrome (MERS), and the recent coronavirus (COVID-19) outbreak, which has emerged as one of the most severe pandemics in recent history. Throughout history, pandemics have included diseases such as cholera, smallpox, leprosy, measles, polio, and yellow fever, among others.

The International Federation of Red Cross and Red Crescent Societies [15] states that pandemics or epidemics can spread through various means:

i. Airborne transmissions, such as flu, measles, SARS, MERS, and COVID-19 (WHO, 2022), are carried through air and droplets;

ii. Transmission through blood and body fluids, including blood transfusion, mother-to-child during pregnancy, and sexual activity, for example, Ebola virus and HIV;

iii. Waterborne transmission, as seen in cholera;

iv. Zoonotic transmission occurs between animals and humans through direct or indirect contact with viruses, bacteria, parasites, and fungi;

v. Vector-borne transmission, when bitten by mosquitoes, fleas, ticks, etc., leads to diseases like malaria, dengue, and plague; and

vi. Food-borne transmission, which happens during food preparation and consumption, results in diseases like salmonella, listeria, and hepatitis A.

3. Research methodology

The current body of scholarly work addressing pandemics from archaeological and heritage perspectives is notably lacking. This knowledge gap hinders our ability to comprehend the underlying causes of historical pandemics, which is crucial for gaining insights into the origins of contemporary pandemics. Consequently, there is a pressing need for comprehensive research that employs archaeological and heritage methodologies to investigate the impact of pandemic diseases. This paper advocates for a rigorous examination of pandemics through these interdisciplinary approaches, aiming to shed light on their historical and cultural dimensions. Notably, the information presented in this paper is primarily derived from secondary sources. The researcher meticulously reviewed pertinent documents from various health-related institutions and organizations to inform the content of this paper.

This paper has thoroughly reviewed recent reports on the COVID-19 pandemic and other pandemics/epidemics to gain insights into the current situation and historical context. In addition to this, it has extensively examined a range of articles that delve into pandemic-related issues within the fields of humanities and social sciences. Furthermore, the study has delved into ground-breaking research that emphasizes the crucial role of archaeology and heritage in understanding and addressing pandemics. This comprehensive review has not only provided valuable direction to my research but has also facilitated the identification of specific gaps that my current research aims to fill.

4. Pandemic Diseases in the Face of Archaeology and Heritage

Pandemic outbreaks, which encompass diseases such as cholera, smallpox, leprosy, measles, polio, yellow fever, HIV, Ebola virus, and the more recent Novel Coronavirus (COVID-19), have spurred scholars in the humanities and social sciences to collaborate with their counterparts in the medical and health fields. This collaboration aims to conduct comprehensive research that delves into various aspects of pandemics, including their modes of transmission, societal impact, disaster management, and the significant human toll they exact. This interdisciplinary approach seeks to shed light on the multifaceted challenges posed by pandemics and to contribute to the development of effective strategies for mitigating their devastating effects.

Consequently, the scholarly environment has begun looking at questions about pandemic diseases that can best be answered through archaeological research. Prominent among these questions are those asked in relation to the coronavirus pandemic by Ogundiran [16] in his publication "The COVID-19 Pandemic: Perspectives for Reimaging and Reimagining Archaeological Practice". These include:

i. How does the coronavirus pandemic influence your understanding of the African past, particularly regarding your interest in the study of social formations and emergence?

ii. In what ways are you reconsidering cultural change, processes, bio-cultural evolution, social stability, mobility, disturbances, resilience, collapse, and revival based on your research in various areas, time periods, and archaeological sites?

iii. How does this global pandemic impact your approach, study, and interpretation of archaeological contexts and issues related to heritage and human development?

iv. What connections do you observe between this pandemic and past epidemic events in Africa?

v. How can archaeology and heritage offer insights to improve the management of the current pandemic on the continent?

vi. What lessons can African archaeology and heritage draw from the social, political, economic, and ecological aspects of the COVID-19 pandemic?

vii. What are the physical manifestations of COVID-19 in different parts of Africa today, and what do they reveal about public fears, coping mechanisms, and the socio-political dynamics of the pandemic?

viii. What are the materialities of COVID-19 in different parts of Africa today, and what do they tell us about public anxieties, coping strategies, and socio-politics of the pandemic? The present author has added the following;

ix. How can research in African archaeology and heritage contribute to the fight against pandemic diseases?

x. Can archaeology and heritage studies provide information on how the world can prepare against any future outbreak of pandemic diseases?

The answers to these questions can be found via the application of archaeological methods, approaches and techniques. Most of the data archaeologists acquire during research are about past human evolution, cultural development, migration, war, and the diet of past people and groups among other things. Archaeologists face a significant knowledge gap when it comes to preparing for pandemic diseases and other potential disasters [17]. While they are more focused on geological disasters like volcanoes, floods, and earthquakes, they have largely overlooked quieter disasters such as famines, refugee crises, and pandemics [17].

This is kindly inadequate for an extensively equipped profession like archaeology and heritage studies, and because these challenges keep coming, the need to concisely address the above questions in a heritage context becomes sacrosanct. The fact that contemporary pandemics and outbreaks of diseases, such as the current COVID-19 pandemic, as well as the Ebola virus, Polio, and Severe Acute Respiratory Syndrome (SARS), *inter alia*; are poignant reminders of our global vulnerability to emergent threats to human health [18]. Therefore, our current inability to predict or prevent such events has made it compulsory for archaeologists to begin to look for ways of contributing to solving major challenges confronting contemporary human health and safety.

For instance, research into the COVID-19 pandemic using African Indigenous Knowledge Systems (AIKS) indicates that many of the symptoms commonly associated with COVID-19, such as fever, shortness of breath, fatigue, confusion, drowsiness, pneumonia, and others, have long been recognized within these systems [1]. Akinwumi asserts that studies have identified over 30 plant species and recipes, as well as additional ingredients like rock salts, salt, hot water, mentholated ointment, honey, olive oil, bicarbonate, and even urine extracts from humans, which have been traditionally used. Selected plant extracts, along with other substances, are derived from various sources such as tree bark, herbs, shrubs, trunks, flowers, leaves, and bulbs. Furthermore, fruits like pawpaw, mango, avocado, ginger, and garlic, among others, have been found to be effective in treating symptoms associated with COVID-19 infection, such as fever and gastrointestinal disorders.

Ethnographic research into traditional knowledge can yield valuable insights into herbal remedies and practices historically used to treat various diseases. Many of these traditional medicines may possess antimicrobial properties that could be harnessed for modern medical applications. Furthermore, understanding traditional rituals and social customs enables public health officials to design culturally sensitive interventions, increasing the likelihood of acceptance and effectiveness within local communities.

In addition to ethnographic studies, historical and archaeological records offer critical data on past pandemics and epidemics, such as the Black Death, the 1918 influenza pandemic, and various outbreaks of smallpox and cholera. These records document the spread of diseases, their societal impacts, and the effectiveness of historical responses. By examining how different cultures managed diseases in the past, we can derive valuable lessons for contemporary public health practices. For instance, the use of quarantine during the Black Death has influenced modern practices of isolation and social distancing.

Bioarchaeologists contribute to this understanding by studying human remains to identify evidence of diseases, nutritional deficiencies, and overall health. This information reveals how ancient populations were affected by and responded to infectious diseases. Complementing this, the analysis of ancient DNA (aDNA) from human remains helps identify pathogens responsible for past epidemics, enhancing our understanding of disease evolution and human vulnerabilities.

Cultural heritage also plays a significant role in maintaining the mental well-being of communities impacted by pandemics. Engaging with cultural heritage, whether through virtual or physical visits to heritage sites, participating in traditional practices, or storytelling, can provide comfort and continuity. Heritage sites and practices strengthen community identity and cohesion, which are crucial for collective action during health crises. Shared cultural heritage fosters a sense of belonging and mutual support, essential during times of social isolation caused by pandemics.

Cultural heritage sites serve as community hubs, fostering reconciliation and unity, which is especially important during the mental and emotional strain of pandemics. Allowing citizens to engage in dialogues about history and tradition, share experiences, and visit national memorials with appropriate safety measures can help mitigate the psychological toll of pandemics. These sites instil a sense of history, community, and solidarity, serving as sources of inspiration, resilience, courage, and artistic innovation needed during crises. Efforts to raise awareness about the benefits of cultural heritage sites and ensure they remain accessible are crucial, as nearly 90% of World Heritage sites were closed or partially closed due to COVID-19.

Intangible cultural heritage also plays a role in recovery processes and building resilience in the face of disasters and crises like pandemics. Webinars have highlighted the vulnerabilities of intangible heritage in such contexts and strategies to manage them effectively.

This comprehensive approach illustrates how thorough archaeological and heritage research on pandemics can contribute significantly to pandemic prevention, treatment, and overall control.

5. Conclusion

Emerging research regarding the contribution of archaeology and heritage towards combating pandemic diseases has increasingly shown confidence in the potential of archaeological findings to address issues related to pandemic outbreaks. Archaeology presents a vast 3.5 million-year-old scientific record of human and earlier hominid problem-solving, offering profound insights into past human responses to pandemics and epidemics. This extensive record can inform us about how to prevent, control, and cope with pandemic diseases as well as similar challenges.

Archaeologists and heritage experts possess a unique ability to analyse shifts in material culture resulting from widespread disease outbreaks. Material culture, such as the varied styles of masks used during present-day pandemics, often reflects social group membership and shared beliefs. These professionals are therefore well-equipped to offer guidance based on historical responses to pandemics. By studying how past societies managed, controlled, or prevented disease outbreaks, archaeologists and heritage experts can provide valuable insights into the origins of pandemics, their impact on populations, and effective mitigation strategies.

This historical perspective offers valuable lessons for addressing current and future challenges related to pandemics, allowing us to better navigate these complex issues in the contemporary world. The lessons drawn from archaeology and heritage are not merely academic; they have practical implications for public health policy and community resilience. For instance, understanding how ancient societies developed and implemented public health measures, quarantines, and social distancing can inform modern strategies to curb the spread of diseases. Also, the study of historical pandemics can reveal how cultural practices and societal structures either facilitated or hindered the spread of disease, offering a nuanced understanding of the interplay between human behaviour and health outcomes.

Moreover, the role of heritage experts extends beyond the analysis of artefacts to include the preservation and interpretation of historical sites that bear witness to past pandemics. These sites serve as educational resources, reminding us of the enduring human struggle against disease and the innovative solutions that have emerged over millennia. They

provide a tangible connection to the past, fostering a deeper appreciation of our shared history and the resilience of human societies in the face of existential threats.

In conclusion, the integration of archaeological and heritage insights into the fight against pandemic diseases offers a comprehensive approach that bridges the gap between past and present. By leveraging the rich scientific record of human problem-solving, archaeologists and heritage experts can contribute to a more informed and effective response to contemporary health crises. Their work underscores the importance of historical knowledge in shaping future strategies for pandemic preparedness and response, ultimately enhancing our ability to safeguard public health and wellbeing.

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SOME IMPORTANT ASPECTS USED IN ENHANCING STUDENTS' PROFICIENCY WHILE TEACHING SPECIALIZED ENGLISH

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Abstract. The teaching of specialized English encompasses a multifaceted approach that integrates the four fundamental language competences - writing, speaking, reading, and listening - within the context of specific professional domains. This article synthesizes the most important aspects in teaching specialized English, elucidating the significance of genre-based instruction, authentic materials, task-based learning, and formative assessment in fostering language proficiency and disciplinary literacy. Drawing upon theoretical frameworks and empirical evidence, we delineate pedagogical strategies and approaches that empower learners to navigate the complexities of language use within specialized domains with confidence and competence. Knowledge of specialized English is an indispensable tool for people who want to excel in various professional fields, where effective communication is essential for success. That is why teachers should analyze thoroughly the students' level of English and provide them with necessary information and authentic materials in order to develop their skills and help them become high quality specialists in their domains.

Keywords: *comprehensive approach, effective communication, disciplinary literacy, integrated language skills, linguistic competence, written and oral discourse.*

Abstract. Predarea limbii engleze specializate cuprinde o abordare cu mai multe fațete care integrează cele patru competențe lingvistice fundamentale - scris, vorbit, citit și ascultat - în contextul unor domenii profesionale specifice. Acest articol sintetizează cele mai importante aspecte ale predării limbii engleze specializate, elucidând importanța instruirii bazate pe gen, a materialelor autentice, a învățării bazate pe sarcini și a evaluării formative în promovarea competenței lingvistice și a alfabetizării disciplinare. Bazându-ne pe cadre teoretice și dovezi empirice, delimităm strategii și abordări pedagogice care le dă putere studenților să navigheze în complexitățile utilizării limbii în domeniile specializate cu încredere și competență. Cunoașterea limbii engleze de specialitate este un instrument indispensabil pentru persoanele care doresc să exceleze în diverse domenii profesionale, unde comunicarea eficientă este esențială pentru succes. De aceea, profesorii ar trebui să analizeze temeinic nivelul de limba engleză al studenților și să le ofere informațiile necesare și materiale

autentice pentru ca ei să își dezvolte abilitățile și să îi ajute să devină specialiști de înaltă calitate în domeniile lor.

Cuvinte cheie: *abilități lingvistice integrate, abordare cuprinzătoare, alfabetizare disciplinară, competență lingvistică, comunicare eficientă, discurs scris și oral.*

1. Introducere

Limba constituie un element esențial al identității umane, fundamentat pe abilități sociale distincte prezente în mod natural la oameni, precum cooperarea, înțelegerea perspectivelor celorlalți, interpretarea intențiilor și coordonarea mentală [1]. Ea nu este doar una dintre cele mai complexe funcții cognitive pe care le posedăm, ci și aspectul minții care ne face oameni [2]. Învățarea limbilor străine în cadrul învățământului universitar și postuniversitar este crucială pentru umanizarea procesului educațional, deoarece contribuie la formarea unei viziuni coerente asupra lumii și la încurajarea valorilor educaționale, promovând comunicarea și înțelegerea reciprocă între diverse persoane, națiuni și culturi. Cunoașterea limbii engleze de specializate este un instrument indispensabil pentru persoanele care doresc să exceleze în diverse domenii profesionale, unde comunicarea eficientă este esențială pentru succes. Predarea limbii engleze specializate necesită o abordare cuprinzătoare care să dezvolte competența lingvistică a studenților pentru a include conștientizarea genului, strategiile de comunicare și alfabetizarea disciplinară. Limbajul servește și ca instrument de socializare neintenționat în timpul interacțiunilor zilnice. Acest articol explorează cele mai importante aspecte folosite în predarea limbii engleze de specialitate, elucidând considerente pedagogice cheie și strategii pentru îmbunătățirea competenței lingvistice în contexte profesionale specifice.

În domeniul educației specializate în limba engleză, încorporarea conținutului specific disciplinei reprezintă o piatră de temelie pentru promovarea competenței lingvistice, a alfabetizării disciplinare și a comunicării eficiente în domeniile profesionale. Educația specializată în limba engleză își propune să echipeze studenții cu vocabular și terminologie specifice disciplinei predominante în domeniile lor profesionale. Selectarea materialelor care conțin elemente lexicale specifice domeniului expune cursanții la vocabularul autentic în context, îmbunătățind achiziția și reținerea lexicală. Întâlnind elemente lexicale specifice domeniului în context, tinerii dezvoltă o înțelegere nuanțată a jargonului disciplinar, terminologiei și convențiilor, permițându-le să comunice eficient și precis în domeniile alese de ei.

Tehnologiile informaționale și de comunicare joacă și ele un rol esențial în acest proces, schimbând peisajul social și cel al comunicării și oferind noi posibilități pentru dezvoltarea dialogului euristic. În special, comunicarea online (prin forumuri web, conferințe audio-video, chat-uri, bloguri, e-mail, partajarea de fișiere online, table interactive etc.) are un impact semnificativ în promovarea interacțiunii cognitive și comunicative. Toate aceste tehnici contribuie la acumularea de cunoștințe solide despre domeniul lor viitor și, în cele din urmă, la dezvoltarea lor ca profesioniști bine pregătiți.

2. Instruirea bazată pe gen

Instruirea bazată pe gen are o importanță semnificativă în educație deoarece se concentrează pe predarea limbii prin intermediul diferitelor tipuri de texte sau genuri, cum ar fi narațiuni, rapoarte, scrisori, e-mailuri, argumente, etc. Scopul acestei metode este să îi facă pe studenți să recunoască modul în care sunt structurate textele, ce caracteristici

lingvistice conțin și modul în care funcționează în contexte specifice. De exemplu, înțelegerea structurii și a caracteristicilor lingvistice ale unui raport științific față de un text narativ îi ajută pe tineri să navigheze mai eficient în comunicarea de zi cu zi. Această metodă nu numai că îmbunătățește competența lingvistică, dar și stimulează gândirea critică, conștientizarea culturală și abilitățile de comunicare eficientă.

Această formă de predare nu doar sprijină dezvoltarea competențelor lingvistice în citire, scriere, ascultare și vorbire, dar și le permite studenților să analizeze, să interpreteze și să producă texte explorând scopurile lor comunicative, organizarea și modelele lingvistice. Astfel, studenții nu doar că învață vocabularul și gramatica asociate cu fiecare gen, dar și dezvoltă abilitatea de a adapta utilizarea limbajului în funcție de diferite contexte și audiențe. Indiferent dacă scriu o propunere de afaceri sau analizează un text literar, înțelegerea convențiilor genului sporește eficiența comunicativă. Această abilitate este esențială pentru evaluarea și sintetizarea informațiilor într-un mod eficient, contribuind astfel la succesul academic și la luarea deciziilor informate în diverse aspecte ale vieții.

Diferite genuri sunt adesea legate de culturi sau discipline academice specifice. Prin instruirea bazată pe gen, studenții dobândesc o apreciere mai profundă pentru diversitatea culturală și pentru convențiile disciplinare în comunicare. Aceasta încurajează respectul pentru diferențele culturale și îi pregătește pe tineri pentru interacțiuni eficiente în medii multiculturale și interdisciplinare.

Abilitățile dobândite prin instruirea bazată pe gen - cum ar fi analiza structurilor textuale, scrierea persuasivă sau prezentarea coerentă a informațiilor - sunt transferabile între diverse subiecte și discipline, contribuind astfel la succesul academic pe termen lung și la învățarea continuă pe tot parcursul vieții.

3. Învățare bazată pe sarcini

Un alt aspect important în predarea limbajului de specialitate este instruirea bazată pe sarcini care îi expune pe studenți la diversele genuri și tipuri de text predominante în domeniile specializate, încurajând conștientizarea genului și competența retorică. Abordările bazate pe sarcini se referă la materiale sau cursuri care sunt concepute în jurul unei serii de sarcini autentice care oferă cursanților experiența utilizării limbajului în moduri în care este folosită în „lumea reală" în afara sălii de clasă [3]. Analizarea și emularea caracteristicilor structurale, modelelor lingvistice și scopurilor comunicative ale textelor autentice le permite cursanților să navigheze și să producă discursuri scrise și orale în domeniile lor respective.

Învățarea bazată pe sarcini oferă un cadru pentru predarea limbii contextualizate, permițând studenților să aplice abilitățile lingvistice în activități semnificative, care sunt orientate spre anumite obiective. Proiectarea sarcinilor care oglindesc cerințele comunicative din lumea reală, cum ar fi jocurile de rol, activitățile de rezolvare a problemelor și proiectele de colaborare, promovează utilizarea autentică a limbajului și încurajează transferul abilităților în contexte profesionale. Confruntându-se cu provocările și constrângerile din lumea reală, cursanții dezvoltă abilități analitice, creativitate și adaptabilitate, care sunt esențiale pentru a avea succes în domenii specializate. Activitățile bazate pe sarcini îi determină pe cursanți să evalueze informațiile, să genereze soluții și să ia decizii informate, favorizând o înțelegere mai profundă a conținutului și proceselor disciplinare.

Acest tip de învățare reprezintă o abordare transformatoare în educația specializată în limba engleză, oferind cursanților oportunități semnificative de a se angaja în sarcini autentice, orientate spre obiective în domeniile lor profesionale. Învățarea bazată pe sarcini

promovează experiențe de învățare colaborativă, în care cursanții colaborează cu colegii pentru a atinge scopuri sau obiective comune, necesare pentru a comunica eficient în contexte profesionale. Lucrând în colaborare la sarcini precum proiecte de grup, studii de caz și simulări, cursanții dezvoltă abilități interpersonale, lucru în echipă și competențe de comunicare interculturală, ceea ce îi încurajează să se implice în rezolvarea problemelor și le dezvoltă gândirea critică în contexte profesionale autentice.

Sarcinile de colaborare reflectă natura colaborativă a practicii profesionale, pregătind studenții pentru o colaborare eficientă în cadrul echipelor interdisciplinare și al comunităților profesionale.

În cadrul orelor de limbă engleză studenții de la specialitatea DTP-231 și TMAP-231 au pregătit postere pe teme strâns legate de specialitatea pe care doresc să o obțină. Cu aceste postere ei au participat la evenimentele organizate în cadrul săptămânii limbilor străine și au fost apreciați de către membrii juriului. În Figura 1 se poate vedea rezultatul colaborării dintre Casianov Olga și Țuguțchi Anastasia, studentele grupei DTP-231, facultatea de Design.

Figura 1. Poster efectuat de Casianov Olga și Țuguțchi Anastasia, DTP-231.

Studiile de caz și simulările sunt activități preferate de studenți, deoarece aceste metode le oferă studenților oportunități practice de a aplica cunoștințele teoretice în situații reale sau simulate și le permit să-și dezvolte abilitățile de comunicare, gândire critică și rezolvare de probleme într-un context autentic. În continuare este descris un exemplu de studiu de caz care este folosit în cadrul orelor de limbă engleză pentru studenții care își fac studiile la facultatea Tehnologia Alimentelor, cu tema: "Explorarea Impactului Global al Produselor Alimentare Tradiționale". Studenții sunt angajați ca echipă de cercetare pentru a analiza impactul global al unor produse alimentare tradiționale, cum ar fi pâinea, carnea și caşcavalul, asupra diverselor culturi și societăți din întreaga lume. Scopul acestei activități este ca profesorul să îi facă pe studenți să înțeleagă și să evalueze influența și importanța acestor alimente tradiționale din punct de vedere cultural, economic și social. Activități propuse:

1. **Cercetare individuală.** Fiecare student primește un produs alimentar specific pentru a investiga istoria sa, metodele tradiționale de producție, ingredientele utilizate și rolul său în cultura locală.

2. **Dezbateri în echipă.** Studenții se reunesc în echipe pentru a compara și contrasta produsele alimentare studiate. Ei discută despre modul în care aceste alimente au influențat economiile locale, obiceiurile alimentare, tradițiile și identitatea culturală în diferite regiuni ale lumii.

3. **Simulare de conferință.** Fiecare echipă prezintă rezultatele cercetării lor în cadrul unei simulări de conferință despre alimentație și cultură. Ei își împărtășesc descoperirile cu colegii lor, abordând subiecte precum valorile nutriționale, tehnologiile de producție și impactul asupra mediului înconjurător.

4. **Redactarea unui raport.** Pe baza cercetării lor și a dezbaterilor din cadrul simulării de conferință, studenții sunt rugați să redacteze un raport detaliat în limba engleză, în care ei trebuie să prezinte concluziile și să-și argumenteze punctele de vedere cu referințe la sursele utilizate.

Prin intermediul acestui studiu de caz, studenții își îmbunătățesc abilitățile de cercetare, dezbateri și redactare în limba engleză, în timp ce învață despre importanța și impactul global al produselor alimentare tradiționale.

Acest tip de activitate încorporează strategii de evaluare formativă care oferă cursanților feedback continuu cu privire la performanța și progresul lor. Primind feedback la finalizarea sarcinii, studenții pot identifica domenii de îmbunătățire, își pot perfecționa abilitățile lingvistice și își pot monitoriza dezvoltarea limbajului în timp. Evaluarea formativă promovează conștientizarea metacognitivă și abilitățile de autoreglare, dând putere cursanților să își asume procesul de învățare și să depună eforturi pentru îmbunătățirea continuă. Prin implicarea în activități bazate pe sarcini care oglindesc cerințele comunicative din lumea reală, studenții își dezvoltă abilitățile, strategiile și încrederea necesare pentru a naviga în complexitatea utilizării limbii în domeniile specializate cu competență și încredere.

4. Importanța materialelor autentice

O altă latură esențială în predarea textelor de specialitate sunt materialele autentice care sunt componente indispensabile ale predării limbii engleze specializate, oferind studenților experiențe de utilizare a limbii reale în domeniile lor profesionale. Alegerea materialelor ar trebui să se alinieze cu obiectivele de învățare și rezultatele predării limbii străine, ghidând studenții către scopuri lingvistice și comunicative specifice. Materialele autentice sunt texte de citire care au fost scrise de vorbitori nativi și publicate în contexte concepute special pentru consumul de vorbitori nativi, fără să se acorde atenție accesibilității non-native. Subiectele, limbajul, sintaxa, structura etc., toate sunt prezentate unui public țintă de vorbitori nativi și oferite prin mijloace media destinate în primul rând vorbitorilor nativi [4]. Indiferent dacă se pune accentul pe studierea vocabularului, înțelegerea discursului sau competența pragmatică, selectarea materialelor care se adresează abilităților și competențelor vizate ale studenților îmbunătățește eficacitatea și relevanța instruirii.

Dezbaterea asupra rolului autenticității, precum și a ceea ce înseamnă a fi autentic, a devenit din ce în ce mai sofisticată și complexă de-a lungul timpului, implicând acum cercetări dintr-o gamă largă de domenii, precum analiza discursului, pragmatica, studiile interculturale, sociolingvistica, etnologia, achiziția unei limbi străine, psihologia cognitivă și socială, autonomia studentului, tehnologiile informației și comunicațiilor (TIC), motivarea și dezvoltarea materialelor. Cu toate acestea, mulți cercetători se concentrează doar pe propriile domenii de specializare, limitându-și expunerea la perspectivele din alte domenii. Acest lucru poate fi înțeles, având în vedere volumul mare de publicații din fiecare domeniu, dar poate duce la neglijarea unor perspective importante din alte domenii [5]. Cu toate acestea, utilizarea textelor autentice în procesul educațional reprezintă un instrument didactic extrem de valoros pentru dezvoltarea conectată a competențelor lingvistice, pragmatice, culturale și sociolingvistice la studenți în limba străină. Totodată cu selectarea materialelor profesorii ar

trebui să ia în considerare nivelurile de competență lingvistică ale studenților, asigurându-se că textele sunt accesibile și provocatoare în funcție de abilitățile lor lingvistice. Furnizarea unei varietăți de tipuri de text și niveluri de dificultate se potrivește nevoilor și preferințelor diverse ale studenților, promovând incluziunea și diferențierea în instruire. Iată de ce profesorul este obligat la începutul anului de studii să evalueze nivelul de limbă engleză a studenților și să aleagă setul de materiale potrivit nivelului grupei de studenți în dependență de rezultatele evaluării inițiale. Beneficiile educative ale textului autentic rezultă din selecția atentă a surselor media conform principiilor lingvistice și psihopedagogice, și din elaborarea metodologiilor eficiente pentru integrarea lor în activitățile didactice, cu un impact preconizat asupra evoluției competențelor la studenții. Materialele autentice se află în centrul educației specializate eficiente în limba engleză, oferind cursanților oportunități de a se angaja cu utilizarea limbii reale în contextul lor profesional. Într-o eră în care comunicarea în domeniile specializate necesită precizie, claritate și relevanță, integrarea materialelor autentice devine primordială. Selectarea atentă a materialelor autentice care se aliniază cu interesele profesionale ale cursanților, nivelurile de competență lingvistică și obiectivele de învățare este crucială. Încorporarea unei varietăți de tipuri de text, genuri și resurse multimedia asigură diversitatea și relevanța, răspunzând nevoilor și preferințelor diverse ale cursanților.

Materialele autentice cuprind o gamă largă de texte, resurse audiovizuale și materiale multimedia provenite direct din contexte reale. Aceste materiale reflectă utilizarea limbajului natural, convențiile discursului și scopurile comunicative predominante în domenii profesionale specifice, oferind cursanților o intrare și o expunere autentică a limbajului. De aceea, integrarea materialelor autentice, cum ar fi articolele academice, rapoartele din industrie și corespondența profesională, expune studenții la utilizarea limbajului din lumea reală și la discursul disciplinar. Documentele autentice oferă informații valoroase despre vocabularul specific disciplinei, convențiile discursului și strategiile de comunicare, îmbunătățind competența lingvistică și competența culturală a cursanților. Încorporarea materialelor care rezonează cu obiectivele de carieră ale studenților și cu activitățile academice promovează implicarea și investiția în procesul de învățare. Pentru a rezuma avantajele materialelor autentice sunt: ele ajută să pregătească cursanții pentru lumea „reală" a comunicării; ghidează studenții către limba de care au nevoie pentru contextul lor particular și îi motivează să comunice, pentru că ele ajută la realizarea comunicării „reale".

Pe lângă materialele textuale, resursele multimedia precum înregistrările audio, prelegerile video și simulările online oferă experiențe de învățare dinamice și interactive. Înțelegerea auditivă se referă la „abilitatea de a extrage informații din materialul lingvistic prezentat auditiv" [6]. Ascultarea, în comparație cu vorbirea, citirea și scrierea este cea mai frecvent utilizată abilitate lingvistică atât în sala de clasă, cât și în comunicarea zilnică [7]. Într-o clasă de limbă, înțelegerea secvențelor audio joacă un rol esențial în învățarea limbilor străine. Prin urmare, este important ca ascultarea să fie accentuată încă de la începutul predării limbilor străine. În ciuda semnificației abilității de ascultare, o clasă de limbi tradiționale se concentrează în mod extins pe abilitățile de citire și scriere și îi expune pe studenții mai mult la input scris decât la input sonor [8, 9].

Integrarea resurselor multimedia îmbunătățește angajamentul și se adaptează la diverse stiluri de învățare, satisfăcând preferințele și nevoile cursanților vizuali, auditivi și chinestezici. Profesorii pot oferi studenților posibilitatea să navigheze cu încredere și

competență în domenii lingvistice specializate, alegând și combinând materiale care se potrivesc cu interesele lor profesionale, abilitățile lingvistice și obiectivele de învățare.

Din punct de vedere pedagogic, integrarea textelor audio autentice poate fi o metodă eficientă de predare, în special în instituțiile de învățământ superior și este evident că utilizarea acestor texte într-un context specific are un impact pozitiv asupra capacității studenților de a înțelege auditiv și ar putea fi considerată ca o resursă de învățare suplimentară.

Un alt aspect relevat de acest studiu este necesitatea acordării unei perioade mai lungi pentru dezvoltarea abilităților specifice de ascultare în cadrul unei discipline și încurajarea utilizării textelor audio autentice în sala de clasă pentru pregătirea studenților în vederea practicării ascultării independente [10].

Cea mai eficientă metodă de a îmbunătăți înțelegerea auditivă în timpul studiului limbii engleze este ca profesorii să îi facă pe studenți să asculte, să fie testați și să primească feedback. Studenții care trebuie să învețe limba engleză și să-și îmbunătățească înțelegerea, chiar dacă se află într-o zonă în care limba engleză nu este limba predominantă, pot beneficia de resursele educaționale online. Aceste site-uri web furnizează materialele necesare pentru a învăța cum să înțeleagă eficient limba engleză, contribuind astfel la dezvoltarea capacității lor de ascultare.

Sarcinile de evaluare autentice apreciază capacitatea cursanților de a aplica abilitățile lingvistice în contexte practice, reflectând cerințele comunicative din lumea reală. Evaluările bazate pe performanță, proiectele de portofoliu, prezentările PowerPoint și simulările interacțiunilor profesionale oferă cursanților oportunități de a-și demonstra stăpânirea limbii engleze specializate și de a primi feedback cu privire la performanța și progresul lor. Iată de ce studenții pregătesc câte un portofoliu și câte două-trei prezentări PowerPoint pe parcursul fiecărui semestru. Portofoliu include patru teme adiționale la temele studiate pe durata cursului, unde studenții își dezvoltă abilitățile de a rezuma o informație, de a o prezenta în fața colegilor și lucra cu vocabularul, pentru a-și aprofunda cunoștințele. Pe de altă parte, având același scop prezentările PowerPoint sunt mai eficiente, deoarece includ și imagini care ajută studenții să înțeleagă și asimileze informația mai repede și mai ușor.

5. Învățare contextualizată

Învățarea contextualizată este o abordare esențială în predarea limbii engleze de specialitate, ancorând predarea limbii în contexte profesionale autentice și totodată, este o piatră de temelie în predare, reducând decalajul dintre predarea limbii străine și cerințele de comunicare din lumea reală în contexte profesionale. Predarea și învățarea contextualizată este o concepție despre predare și învățare care îi ajută pe profesori să relaționeze conținutul subiectului cu situația din lumea reală și îi motivează pe studenți să facă conexiuni între cunoștințe și aplicațiile acestora în viața lor ca membri ai familiei, cetățeni și muncitori. Aceasta devine din ce în ce mai mult o parte a reformelor atât ale educației profesionale, cât și ale educației tehnice și ale educației academice [11].

Importanța învățării contextualizate în învățământul specializat în limba engleză evidențiază rolul acesteia în îmbunătățirea achiziției lingvistice, a competenței de comunicare și a alfabetizării disciplinare. Într-o epocă în care comunicarea eficientă este esențială pentru succesul în domenii specializate, integrarea învățării contextualizate devine primordială. Există o varietate considerabilă de metode de predare, în special în ceea ce privește modul în care sunt concepute pentru predare și învățare, precum și modalitatea lor de implementare.

Predarea limbii engleze specializate se concentrează pe dezvoltarea abilităților lingvistice într-un anumit domeniu de specialitate, cum ar fi designul, tehnologia alimentelor, afacerile, ingineria, dreptul, etc. Aceste metode de predare sunt concepute pentru a ajuta studenții să dobândească vocabularul, structurile gramaticale și abilitățile de comunicare specifice acestor domenii, astfel încât să fie capabili să interacționeze eficient în contexte profesionale. Iată câteva metode eficiente de predare a limbii engleze specializate folosite de profesori în cadrul orelor de limbă străină:

1. **Materiale de învățare adaptate.** Profesorii utilizează materiale de învățare adaptate pentru a se potrivi cu domeniul de specialitate al studenților, cum ar fi manualele, articolele de revistă, studiile de caz și simulările legate de acel domeniu. Aceste materiale oferă studenților exemple concrete și autentice care îi ajută să-și dezvolte abilitățile lingvistice în contexte profesionale.

2. **Focus pe vocabularul și terminologia specifică.** Predarea limbii engleze specializate implică învățarea și practicarea unui vocabular și a unei terminologii specifice domeniului respectiv. Profesorii organizează activități și exerciții care să se concentreze pe învățarea și utilizarea acestui vocabular în contexte relevante, precum discuții, rol-play-uri sau proiecte de cercetare.

3. **Simulări și jocuri de rol.** Simulările și jocurile de rol sunt metode interactive și captivante de predare a limbii engleze specializate. Aceste activități oferă studenților oportunități practice de a aplica vocabularul și structurile gramaticale în situații profesionale simulare, precum întâlniri de afaceri, consultări medicale sau negocieri contractuale.

4. **Colaborare cu profesioniști din domeniu.** Profesorii pot colabora cu profesioniști din domeniul respectiv pentru a oferi studenților perspective autentice și expertiză în legătură cu utilizarea limbii engleze în contexte profesionale. Aceste colaborări pot include prelegeri invitate, ateliere practice sau proiecte de colaborare între studenți și profesioniști din domeniu.

Prin utilizarea acestor metode de predare, profesorii pot ajuta studenții să-și dezvolte abilitățile lingvistice într-un domeniu specific și să devină mai siguri și mai competenți în utilizarea limbii engleze în contexte profesionale.

Sarcinile de învățare contextualizate simulează cerințele de comunicare din lumea reală, permițând studenților să aplice abilitățile lingvistice în contexte semnificative. Activități de învățare bazate pe sarcini care oglindesc scenarii profesionale, cum ar fi jocuri de rol, studii de caz și simulări, promovează utilizarea autentică a limbajului și încurajează transferul competențelor în medii profesionale. Conectând predarea limbilor străine la cerințele comunicative din lumea reală și la scenarii profesionale, învățarea contextualizată îmbunătățește motivația, implicarea și păstrarea abilităților lingvistice ale cursanților. Studenții învață din texte autentice, cum ar fi: articole de cercetare, rapoarte tehnice și publicații din industrie, resurse multimedia și contexte situaționale care rezonează cu interesele și aspirațiile lor profesionale, stimulând relevanța și motivația în învățarea limbilor străine și dezvoltarea abilităților critice de citire necesare înțelegerii, analizei și evaluării conținutul disciplinar cu profunzime și precizie.

Învățarea contextualizată integrează cele patru competențe lingvistice - scris, vorbit, citit și ascultat - în contextul sarcinilor și activităților autentice. Iată de ce o lecție bine organizată este una ce are drept scop dezvoltarea celor patru competențe și include exerciții și activități de diferite tipuri, iar strategiile didactice trebuie concepute în așa mod ca studenții să asimileze vocabularul, structurile gramaticale și abilitățile de comunicare

specifice domeniilor de studii, facilitându-le interacțiunea eficientă în medii profesionale. În continuare este oferită descrierea unei lecții detaliate de limbă engleză care explorează istoria designului jocurilor video și dezvoltă toate cele patru competențe: scris, citit, vorbit și ascultat. Tema lecției este "Explorarea Istoriei Designului Jocurilor Video", nivel: Intermediar (B1), iar obiectivele sunt: dezvoltarea abilităților de citire, ascultare, vorbire și scriere în limba engleză; îmbunătățirea vocabularului legat de domeniul designului jocurilor video; stimularea gândirii critice și a creativității în contextul istoriei jocurilor video. Structura lecției:

- Introducere (10 minute).
- **Bun venit și prezentare.** Profesorul introduce tema lecției și îi întreabă pe studenți cât de familiarizați sunt cu istoria designului jocurilor video.
- **Activitate de brainstorming.** Studenții sunt încurajați să împărtășească cunoștințele și impresiile lor inițiale despre subiect. Folosind brainstormingul în cadrul lecțiilor, profesorul le permite studenților să abordeze un subiect cu o minte deschisă, deoarece ei pot veni cu idei pe care poate nici nu știau că le-au avut [12].
- Citire (15 de minute).
- Citirea unui articol despre istoria designului jocurilor video. Studenții citesc individual și subliniază cuvintele necunoscute sau conceptele cheie.
- **Discuție în grup.** Studenții împărtășesc informațiile pe care le-au înțeles din articol și își exprimă opinii sau întrebări legate de subiect.
- Ascultare (15 minute).
- Ascultarea unui podcast sau a unei prelegeri despre evoluția designului jocurilor video. Studenții ascultă atent și notează aspectele principale discutate.
- **Dezbatere în perechi.** Studenții discută ideile prezentate în podcast și își împărtășesc opinii și interpretări.
- Studenții mai ascultă o dată atent informația și completează un exercițiu cu cuvintele lipsă. Apoi verifică împreună cu profesorul.
- Vorbit (20 de minute).
- **Prezentare a unor jocuri video iconice.** Profesorul prezintă imagini și descrieri ale unor jocuri video semnificative din diverse perioade istorice.
- **Dezbateri și analiză**. Studenții sunt împărțiți în grupuri și li se cere să discute despre impactul și inovațiile aduse de aceste jocuri video. Fiecare grup prezintă apoi concluziile lor și argumentele în fața clasei.
- Scriere (20 de minute).
- **Redactare de eseuri scurte.** Studenții sunt încurajați să redacteze eseuri scurte în care să-și exprime opinia despre modul în care evoluția designului jocurilor video a influențat cultura și societatea. Eseurile trebuie să includă exemple specifice și să fie susținute de argumente.
- Concluzie (10 minute).
- **Recapitulare și evaluare.** Profesorul sintetizează principalele idei discutate în timpul lecției și îi încurajează pe studenți să împărtășească impresiile și concluziile lor finale.
- **Feedback și întrebări finale.** Studenții au ocazia să ofere feedback asupra lecției și să pună întrebări suplimentare.

Această lecție oferă oportunități ample pentru dezvoltarea tuturor celor patru competențe lingvistice într-un mod interactiv și captivant, explorând în profunzime istoria designului jocurilor video și încurajând gândirea critică și creativă a studenților.

6. Integrarea competențelor lingvistice în predarea limbii engleze specializate

Integrarea competențelor lingvistice este esențială în educația specializată în limba engleză, oferind studenților șanse complete de a-și îmbunătăți abilitățile în mai multe moduri relevante pentru cariera lor. Aceste abilități permit studenților să sintetizeze informații în diverse forme, consolidând astfel înțelegerea și reținerea conținutului specific disciplinei. Prin implicarea în activități care necesită citire, ascultare, vorbire și scriere, cursanții dezvoltă o înțelegere mai profundă a conceptelor complexe și își îmbunătățesc capacitatea de a articula eficient ideile în domeniile lor profesionale.

Predarea integrată a competențelor lingvistice reflectă cerințele comunicative din lumea reală, în care tinerii trebuie să navigheze fără probleme în diverse modalități lingvistice pentru a-și atinge obiectivele. Prin aplicarea abilităților lingvistice în contexte profesionale autentice, cursanții dezvoltă competențele lingvistice practice necesare pentru a reuși în domeniile academice, de cercetare, de afaceri și în alte domenii specializate. Comunicatorii competenți pot transmite informații complexe în mod clar și persuasiv, facilitând colaborarea, inovația și schimbul de cunoștințe în cadrul echipelor interdisciplinare și comunităților profesionale. În plus, instruirea integrată a competențelor lingvistice promovează competența pragmatică prin expunerea studenților la normele socio-culturale, convențiile și așteptările predominante în domeniile lor profesionale, ei dezvoltă strategiile lingvistice și sociolingvistice necesare pentru a naviga în contexte profesionale și pentru a-și adapta utilizarea limbii la diverse audiențe, transmițând în mod eficient sensul în diverse situații de comunicare. Mai mult decât atât, predarea integrată a competențelor lingvistice facilitează dobândirea și stăpânirea vocabularului și terminologiei specifice domeniului. Cursanții întâlnesc elemente lexicale specifice disciplinei în context, îmbunătățind înțelegerea și reținerea terminologiei și conceptelor specializate esențiale pentru comunicarea și colaborarea eficientă în domeniile lor de expertiză. Prin furnizarea unor oportunități cuprinzătoare de dezvoltare a abilităților în multiple moduri, educația specializată în limba engleză îi împuternicește pe studenți să se distingă în domenii academice, de cercetare, de afaceri și în alte domenii specializate, unde comunicarea eficientă este crucială pentru obținerea succesului și progresului.

Învățământul specializat în limba engleză alimentează inovația și excelența în domeniile specializate, oferind studenților putere să comunice și să colaboreze eficient peste granițele disciplinare. Comunicatorii competenți servesc drept catalizatori pentru schimbul de cunoștințe, colaborarea interdisciplinară și descoperirile inovatoare, stimulând inovația și excelența în cercetare, industrie și mediul academic. Integrarea conținutului specific disciplinei este fundamentală în predarea limbii engleze specializate, încurajarea alfabetizării disciplinare, îmbunătățirea abilităților de comunicare și promovarea avansării în carieră în domeniile profesionale.

7. Beneficii și Implicații

Limbajul servește și ca instrument de socializare neintenționat în timpul interacțiunilor zilnice [13], fie în cadrul orelor, la serviciu, cu prietenii din țară sau de peste hotare, etc. Predarea limbii engleze specializate poartă cu ea o multitudine de beneficii și implicații care se extind cu mult dincolo de domeniul competenței lingvistice. Avantajele sunt:

1. Cunoștințe lingvistice îmbunătățite: competența în limba engleză specializată echipează cursanții cu abilitățile și competențele lingvistice necesare pentru a comunica

eficient în domeniile lor profesionale. Înțelegând vocabularul specific al domeniului, regulile discursului și tehnicile de comunicare, studenții își dezvoltă abilitatea de a exprima idei complexe, de a negocia sensul și de a participa în mod competent și încrezător în interacțiuni profesionale. Competența comunicativă implică cunoașterea următoarelor aspecte ale limbajului:

- Capacitatea de a utiliza limba în diverse scopuri și contexte funcționale.
- Abilitatea de a adapta utilizarea limbii în funcție de context și de interlocutori, incluzând utilizarea stilurilor formale și informale sau a limbajului adecvat pentru comunicare scrisă versus cea orală.
- Competența în producerea și înțelegerea diferitelor tipuri de texte, precum narațiuni, rapoarte, interviuri și conversații.
- Capacitatea de a menține comunicarea chiar și în situații în care există limitări ale cunoștințelor lingvistice, folosind diverse strategii de comunicare [14].

2. Alfabetizare disciplinară. Educația specializată în limba engleză promovează alfabetizarea disciplinară prin expunerea studenților la cunoștințe de conținut specifice disciplinei, cadre conceptuale și metodologii de cercetare. Implicarea cu texte autentice, cum ar fi articolele academice, rapoartele tehnice și publicațiile din industrie, îmbunătățește înțelegerea de către cursanți a discursului disciplinar și îi echipează cu abilitățile de gândire critică necesare pentru a
analiza, sintetiza și evalua informațiile din domeniile lor.

3. Avansare în carieră: competența în limba engleză de specialitate deschide porțile către diverse oportunități de carieră și avansare în domeniile de specialitate. Persoanele dotate cu abilități lingvistice specializate sunt mai bine poziționate pentru a urma o carieră în mediul academic, cercetare, afaceri, asistență medicală, inginerie și alte domenii profesionale în care comunicarea eficientă este esențială pentru succes. Educația specializată în limba engleză servește ca un catalizator pentru creșterea carierei, permițând indivizilor să prospere în medii profesionale competitive și dinamice. Într-o eră tot mai interconectată și globalizată, abilitățile specializate în limba engleză deschid uși către oportunități globale de colaborare, creare de rețele și schimb de cunoștințe. Persoanele care stăpânesc această competență pot comunica eficient cu colegi, parteneri și alte părți interesate din diverse medii lingvistice și culturale, promovând astfel înțelegerea interculturală și facilitând colaborarea internațională în domenii precum cercetarea, inovarea și afacerile.

Implicații

1. **Responsabilitatea profesorilor.** Profesorii joacă un rol esențial în modelarea experiențelor de învățare și a rezultatelor educației specializate în limba engleză. Ei trebuie să conceapă și să implementeze strategii pedagogice care să promoveze competența lingvistică, alfabetizarea disciplinară și competența comunicativă în contexte profesionale autentice. Mai mult decât atât, profesorii trebuie, de asemenea, să recunoască nevoile și preferințele diverse ale studenților, adaptându-se la diferențele individuale și promovând incluziunea în instruire. Profesorii doresc ca studenții să nu se limiteze doar la învățarea corectă a structurilor limbii țintă, ci să înțeleagă și să aplice aceste structuri în diverse contexte sociale specifice limbii respective, pentru a comunica în mod adecvat, coerent și eficient conform standardelor lingvistice ale vorbitorilor nativi. Astfel, studiul unei limbi străine devine un proces de asimilare culturală, în care se însușesc noi cadre de referință

culturale și o perspectivă nouă asupra lumii, reflectând valorile și perspectivele culturale ale vorbitorilor nativi ai acelei limbi [15].

2. **Dezvoltare profesională continuă.** Profesorii specializați în limba engleză trebuie să se angajeze într-o dezvoltare profesională continuă pentru a fi la curent cu progresele în metodologiile de predare a limbilor străine, inovațiile tehnologice și cunoștințele disciplinare în domeniile lor respective. Învățarea pe tot parcursul vieții este esențială pentru ca profesorii să rămână eficienți și receptivi la nevoile și cerințele în evoluție ale educației specializate în limba engleză și să transmită cunoștințele tinerelor generații.

3. **Considerații etice.** Educația specializată în limba engleză ridică considerații etice legate de tratamentul corect și echitabil al cursanților, protecția drepturilor de proprietate intelectuală și promovarea integrității academice. Profesorii trebuie să respecte standardele etice în practicile lor de predare, asigurându-se că studenții sunt tratați cu respect, integritate și corectitudine pe parcursul călătoriei lor educaționale.

4. **Sensibilitate culturală.** Sensibilitatea culturală este crucială în educația și predarea limbii engleze specializate, în special în mediile de învățare multiculturale și multinaționale. Comunicarea de succes are loc atunci când vorbitorii împărtășesc cunoștințe, credințe și presupuneri și atunci când acestea aderă la reguli similare de interacțiune cooperativă [16]. Iată de ce profesorii trebuie să promoveze un mediu de învățare favorabil și incluziv, care respectă și celebrează diversele medii lingvistice și culturale ale studenților. Promovarea sensibilității culturale îmbunătățește colaborarea, comunicarea și înțelegerea reciprocă între cursanții din medii culturale și lingvistice diverse.

Înțelegerea beneficiilor și implicațiilor predării limbii engleze specializate este esențială pentru profesori, studenți și părțile interesate deopotrivă. Recunoscând potențialul de transformare al educației specializate în limba engleză, profesorii pot valorifica puterea de a împuternici tinerii, de a stimula creșterea profesională și de a facilita colaborarea globală și inovarea în domenii specializate.

7. Concluzii

În concluzie, predarea limbii engleze de specialitate necesită o abordare multifuncțională care să integreze instruirea bazată gen și pe sarcini, materiale autentice și evaluarea formativă. Îmbunătățirea abilităților în predarea limbii engleze este crucială pentru profesori deoarece garantează o experiență de învățare mai eficientă și mai interesantă pentru studenți. Prin explorarea și aplicarea continuă a metodelor noi de predare și a tehnologiilor educaționale moderne, profesorii pot dezvolta competențele necesare pentru a livra conținutul într-un mod accesibil și captivant. Participarea activă la training-uri și workshop-uri specializate în domeniul predării limbii engleze poate, de asemenea, să ajute la crearea unei game variate de strategii didactice adaptate nevoilor diverse ale studenților. Astfel, investiția în îmbunătățirea competențelor pedagogice nu doar îmbunătățește calitatea procesului educațional, ci și sporește nivelul de încredere și satisfacție al cadrelor didactice în propria lor performanță. Prin valorificarea acestor considerente și strategii pedagogice, profesorii își pot ghida studenții să navigheze în complexitățile utilizării limbii în domenii specializate cu încredere și competență, promovând competența lingvistică și alfabetizarea disciplinară esențială pentru succesul în contexte profesionale.

Implicarea studenților în medii profesionale din lumea reală joacă un rol crucial în predarea limbii engleze specializate, îmbunătățirea abilităților lingvistice, cunoștințele disciplinare și eficacitatea comunicării în anumite domenii. Prin imersarea cursanților în

contexte profesionale autentice, ei dobândesc cunoștințe și competențe specifice domeniului. Prin valorificarea materialelor autentice și a învățării contextualizate prin strategii pedagogice, profesorii pot încuraja studenții să devină specialiști care vor da dovadă de cunoștințe aprofundate, abilități de soluționare a problemelor și profesionalism.

Pe baza recomandărilor menționate mai devreme, profesorii îndrumă studenții în cultivarea preciziei lingvistice, fluenței și abilităților pragmatice necesare unei comunicări de succes în domeniile de specialitate. Studenții care demonstrează competențe într-un anumit domeniu deschid uși către multiple oportunități de carieră și avansare în diferite sfere specializate. Cei care sunt înzestrați cu abilități lingvistice specializate se află într-o poziție privilegiată pentru a-și construi cariere în mediul academic, de cercetare, de afaceri, în inginerie și alte sectoare profesionale în care comunicarea eficientă este cheia succesului.

Prin utilizarea instruirii bazate pe gen și pe sarcini, a materialelor autentice și a evaluării formative pentru promovarea competenței lingvistice și a alfabetizării în domeniul respectiv, profesorii pot îmbunătăți autenticitatea, relevanța și eficacitatea predării limbii engleze în contexte profesionale.

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METHODS OF ASSESSING STUDENTS' KNOWLEDGE IN ENGLISH LANGUAGE LESSONS

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Abstract. Assessing students' knowledge in English language lessons is a crucial aspect of language education, impacting both teaching effectiveness and student outcomes. This article explores a variety of methods used to evaluate English language proficiency, considering both traditional and modern assessment techniques. Traditional methods such as written and oral exams are examined alongside performance-based assessments like portfolios and project-based learning. Additionally, the article delves into formative assessments, including quizzes and classroom activities, and the growing role of technology-enhanced assessments through computer-based testing and language learning apps. By examining the effectiveness, advantages, and limitations of each method, the article provides valuable insights into how these diverse tools can be integrated into a comprehensive assessment strategy. The ultimate aim is to offer educators a detailed understanding of assessment practices to enhance language teaching and learning outcomes, ensuring that students are accurately and fairly evaluated in their English language proficiency.

Key words: *assessment, knowledge, performance, methods, abilities, skills.*

Rezumat. Evaluarea cunoștințelor studenților la lecțiile de limba engleză prezintă un aspect crucial al educației lingvistice, influențând atât eficacitatea predării, cât și rezultatele studenților. Acest articol explorează o varietate de metode utilizate pentru a evalua competența în limba engleză, luând în considerare atât tehnicile de evaluare tradiționale, cât și cele moderne. Metodele tradiționale, cum ar fi examenele scrise și orale, sunt examinate alături de evaluările bazate pe performanță, cum ar fi portofoliile și învățarea bazată pe proiecte. În plus, articolul analizează evaluările formative, inclusiv chestionarele și activitățile de clasă, precum și rolul tot mai important al evaluărilor îmbunătățite prin tehnologie, cum ar fi testele pe calculator și aplicațiile de învățare a limbilor străine. Prin examinarea eficacității, avantajelor și limitărilor fiecărei metode, articolul oferă perspective valoroase despre modul în care aceste instrumente diverse pot fi integrate într-o strategie de evaluare cuprinzătoare. Scopul final este de a oferi profesorilor o înțelegere detaliată a practicilor de evaluare pentru a îmbunătăți rezultatele predării și învățării limbii, asigurându-se că studenții sunt evaluați corect și precis în competențele lor de limba engleză.

Cuvinte cheie: *evaluare, cunoștințe, performanță, metode, abilități, competențe.*

1. Introduction

Assessment in education is the systematic process of documenting and using empirical data on knowledge, skills, attitudes, and beliefs to refine programs and improve student learning [1]. It serves as a crucial component in the educational process, providing educators with essential information to guide instruction and enhance student outcomes. In the context of English language lessons, assessment methods must accurately measure students' abilities in core language skills such as reading, writing, listening, and speaking [2]. Effective assessment strategies not only gauge student proficiency but also inform instructional practices and curriculum adjustments.

With the diverse needs of learners and the evolving nature of language education, it is imperative to employ a variety of assessment techniques [3]. Traditional tests, such as written exams and oral presentations, have long been staples in language assessment. However, the growing recognition of performance-based assessments, which include portfolios and project-based learning, highlights the need for more dynamic and comprehensive evaluation methods. These approaches provide deeper insights into students' practical language use and critical thinking skills [4].

Formative assessments, such as quizzes and classroom activities, play a vital role in monitoring student progress and providing ongoing feedback. These assessments help teachers identify areas where students struggle and adjust their teaching strategies accordingly. Additionally, the integration of technology-enhanced assessments, such as computer-based testing and language learning apps, has introduced innovative ways to evaluate language proficiency. These tools offer interactive and adaptive testing environments that can cater to individual learning needs.

This article will explore these diverse assessment methods, examining their effectiveness, advantages, and limitations, to provide educators with a detailed understanding of how to implement a comprehensive assessment strategy in English language education.

2. Materials and Methods

In writing this article on the Methods of Assessing Students' Knowledge in English Language Lessons, a comprehensive and well-researched approach was taken by the authors. Various materials were consulted, and methodological approaches were employed to ensure depth and reliability in the findings.

Key references included works by Brown, Hughes, Fulcher, Davidson, Bachman, Palmer, Andrade, Cizek, Chapelle, and Douglas, covering essential aspects of language assessment principles, practices, and technology integration. Databases such as Google Scholar, JSTOR, and ERIC were utilized to access a wide range of peer-reviewed articles and educational research. Institutional access to online libraries facilitated comprehensive literature reviews. Moreover, articles and blogs from reputable educational websites like Edutopia, TESOL, and the British Council were reviewed for current practices. Resources from language learning platforms such as Duolingo, Babbel, and Rosetta Stone provided insights into technology-enhanced assessments [5].

National and international curriculum standards, including those from the Common European Framework of Reference for Languages (CEFR) and the American Council on the Teaching of Foreign Languages (ACTFL), were examined to understand standardized assessment requirements all over the world, in the best educational establishments [6].

A systematic literature review was conducted, gathering existing research and theoretical perspectives on language assessment. This involved identifying and reviewing relevant books, journal articles, and online resources to understand the current landscape of English language assessment methods. Traditional and modern assessment methods were compared in terms of their effectiveness, advantages, and limitations. Empirical studies, expert opinions, and case studies were examined to draw informed conclusions about each method's utility.

The information from various sources was synthesized to provide a comprehensive overview of assessment methods. This involved integrating theoretical insights with practical examples to create a balanced and informative article. Each assessment method was evaluated based on criteria such as reliability, validity, feasibility, and educational impact. This evaluation was guided by established frameworks and best practices in language assessment [1, 7].

All sources were properly cited to acknowledge the contributions of original authors and researchers. Efforts were made to present a balanced view of various assessment methods, avoiding favoritism towards any particular approach.

The materials and methods used in writing this article were carefully selected to provide a thorough and balanced examination of assessment methods in English language lessons. By leveraging a wide range of academic resources, conducting detailed comparative analyses, and incorporating expert insights, this article aims to offer valuable guidance to educators on effective assessment practices.

3. Traditional Assessment Methods

The best known and most frequently used knowledge evaluation methods, traditional methods, are the exams. These include the written and the verbal/oral examination.

Written exams are a conventional method of assessment and are widely used to evaluate students' understanding of grammar, vocabulary, reading comprehension, and writing skills. These exams typically include multiple-choice questions, short answer questions, essays, and translation exercises [8]. Such an assessment offers an objective grading through multiple-choice and true/false questions, providing a standardized method of assessment that minimizes grading bias and allows for objective scoring. It can cover a broad range of topics and are standardized, making it easy to compare results across different students, in different groups, facilitating large-scale assessments and benchmarking. On the other hand, it may not effectively assess oral communication skills, which are crucial for language proficiency. The written type of evaluation can encourage rote memorization rather than deep understanding of the material, potentially limiting students' ability to apply knowledge in practical situations. Quite often written examination cause high anxiety levels among students, which obviously can affect performance, leading to results that may not accurately reflect their true abilities.

Oral exams assess students' speaking and listening skills [9]. These exams often involve one-on-one interviews, presentations, or group discussions which directly measures speaking proficiency and listening comprehension - essential components of language learning. Oral examination is very convenient as provides immediate feedback, allowing students to understand their strengths and areas for improvement in real-time while assessing fluency, pronunciation, and interactive communication skills, offering a well-rounded assessment of their oral abilities [10]. But again, it is not perfect as it gives subjective grading that can lead to inconsistencies. This can affect the reliability and fairness of the

assessment. Oral examination is time-consuming; it requires significant time for both students and educators, limiting their practicality in large classes or institutions with limited resources. Similar to written exams, oral exams can induce anxiety, particularly for students who are uncomfortable with public speaking or one-on-one interactions.

Both written and oral exams are integral to assessing English language proficiency. While written exams offer a structured and objective means of evaluating certain skills, oral exams provide a necessary measure of students' interactive and communicative abilities. Balancing these methods within an assessment strategy can help educators achieve a comprehensive understanding of their students' language proficiency.

4. Performance-Based Assessments

Performance-based assessments are dynamic evaluation methods that emphasize students' practical application of knowledge and skills. Unlike traditional assessments, these approaches focus on real-world tasks and projects, allowing students to demonstrate their learning in more authentic contexts. By engaging in activities such as creating portfolios and undertaking project-based learning, students can showcase a range of competencies, from critical thinking and problem-solving to collaboration and communication [11]. These methods not only provide a comprehensive view of student progress but also encourage self-reflection and deeper learning. However, they require significant time and resources, and the subjective nature of their evaluation can present challenges.

Briefly analyzing the constituents of Performance-Based type of Evaluation, we can come up with such a description:

a) Portfolios are collections of students' works accumulated over time, showcasing their progress and achievements. These may include essays, project reports, recorded speeches, and reflective journals. Portfolios provide a holistic view of a student's abilities and progress, capturing a wide range of skills and learning experiences. They encourage students to engage in self-reflection and self-assessment, fostering a deeper understanding of their own learning processes. Portfolios can include diverse types of work, demonstrating different skills such as writing, speaking, and critical thinking. But then again, they have limitations as well. Compiling and assessing portfolios can be very time-consuming for both students and educators. The evaluation of portfolios can be subjective, potentially leading to inconsistencies in grading. Managing portfolios may not be feasible for large classes due to the extensive time and resources required.

b) Project-based learning involves students working on a project over an extended period, culminating in a presentation. This method assesses a variety of skills, including research, writing, collaboration, and presentation. This approach engages students in real-world tasks, making learning more relevant and meaningful. It develops higher-order thinking skills, such as analysis, synthesis, and evaluation, by challenging students to apply their knowledge in practical contexts. Project-based learning encourages collaboration, promoting teamwork and communication skills, and allows students to experience practical application of their knowledge.

The opposite side of Project-Based entry is that implementing project-based learning requires significant time and resources, which may not always be available. Assessing group work can be challenging, as it is difficult to ensure that all group members contribute equally and receive fair evaluations.

Performance-based assessments, through portfolios and project-based learning, offer valuable insights into students' abilities by emphasizing practical application and reflective

learning [12]. However, they also pose challenges in terms of time, resources, and subjective evaluation, requiring careful planning and implementation to be effective. Balancing these methods with traditional assessments can provide a more comprehensive evaluation of students' language proficiency and overall educational development.

5. Formative Assessment Methods

Formative assessment methods are integral tools in the educational process, designed to monitor student learning and provide ongoing feedback that can be used to improve both teaching and student performance. Unlike summative assessments, which evaluate student learning at the end of an instructional period, formative assessments are conducted continuously throughout the learning process. This ongoing evaluation enables teachers to identify learning gaps and address them promptly, ensuring that students receive the support they need when they need it [13].

These methods include quizzes, classroom activities, peer assessments, and teacher observations, all aimed at identifying students' strengths and areas for improvement in real-time. Quizzes offer a quick check of understanding and can be easily integrated into daily lessons. Classroom activities, such as group work and discussions, provide opportunities for students to apply their knowledge in collaborative settings, fostering deeper understanding and critical thinking skills. Peer assessments encourage students to engage with each other's work, promoting a sense of responsibility and improving their analytical skills [14].

Teacher observations are another crucial component of formative assessment, allowing educators to gather insights into student behavior, participation, and engagement. By offering immediate feedback, formative assessments help students understand their progress, pinpoint their learning challenges, and recognize their achievements. This feedback is essential for guiding teachers in adjusting instructional strategies to meet diverse learning needs, tailoring their approaches to support each student's unique learning journey.

This approach fosters a more responsive and adaptive learning environment, promoting student engagement and motivation. When students receive constructive feedback regularly, they are more likely to stay motivated and invested in their learning. They become active participants in their educational journey, setting goals, and taking ownership of their progress. Despite their benefits, implementing formative assessments effectively can be time-consuming and requires careful planning. Teachers must balance the need for continuous assessment with the demands of delivering curriculum content, often requiring creativity and flexibility.

Nonetheless, the role of formative assessments in enhancing learning outcomes and supporting personalized education makes them a valuable component of effective teaching practices. They enable a nuanced understanding of student needs and progress, ensuring that education is not just a one-size-fits-all process but a dynamic, tailored experience that evolves with the learner.

6. Technology-Enhanced Assessments

Technology-enhanced assessments (TEAs) are innovative tools that leverage digital platforms and tools to evaluate student learning in more dynamic and interactive ways [15]. As educational technology continues to evolve, these assessments have become increasingly integral to modern education, offering numerous benefits over traditional assessment methods. By utilizing computers, tablets, and other digital devices, TEAs can provide

immediate feedback, adapt to the individual needs of students, and engage learners through interactive content.

One of the key advantages of technology-enhanced assessments is their ability to deliver immediate, actionable feedback. Unlike traditional paper-based tests, which can take time to grade and return, TEAs often use automated scoring systems that provide students with instant results. This immediate feedback helps students quickly identify areas where they need improvement and allows teachers to adjust their instruction accordingly. For example, computer-based tests can offer interactive questions that adjust in difficulty based on the student's responses, ensuring that the assessment is appropriately challenging for each learner [16].

TEAs also support personalized learning by adapting to the unique needs and abilities of each student. Adaptive assessments can modify the difficulty and type of questions based on real-time performance, providing a tailored evaluation experience that more accurately reflects a student's capabilities. This personalized approach can help educators identify specific areas where individual students may need additional support or enrichment, enabling more targeted and effective teaching strategies.

Moreover, technology-enhanced assessments often incorporate multimedia elements such as videos, simulations, and interactive exercises, making the assessment process more engaging and relevant to students. These interactive elements can help maintain student interest and motivation, leading to a more positive attitude towards testing and learning in general. For example, language learning apps like Duolingo use gamification to make the assessment process more enjoyable, encouraging regular practice and improvement.

Despite their many benefits, implementing technology-enhanced assessments also presents challenges. Schools must invest in the necessary infrastructure, such as reliable internet access and digital devices, and provide adequate training for teachers to effectively use these tools. Additionally, there are concerns about ensuring the security and privacy of student data, which must be carefully managed to protect sensitive information.

To put it briefly, technology-enhanced assessments represent a significant advancement in educational evaluation, offering immediate feedback, personalized learning experiences, and engaging content. While there are challenges to their implementation, the benefits of TEAs make them a valuable component of modern education, capable of enhancing both teaching and learning outcomes in significant ways [17]. By embracing these technological tools, educators can create a more responsive, adaptive, and engaging assessment environment that meets the diverse needs of today's learners.

7. Integrating Multiple Assessment Methods

Effective assessment of English language proficiency often requires a combination of different methods to capture the full range of student abilities. Integrating traditional, performance-based, formative, and technology-enhanced assessments can provide a comprehensive evaluation of students' skills [18]. For instance, a balanced assessment strategy might include periodic written and oral exams to gauge fundamental grammar and speaking skills, ongoing quizzes to monitor progress, portfolio assignments to showcase students' work over time, project-based learning to develop practical language use, and the use of language learning apps to reinforce learning through interactive exercises [19].

After a thorough and detailed study of the subject, we can come up with some practical suggestions for an efficient integration of all the presented methods. If we were to list the most effective practices, they would be described in the following way:

- Ensure that all assessment methods are directly related to the learning goals of the course. This alignment helps maintain the focus on essential language skills and ensures that assessments accurately measure what students are expected to learn. Clear alignment also helps students understand the purpose of each assessment and how it contributes to their overall language proficiency.
- Use a variety of assessments to capture different aspects of language proficiency. For example, written exams can evaluate reading comprehension and grammar, oral exams can assess speaking and listening skills, and portfolios can provide a broad view of a student's abilities through collected works. Project-based learning allows students to demonstrate their language skills in real-world contexts, promoting deeper understanding and application of the language [20].
- Provide students with timely and constructive feedback to guide their learning. Immediate feedback from formative assessments like quizzes and interactive activities helps students identify areas for improvement quickly. Constructive feedback on written and oral exams, as well as on portfolio and project-based work, helps students refine their skills and develop greater language proficiency over time.
- Engage students in the assessment process through self-assessment and peer reviews. Encouraging students to assess their own work helps them develop critical thinking skills and a deeper understanding of the assessment criteria. Peer reviews foster collaborative learning and allow students to gain insights from their peers' perspectives.
- Leverage technology to enhance the assessment process while ensuring accessibility for all students. Technology-enhanced assessments can include online quizzes, digital portfolios, and language learning apps that offer interactive and adaptive exercises. These tools can provide immediate feedback, accommodate diverse learning styles, and make assessments more engaging. Ensuring that all students have access to the necessary technology is crucial to the effective integration of these tools.

To sum up, integrating multiple assessment methods creates a more comprehensive and effective approach to evaluating English language proficiency. By combining traditional assessments with performance-based, formative, and technology-enhanced methods, educators can address the diverse needs and skills of their students [21]. This holistic approach not only provides a more accurate measure of student learning but also fosters a more engaging and supportive learning environment. Through careful alignment with learning objectives, diverse assessment types, regular feedback, student involvement, and the strategic use of technology, educators can enhance their assessment practices and ultimately improve student outcomes in language education.

8. Conclusion

Assessing students' knowledge in English language lessons requires a multifaceted approach that acknowledges the diverse ways in which students learn and demonstrate their proficiency. Traditional assessments, such as written and oral exams, provide structured and standardized ways to measure foundational language skills like grammar, vocabulary, and comprehension. These methods are well-established and offer the advantage of objectivity and comparability across different student populations. However, they also have limitations, particularly in assessing interactive communication skills and fostering deep, meaningful learning.

Performance-based evaluations, such as portfolios and project-based learning, address some of these limitations by allowing students to showcase their abilities in more

dynamic and authentic contexts. Portfolios provide a comprehensive view of a student's progress over time, encouraging self-reflection and continuous improvement. Project-based learning engages students in real-world tasks, promoting the development of higher-order thinking skills and practical application of knowledge. These methods, while time-consuming and sometimes challenging to assess consistently, offer valuable insights into students' practical language abilities and their ability to use English in diverse contexts.

Formative assessments play a crucial role in this multifaceted approach by providing ongoing feedback that guides both teaching and learning. Quizzes, classroom activities, peer assessments, and teacher observations help identify students' strengths and areas for improvement in real-time. This immediate feedback is essential for adjusting instructional strategies and supporting students' continuous development. Formative assessments foster a responsive and adaptive learning environment, promoting student engagement and motivation through regular, constructive feedback.

Technology-enhanced tools have become increasingly important in modern education, offering innovative ways to assess language proficiency. These tools include computer-based tests, language learning apps, and digital portfolios, which can provide immediate feedback and adapt to individual learning needs. Technology-enhanced assessments can make the assessment process more engaging and accessible, incorporating multimedia elements and interactive exercises that appeal to a variety of learning styles. While the implementation of these tools requires careful planning and resources, their potential to enhance both teaching and learning outcomes is significant.

By integrating traditional, performance-based, formative, and technology-enhanced assessments, educators can create a robust and comprehensive assessment strategy. This integrated approach not only measures students' proficiency accurately but also promotes continuous learning and improvement. It recognizes that different assessment methods have unique strengths and can complement each other to provide a fuller picture of student learning.

As the field of education continues to evolve, so too must our approaches to assessment. Educators need to stay informed about new assessment techniques and technologies, and be willing to adapt their practices to meet the changing needs of their students. Effective assessment strategies should be inclusive, ensuring that all students have the opportunity to demonstrate their abilities in ways that suit their individual strengths and learning styles. They should also be adaptive, capable of responding to the diverse and dynamic nature of the classroom environment.

Therefore, a multifaceted approach to assessing students' knowledge in English language lessons is essential for providing a comprehensive, accurate, and meaningful evaluation of their skills. By integrating various assessment methods, educators can support continuous learning, foster student engagement, and ultimately enhance the overall quality of language education. This holistic and adaptive approach ensures that assessment practices remain effective, inclusive, and responsive to the needs of all learners, paving the way for more personalized and impactful educational experiences.

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