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Many thanks to our JISOM community and good luck with your research!

Respectfully,

Alexandru TĂBUȘCĂ, PhD

JISOM Editor-in-Chief

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Abstract

The objective of this study is to provide a comprehensive comparison between open-source projects and closed-source projects by examining several key aspects, including the number of contributors or employees, the number of features introduced per project, the number of vulnerabilities present in the software, revenue or profit, and project management techniques. By comparing these aspects across a range of open-source and closed-source projects, we aim to evaluate the potential for these distribution models to complement each other and identify the contexts in which one model may be more effective than the other. This analysis seeks to provide valuable insights for stakeholders involved in software development, including developers, project managers, and decision-makers. In conclusion, this study provides a nuanced comparison of open-source and closed-source software projects, addressing key areas like contributor numbers, feature development, vulnerabilities, revenue, and project management. The insights gained are intended to guide

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stakeholders in software development, helping to discern which model is more effective in various contexts and how they might complement each other.

Keywords: open-source, closed-source, comparison, software projects

JEL Classification: L86, C88

1. Introduction

1.1 Objective

The primary objective of this study is to conduct a comprehensive comparison between open-source software projects and closed-source software projects. The comparison is based on various key aspects, including the number of contributors/employees, the number of features introduced per project, the number of vulnerabilities (bugs or more serious problems) present in the software, revenue, and project management techniques.

One important metric to consider is the number of contributors, which is relevant due to the fundamental differences in the underlying development models of the two types of projects. Open-source projects rely on contributions from a large and diverse pool of contributors, who may participate on a part-time basis or as paid employees of other organizations. In contrast, closed-source projects typically rely on a fixed number of employees working full-time, with specific tasks assigned to them.

The second metric examined is the number of features introduced in the software project. Open-source projects rely on the voluntary contributions of developers, which can lead to a more decentralized and organic approach to feature development. Conversely, closed-source projects often assign teams to specific features, leading to a more streamlined and efficient process.

The third metric is the number of vulnerabilities present in the software. Open-source projects often have many contributors, which can facilitate the rapid detection and resolution of security issues. In contrast, closed-source projects may prioritize feature development over security, resulting in a higher likelihood of vulnerabilities.

The fourth metric is revenue or profit, which differs significantly between the two models. Closed-source projects prioritize profit, often using aggressive marketing strategies, while open-source projects generally develop software as "freeware", focusing on attracting users and contributors to the project, which can lead to support from large tech companies. However, smaller open-source projects may rely on donations or voluntary contributions from developers.

Finally, the study examines project management techniques employed by both models. Closed-source projects typically follow a strict hierarchical structure, with limited

opportunities for movement or change. In contrast, open-source projects typically operate with little or no formal hierarchy, relying on a decentralized and self-organizing structure that allows developers to work on tasks that interest them.

Overall, this study provides valuable insights into the similarities and differences between open-source and closed-source software projects, which can inform decision-making by developers, project managers, and other stakeholders involved in software development.

1.2 Importance

Historically, the computer market was dominated by big tech companies that held monopolies over different aspects of the supply chain. This created significant challenges for smaller firms seeking to compete, as they lacked the knowledge and resources necessary to do so effectively. Open-source projects have disrupted this status quo by providing access to the same tools and knowledge to all participants, regardless of their size. This has resulted in increased competition and innovation in the industry, benefiting both large and small firms alike.

Today, open-source and closed-source projects coexist in many computer systems and are widely used by companies and individuals around the world. A notable example is the Android operating system, which utilizes a Linux kernel, an open-source project, in combination with proprietary software packages and applications.

Given the ubiquity of both open-source and closed-source software, it is important to conduct a comparative analysis of their respective development methods and associated advantages and disadvantages. Such an analysis can help inform decision-making by software developers and consumers alike and shed light on the potential implications of using one approach over the other.

1.3 Terminology

Throughout this paper, the terms open-source and closed-source will be used frequently. By open-source, we refer to projects that have a publicly available codebase on a hosting site, accessible and usable by anyone. By closed-source, we refer to projects that do not have a publicly available codebase but only provide the application (end-product) to the users. For this paper, we do not consider other aspects such as licensing, which could further categorize these two types of projects. Our focus is on software development projects of any industry or niche.

GitHub[9], a popular code-hosting platform, is used by many projects to share their code and related comments/issues using the git tool as the underlying versioning system.

[9] www.github.com

In this paper, we define a bug as any fault or failure in the code that results in unexpected behavior but does not affect the security or vulnerability of the system. On the other hand, a vulnerability is any fault or failure in the code that results in unexpected behavior and leads to a significant security vulnerability, as classified in the official CVE dataset [1].

A feature refers to any improvement made to an existing codebase, bringing new changes as noticed by the end-user or improving the existing codebase's performance or other noticeable benefits as dictated by common knowledge.

The term end-user can refer to any person or company using a software product, regardless of their technical background. In the case of open-source projects, end-users may also be direct code contributors to the project.

A code contributor is any person who adds or modifies the code in a meaningful way, fixing bugs or developing new features.

In conclusion, this study meticulously examines the multifaceted dynamics between open-source and closed-source software projects, delving into the nuances of contributor engagement, feature development, software vulnerabilities, financial models, and management methodologies. Through this analytical lens, we aim to elucidate the distinct characteristics and operational paradigms of each model, thereby enriching the understanding of their respective efficacies and potential synergies in various contexts. The insights garnered from this comparative analysis are intended to serve as a robust foundation for informed decision-making and strategic planning among software developers, project managers, and other key stakeholders in the realm of software development. This endeavor not only contributes to the academic discourse but also pragmatically guides the evolving practices in the software industry.

The paper's structure is as follows: Chapter 2 compares the number of contributors to different projects, Chapter 3 compares the features of different projects, Chapter 4 compares the number of vulnerabilities in certain projects, Chapter 5 compares profit margins and funding/revenue, and Chapter 6 discusses project management techniques and their influence on project development. Chapter 7 provides the paper's conclusion.

Key Takeaways:

- Objective of Study: To comprehensively compare open-source and closed-source software projects based on contributors, features, vulnerabilities, revenue, and project management techniques.
- Contributors: Open-source projects typically have a large, diverse pool of part-time or externally employed contributors. Closed-source projects rely on a fixed number of full-time employees.
- Feature Development: Open-source projects feature decentralized, organic development, while closed-source projects have a more streamlined, team-specific approach.

- Vulnerabilities: Open-source projects may have quicker detection and resolution of security issues due to many contributors. Closed-source projects might prioritize features over security, potentially increasing vulnerabilities.
- Revenue Models: Closed-source projects focus on profit, often with aggressive marketing. Open-source projects are usually freeware, attracting users and contributors, and may receive support from large tech companies or rely on donations.
- Project Management: Closed-source projects often have a strict hierarchical structure, whereas open-source projects usually have a decentralized, self-organizing structure with more freedom for developers.
- Market Impact: Open-source projects have disrupted traditional tech monopolies, increasing competition and innovation.
- Coexistence of Models: Both open-source and closed-source software are prevalent, exemplified by the Android OS, which uses both.
- Importance of Comparative Analysis: Analyzing these models aids decision-making for developers and consumers, highlighting the implications of each approach.
- Terminology Definitions:
    - Open-Source: Projects with publicly accessible codebases.
    - Closed-Source: Projects without public codebases, offering only the end-product.
    - Bugs and Vulnerabilities: Defined in relation to unexpected behavior and security impact.
    - Features: Improvements or enhancements in the codebase.
    - End-Users and Code Contributors: Defined in the context of software usage and development.

2. Contributors/employees

A crucial aspect in comparing open-source and closed-source projects is the number of contributors or employees involved in the development of a particular project. Although this metric does not directly indicate the pace of development or the number of features a project has, it is still significant and can potentially affect both aspects. A higher number of contributors can facilitate finding support for new features and enable a more efficient resolution of bugs in the software application.

In this paper, we examine data encompassing both open-source and closed-source projects. For instance, Figure 2 displays the most extensive open-source projects on Github ranked by the number of contributors as of 2022, based on a report published by the platform [3]. Interestingly, despite these projects being open-source, the majority of them are owned by major tech companies that utilize these tools in a business setting. Consequently, many

contributors to these projects are likely employees of the tech giants who own the projects, remunerated to work on specific codebases.

To support this assertion, Table 1 and Figures 2 [10] exhibit contributions from companies renowned for closed-source projects rather than open-source ones. Table 1 illustrates the top ten private companies based on the number of active contributors as of January 2023, according to the Open-Source Contributor Index [2], a platform that extracts information about open-source repositories hosted on GitHub. These numbers reflect the contributors directly involved in the codebase for open-source projects.

Rank	**Organization**	**Active Contributors**	**Total Community**
1	Google	7188 *+219*	13819 *+295*
2	Microsoft	6956 *+190*	14417 *+212*
3	Red Hat	4195 *+53*	6085 *+33*
4	Intel	3009 *+96*	5910 *+121*
5	Amazon	2793 *+90*	6571 *+121*
6	IBM	2719 *+72*	6337 *+101*
7	Facebook	1845 *+30*	7134 *+196*
8	GitHub	1845 *+63*	3990 *+37*
9	VMware	1244 *+33*	2271 *+49*
10	SAP	1132 *+50*	2282 *+42*

Table 1. Commercial organizations' contributor numbers as of January 2023, according to the Open-Source Contributor Index (an increase from the previous month).

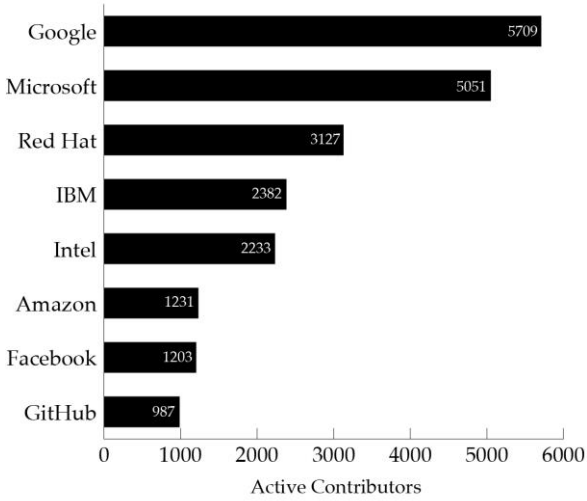

Figure 1. Open-source contributions reported by Github on their platform in December 2020.

Figure 1 illustrates a comparable metric provided by GitHub, dated December 2020, which presents code active contributions on their platform. In this case, active contributors are the users that have more than ten commits. A noteworthy observation is a year-on-year variation. Notably, Google has contributed more than 1,200 new contributors to open-source projects each year [10].

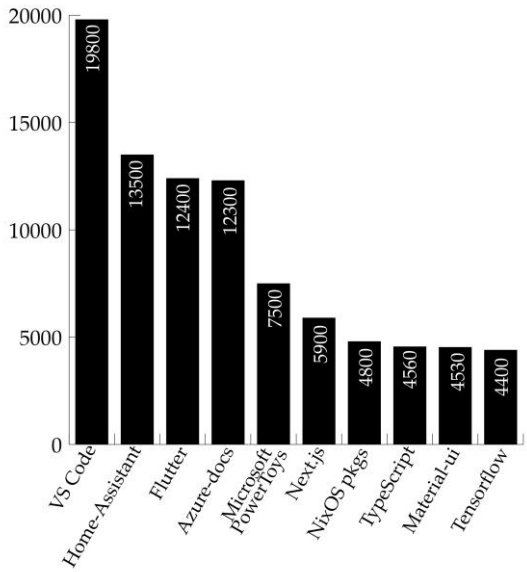

Figure 2. The biggest open-source projects on GitHub, according to the total number of contributors in 2022.

In the context of closed-source projects, the amount of available information is limited. Nonetheless, we were able to gather data regarding the number of employees from four major tech companies, namely [4][5][6][7]. It should be noted, however, that this figure is not indicative of the precise number of software developers, but rather the total number of employees. For instance, some sources estimate that Google has approximately 18,000 employees worldwide that are involved in software creation, development, or related tasks, which is comparable to the number of contributors to major open-source projects. Conversely, Microsoft is reported to have approximately 40,000 employees who work on software development.

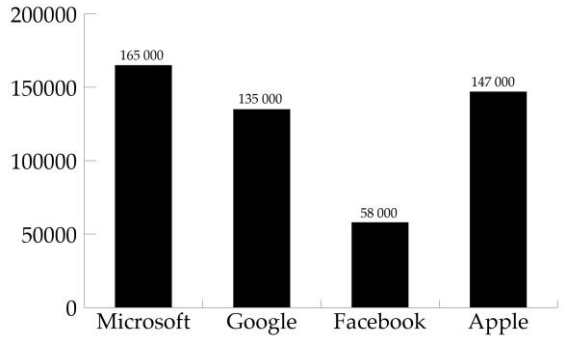

Figure 3. Speculative total number of employees for 4 of the biggest tech companies (all types of employees, not just developers) for 2020.

In conclusion, this chapter's detailed exploration of the number of contributors and employees in both open-source and closed-source projects reveals multifaceted dynamics within the software development landscape. Our analysis, underpinned by data from various reputable sources, indicates a significant presence of major tech companies in the open-source arena, often paralleling their closed-source endeavors. Notably, the juxtaposition of contributor engagement in open-source projects with the employee base in closed-source ventures offers a nuanced understanding of how human resources are allocated and utilized in these distinct yet interconnected domains.

Key Takeaways:

- Contributor/Employee Numbers in Open-Source vs. Closed-Source Projects: The number of contributors or employees is significant in comparing open-source and closed-source projects, though it doesn't directly indicate the development pace or feature count.
- Open-Source Projects Dominated by Major Tech Companies: Most extensive open-source projects are owned by major tech companies, with many contributors being their employees.

- Data from GitHub and Open-Source Contributor Index: Data shows the top open-source projects on GitHub and the top private companies with the most active contributors in open-source projects.
- Tech Giants Leading in Open-Source Contributions: Companies like Google, Microsoft, and Red Hat are leading in terms of active contributors to open-source projects.
- Year-On-Year Variation in Contributions: There is a notable yearly increase in contributors to open-source projects, with Google adding over 1,200 new contributors annually.
- Limited Data on Closed-Source Project Employees: Information about the number of employees in closed-source projects is limited and not necessarily indicative of the number of software developers.
- Comparison of Employees in Major Tech Companies: Estimates show significant numbers of employees in major tech companies involved in software-related tasks, comparable to the number of contributors to major open-source projects.

3. Features comparison

This metric assumes significance in evaluating a software project's success, which directly influences its acceptance among users or investors. The number of features and the development time are critical indicators that determine the speed and efficiency with which the software evolves and is distributed to the end users. In the case of open-source projects, we obtained data from 10 applications, sourced from the TAWOS Dataset [8], which we analyzed and processed as per our research requirements. The outcomes of our analysis are presented in Figure 6, which includes crucial metrics such as the number of bugs or issues, the count of fixed bugs, and the number of features of the respective projects. Additionally, Figure 4 illustrates the number of launched features, in-development features, and the aggregate number of features across all 44 Microsoft applications listed on their official roadmap website [9].

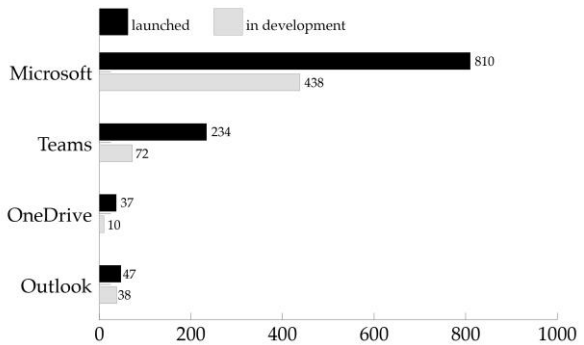

Figure 4. Features numbers and status for Microsoft products, according to the company's official roadmap, between 2021-2023.

Initially, it is crucial to examine Microsoft's closed-source products. Assuming that Microsoft has approximately 40,000 software engineering positions and considering the 1,200 features developed between 2021 and 2023, we can deduce that approximately 33 engineers worked on each feature during this period. It should be noted that not all features were developed simultaneously, and certain features took longer to develop than others. Nonetheless, this approximation offers us a general idea of the engineers' engagement in Microsoft's closed-source projects.

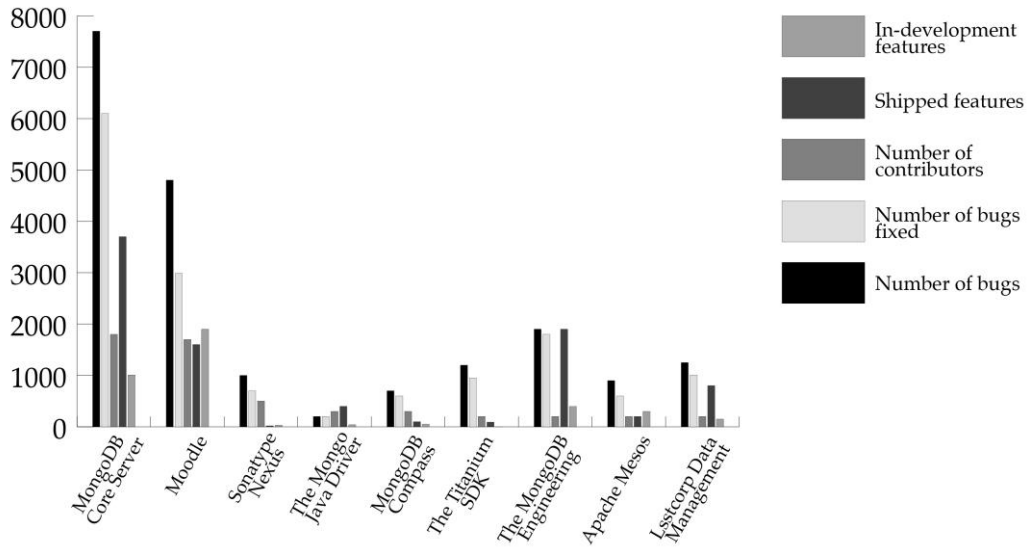

Figure 5. Statistics for 10 open-source projects, sorted by the number of contributors (2018-2020).

Examining several open-source projects presented in Figure 5 (derived from [8]), we have calculated the ratio of contributors to the total number of features for the first three products during a comparable two-year period (2018-2020): MongoDB Core Server - 0.37, Moodle - 0.51, Sonatype Nexus - 0.92. These figures are noticeably different from those of Microsoft's closed-source products. We posit that these differences arise from distinct working methods. On the one hand, Microsoft maintains a clear hierarchy, with numerous personnel working within sub-teams. Conversely, open-source projects lack such a clear hierarchical structure, allowing contributors to move freely between features, codebase issues, or even other projects altogether. Ultimately, these differences reflect each project's objectives. Closed-source projects concentrate on specific features demanded by their clients (either large corporations or a significant number of global users), while open-source projects tend to be more diffuse in their feature objectives, where a particular feature may be introduced by a contributor for personal use or the benefit of a small number of

community members, prioritizing practicality over the service of a large number of end-users. This distinction can be summed up by the term impact (referring to the number of end-users reached): closed-source projects concentrate on fewer features with greater impact, while open-source projects spread out over more features with less impact.

In conclusion, our comparative analysis of features in both open-source and closed-source software projects, as delineated in Figures 4 and 5, underscores the fundamental disparities in development methodologies and objectives between these two paradigms. The data-driven approach, utilizing the TAWOS Dataset and Microsoft's official roadmap, has illuminated the intricate dynamics of feature development and distribution. In particular, the significantly divergent ratios of contributors to features in open-source projects, as compared to the more concentrated and impact-focused approach in Microsoft's closed-source ventures, highlight the distinct operational ethos that characterizes each model. Such insights not only deepen our understanding of software development practices but also offer valuable perspective for stakeholders in making strategic decisions that align with their project's specific goals and intended user impact.

Key Takeaways:

- Significance of Features Comparison: This metric is crucial for assessing a software project's success and its acceptance among users or investors.
- Key Indicators: The number of features and development time are essential indicators for determining the software's evolution speed and efficiency.
- Data Source for Open-Source Projects: Analysis based on data from 10 applications from the TAWOS Dataset, focusing on metrics like bug counts and feature numbers.
- Microsoft's Closed-Source Products: Analysis of around 1,200 features developed between 2021 and 2023, with an estimated 33 engineers working on each feature.
- Variation in Development Patterns: Not all features in Microsoft's projects were developed simultaneously, and some took longer than others.
- Open-Source Projects Analysis: Comparison of the ratio of contributors to features in projects like MongoDB Core Server, Moodle, and Sonatype Nexus, showing significant differences from Microsoft's pattern.
- Differences in Organizational Structure: Microsoft has a clear hierarchy and sub-teams, while open-source projects lack such structure, allowing more flexibility for contributors.
- Project Objectives and Impact: Closed-source projects focus on specific features with greater impact for clients, while open-source projects have more diffuse objectives, often prioritizing practicality for smaller user groups.
- Feature Focus: Closed-source projects concentrate on fewer, high-impact features, whereas open-source projects spread across more features with less overall impact.

4. Vulnerabilities

Security is a crucial aspect of software development, and as such, it is essential to consider it when writing and deploying code online. Therefore, our third metric focuses on the security of both closed-source and open-source projects. Figure 7 showcases ten projects, five of which are open-source and five closed-source, that experienced a high number of security issues, according to the official Common Vulnerabilities and Exposures (CVE) dataset [1], during a period spanning from January 2018 to September 2019. The severity of vulnerabilities is measured by the CVSS score, which takes into account multiple factors such as exploitability, impact, complexity, scope, and other relevant metrics. The CVSS score categorizes issues into high, medium, or low severity.

Figure 6 displays the number of vulnerabilities found in popular open-source and closed-source projects between January 2018 and September 2019. The Common Vulnerabilities and Exposures (CVE) dataset was used to identify and categorize the severity of vulnerabilities. The CVE score considers factors such as exploitability, impact, complexity, and scope to rank vulnerabilities as high, medium, or low severity. Android had the highest number of high-severity vulnerabilities with 403 issues, while Debian had the highest number of medium-severity security vulnerabilities at 658. Firefox had the lowest number of vulnerabilities in all three categories among the five open-source projects.

Regarding closed-source projects, all except Acrobat Reader DC had a lower number of low or medium-severity vulnerabilities compared to high-severity breaches. Windows Server 2019 and Edge had 238 and 135 high-severity issues, respectively, whereas Mac OS X performed the best with only 120 vulnerabilities in all three categories. Overall, closed-source projects had almost half as many vulnerabilities as open-source projects, with 1558 and 2731, respectively.

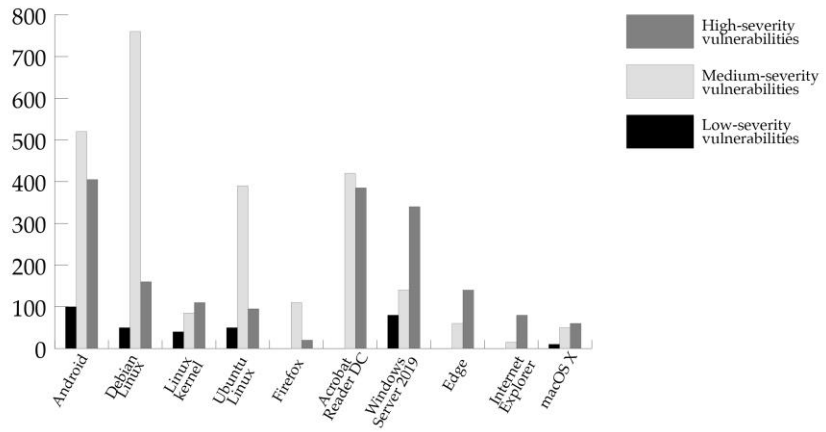

Figure 6. Number of CVE vulnerabilities by severity for 5 open-source projects (first 5 to the left) and 5 closed-source projects (last 5 to the right) between January 2018 and September 2019

However, this figure may be somewhat misleading due to several factors. First, projects that frequently introduce new features may also introduce security issues. Second, the selected period might conceal the number of security issues in the past. Third, differences in project management techniques between open-source and closed-source projects could influence the development and validation process of the product.

Additionally, although the code of open-source projects is publicly available, it does not necessarily make them more vulnerable to attack. There are several examples of severe vulnerabilities in closed-source products that were discovered years after their release. Furthermore, the responsibility of maintaining and securing the code may not be as appealing to contributors in open-source projects as developing new features, whereas closed-source projects often have designated teams for this purpose.

In conclusion, our examination of the security vulnerabilities in open-source and closed-source software projects, as represented in Figure 6 and substantiated by data from the Common Vulnerabilities and Exposures (CVE) dataset, reveals a nuanced landscape of software security. While the initial data suggests a higher incidence of vulnerabilities in open-source projects, this observation must be contextualized within the broader framework of software development practices and the inherent limitations of the study period. The dynamic nature of feature introduction, coupled with the variance in project management methodologies, contributes to the complexity of accurately assessing and comparing the security profiles of these projects. It is also noteworthy that the public availability of open-source code does not axiomatically correlate with increased vulnerability. In contrast, the history of software development contains instances of significant security oversights in closed-source projects, undetected for extended durations. This analysis underscores the multifaceted challenges in maintaining and securing codebases, particularly in open-source projects where the focus may predominantly be on feature development rather than security maintenance, a task often systematically addressed by dedicated teams in closed-source environments.

Key Takeaways:

- Security in Software Development: Security is a critical aspect in software development, requiring careful attention during code writing and deployment.
- Security Metrics: Focuses on assessing the security of both closed-source and open-source projects.
- Use of CVE Dataset: Utilizes the Common Vulnerabilities and Exposures (CVE) dataset to evaluate security issues in ten projects (five open-source, five closed-source) from January 2018 to September 2019.
- Severity Measurement: The severity of vulnerabilities is measured using the CVSS score, which considers factors like exploitability, impact, complexity, and scope.

- Vulnerability Distribution: Android showed the highest number of high-severity vulnerabilities, while Debian had the most medium-severity issues among open-source projects. Firefox had the fewest vulnerabilities.
- Closed-Source Project Vulnerabilities: Closed-source projects, except Acrobat Reader DC, generally had fewer low or medium-severity vulnerabilities compared to high-severity ones. Mac OS X had the best performance in this category.
- Comparison of Open vs. Closed-Source: Closed-source projects had almost half as many vulnerabilities as open-source projects.
- Factors Influencing Vulnerability Figures: Factors like frequent introduction of new features, the selected time period, and differences in project management techniques can affect the number of reported security issues.
- Misconception about Open-Source Security: Open-source projects, despite their public code access, are not inherently more vulnerable to attacks. In contrast, some closed-source products have had severe vulnerabilities undiscovered for years.
- Responsibility in Code Maintenance: In open-source projects, the focus on developing new features may overshadow the responsibility of maintaining and securing code, whereas closed-source projects often have dedicated teams for security.

5. Profit/Funding/Revenue

In the present paper, we examine the metric of profit or funding received by open-source projects or companies. This metric is significant because it serves to attract developers to work on various projects, as well as provide ongoing development and support for the codebase. Established projects that continue to receive funding benefit from increased visibility and greater stability for the future.

Open-source projects can acquire funding through several means, including direct funding from large tech companies that utilize their products. In contrast, smaller open-source projects must rely on donations from end users. Technical support for open-source products is also a way to generate revenue, but it is challenging to implement due to its open-source nature. While this may be a valid way to earn profit for specific projects, it is not the norm and will not be further discussed.

In contrast, closed-source projects generate revenue by selling the rights to access the software to end-users and by selling technical support services. There are other methods for closed-source companies to generate revenue, but they are beyond the scope of this paper. Figure 6 displays a comparison of three open-source projects/companies and three companies that develop closed-source projects.

The significant difference between the two categories is evident from the graph, with closed-source companies aiming to generate profit, while open-source projects do not

prioritize profit-making. This difference is further highlighted in the comparison of Alphabet, Google's parent company, which generated almost 35 billion dollars in 2019, and Linux, one of the largest and most well-funded open-source projects, which received only about 11 million dollars. Apache and Eclipse, other prominent open-source foundations, have even lower profit margins. However, this comparison may be misleading since it compares a project to a company. If we consider just a few of Google's products, the difference may be more comparable [12][14][15][16][17].

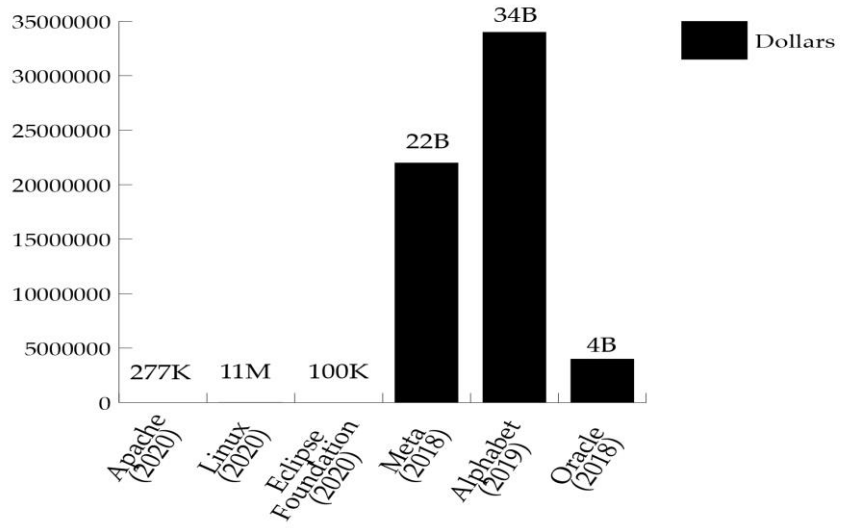

Figure 7. Income for open-source and closed-source projects in recent years.

In conclusion, the exploration of profit, funding, and revenue models in this chapter highlights the distinct financial pathways and priorities that distinguish open-source projects from their closed-source counterparts. Through an analysis of various funding sources and revenue generation mechanisms, it becomes evident that while open-source initiatives often depend on external support such as donations and corporate sponsorship, closed-source entities primarily derive income from direct software sales and associated services. This fundamental divergence in financial strategies underscores the differing objectives and operational paradigms of these two categories. Moreover, the comparison between the financial metrics of leading open-source projects and prominent closed-source companies, as illustrated in Figure 7, offers a revealing snapshot of the economic landscape within the software industry.

Key Takeaways:

- Profit/Funding in Open-Source Projects: The paper discusses the importance of profit or funding for open-source projects and companies, emphasizing its role in attracting developers and supporting ongoing development.
- Funding Sources: Open-source projects acquire funding through various means, including direct funding from large tech companies and donations from end users. Technical support services are a potential but challenging revenue stream.
- Comparison with Closed-Source Projects: Closed-source projects primarily generate revenue by selling software access rights and technical support services. This is in contrast to open-source projects, which don't primarily focus on profit-making.
- Revenue Differences: There's a significant difference in revenue between open and closed-source entities. For instance, Alphabet generated $35 billion in 2019 compared to Linux's $11 million. Apache and Eclipse have even lower profit margins.
- Misleading Comparisons: Comparing open-source projects with large companies like Alphabet can be misleading. A more comparable analysis would be between specific products of such companies and open-source projects.

6. Project management techniques

The final point of discussion in this paper concerns the importance of project organization for the success of both open-source and closed-source projects. While this comparison is based on opinions rather than empirical evidence, we argue that the organization method is a critical factor. Unfortunately, there is a lack of recent data on project management techniques for closed-source projects, as such practices tend to be kept confidential. Nevertheless, it is plausible that closed-source projects rely on Agile or Scrum development techniques with some adaptations to meet their specific needs. For example, Microsoft uses its Microsoft Solutions Framework (MSF) to guide software delivery [11].

In contrast, open-source projects have a distinct organizational structure that relies on the contributions of a community of developers rather than paid employees. Typically, a small team or core group of individuals governs the project, making decisions regarding the project's direction, such as integrating new features, adopting new tools or methodologies, and so on. These decisions can be made either by the governing body of the project or by a vote of the entire community of contributors and developers.

Both closed-source and open-source project management techniques have their advantages and disadvantages. Agile is commonly used in closed-source projects due to its simplicity and effectiveness, but it can also be rigid and inflexible. In contrast, open-source projects

allow for greater flexibility in terms of when developers can contribute, but this can create uncertainty and instability in project planning.

In conclusion, project organization is crucial for the success of any project, whether open-source or closed-source. While there are differences in the organizational structures of these two types of projects, both have their strengths and weaknesses that could be improved upon. Our discussion, though grounded in informed suppositions rather than empirical analysis, highlights that the choice of organizational method is not merely procedural but fundamentally integral to project outcomes. The secretive nature of project management practices in closed-source environments, exemplified by the Microsoft Solutions Framework, contrasts sharply with the more transparent and community-driven approaches prevalent in open-source projects. This dichotomy presents distinct sets of advantages and challenges: the structured efficiency of Agile methodologies in closed-source projects versus the flexible yet occasionally erratic nature of open-source project management.

Key Takeaways:

- Project Organization Importance: The organization method is critical for the success of both open-source and closed-source projects.
- Closed-Source Project Management: There's a lack of recent data on closed-source project management techniques, which are often confidential. These projects may use Agile or Scrum with adaptations, like Microsoft's Microsoft Solutions Framework (MSF).
- Open-Source Project Structure: Open-source projects rely on community contributions and are typically governed by a small team. Decision-making can be centralized or based on community votes.
- Comparative Advantages and Disadvantages: Closed-source projects often use Agile for its simplicity and effectiveness, but it can be rigid. Open-source projects offer more flexibility but can lead to uncertainty in project planning.
- Conclusion on Project Organization: Both open-source and closed-source projects have unique strengths and weaknesses in their organizational structures, highlighting the importance of project organization for success.

7. Conclusion

The open-source community has drawn significant interest from large tech companies, as evidenced by the increasing number of contributors to open-source projects from these companies. This trend suggests that big tech is committed to open-source software development. The high number of contributors in an open-source project enhances its ability to create new features, update existing ones, and address bugs and security vulnerabilities.

The contrast between the developer-to-feature ratio in closed-source and open-source projects is stark. Closed-source projects are created to generate profits for their respective companies, and every feature is planned to meet the needs of a customer base. In contrast, open-source projects are often initiated to satisfy the needs of a few individuals, with no intention of bringing them to the market. The discrepancy in purpose partly explains the difference in the ratio of developers to features. Open-source projects are open to any developer who wishes to contribute to meet their own needs, regardless of whether others share those needs.

In terms of funding, open-source organizations operate with budgets that are several orders of magnitude smaller than those of large tech companies. Tech giants increase profit margins by pushing the boundaries of what has already been developed and by having dedicated departments that identify revenue opportunities. Open-source foundations, in contrast, rely on donations and sponsorships for their funding. While the number of contributors helps open-source projects to identify and develop features, the lack of structure within the development team can result in some features being less impactful and useful primarily to the authors or a small number of end-users.

Closed-source projects typically rely on well-defined hierarchies and structured project management methodologies, such as Waterfall or Agile. This approach has advantages, such as clearly defined project requirements and development stages. Open-source projects lack clear boundaries, which may explain why developers are often drawn to these projects despite the lack of financial incentives. However, the larger pool of contributors and the ability of all contributors to participate in project debates enable faster detection and resolution of potential issues.

In conclusion, both closed-source and open-source software development have their own set of advantages and disadvantages. The interest of large tech companies in open-source software can be attributed to several factors, including the number of people involved in open-source projects. The lack of clear boundaries in open-source projects encourages developers to explore new solutions and ideas, which may be harder to achieve within the more rigid structures of a company.

Key Takeaways:

- Large tech companies are increasingly involved in open-source projects, indicating a commitment to open-source software development.
- Open-source projects benefit from a high number of contributors, improving their capacity for feature creation, updates, and addressing bugs and security issues.
- There is a notable contrast in the developer-to-feature ratio between closed-source and open-source projects, due to differences in their objectives and development approaches.

- Closed-source projects aim for profit and are designed to meet specific customer needs, while open-source projects often start to satisfy individual developers' needs without market intentions.
- Open-source organizations have significantly smaller budgets compared to large tech companies and rely on donations and sponsorships.
- The lack of structure in open-source development can lead to features that are less impactful or useful to a limited audience.
- Closed-source projects use structured project management methodologies, offering clear project requirements and development stages.
- Open-source projects, lacking clear boundaries, attract developers due to the freedom to explore new solutions and ideas.
- Both closed-source and open-source software development have unique advantages and disadvantages.
- The interest of large tech companies in open-source software is driven by factors like the involvement of numerous people and the freedom for innovation in open-source projects.

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INDIE VS AAAS: A FAIR COMPARISON

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Abstract

The purpose of this document is to provide a comprehensive comparison between the production of AAA and indie computer games. While both approaches strive to offer the best possible experience to their audience, the quality of the product may differ depending on various factors, including budget and technology used. To achieve success, game developers must have a clear understanding of the scope that can be accomplished within a reasonable timeframe. This study examines the potential profitability of AAA and indie game development methods. Although there is no single method for success, we postulate that AAA game development generally yields a higher payoff than indie game development. Our analysis compares selected game titles with regards to development budget, marketing push, team size, technology, and franchising opportunities. Our findings

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suggest that, despite the lower cost of indie game development, AAA games offer a safer method of revenue.

Keywords: budget, risk management, marketing, gameplay, popularity, AAA, indie

JEL Classification: O33, I23, I21

1. Introduction

The present article aims to provide an overview of the characteristics and differences between "Triple-A" (AAA) and independent (indie) video game development. The former is comprised of large studios and publishers that invest substantial financial resources in the creation and promotion of high-tech franchises for home consoles, while the latter typically involves small teams of up to 15 developers who prioritize creative independence and financial autonomy. The absence of third-party financial support in indie game development often requires the use of cheaper or free alternatives to software and game assets, resulting in a greater degree of creative control but a higher need for risk management. Although both AAA and indie studios prioritize the delivery of high-quality gameplay experiences, the primary motivation behind the development of AAA games is revenue generation, while indie games are typically created for the enjoyment of the developer and their audience, with revenue being a secondary concern. It is important to acknowledge, however, that developing indie games requires significant resources and funding, and developers must devise effective financing strategies to ensure the success of their projects. Overall, this paper highlights the importance of understanding the key differences between AAA and indie game development, which can aid in better discerning the requirements and expected outcomes of each type of development approach [1].

Key Takeaways:

- AAA game development involves large studios investing heavily in high-tech game franchises for home consoles.
- Indie game development usually features small teams (up to 15 developers) focusing on creative independence and financial autonomy.
- Indie developers often use cheaper or free software and assets due to a lack of third-party financial support, leading to more creative control but increased risk.
- While both AAA and indie studios aim for high-quality gameplay, AAA is primarily motivated by revenue, whereas indie games are driven by developer and audience enjoyment, with revenue as a secondary concern.
- Indie game development requires significant resources and funding, necessitating effective financing strategies for project success.
- Understanding the key differences between AAA and indie game development is crucial for grasping the requirements and expected outcomes of each approach.

2. Developing AAA games

It appears that the principal incentive for game developers to seek employment in AAA game companies is the prospect of participating in a large-scale team effort and making a substantial contribution to game development. However, as they ascend the hierarchical ladder, their involvement in the game development process may become less hands-on. In higher-level roles, individuals may shift towards managerial responsibilities, potentially resulting in reduced motivation and drive [2].

2.1. Advantages

In the context of employment within AAA game companies, financial stability is often cited as a key advantage for employees. Working for a large studio can offer benefits such as medical and dental coverage, sick days, and flexible schedules. While these benefits may be considered standard in other software development industries, they are not always available to those working in indie studios. The financial resources available to large studios also make it easier to undertake complex projects, with sufficient manpower available to distribute tasks effectively. As such, the benefits offered to employees are considered a worthwhile investment, given the potential for large-scale game sales [3].

Collaboration with highly talented individuals from various disciplines is another benefit of working on AAA projects. Employees have the opportunity to improve and expand their skill set through collaboration with colleagues in fields such as QA, finance, legal, IT, HR, and facilities. Additionally, AAA projects often have substantial budgets for marketing, enabling them to reach a large audience early on. Furthermore, these projects are often designed for multiple gaming platforms, making them accessible to a wider audience and increasing the potential for revenue generation.

The large budgets available to AAA game companies also enable the development of massively multiplayer games, which require significant hardware and server resources, as well as ongoing expenses to sustain. These games often incorporate multiple monetization methods to recoup development costs. AAA projects can also provide opportunities for employee career development beyond on-the-job learning. With sufficient resources and funding, studios can provide training to help employees stay up-to-date with the latest technologies and ideas, fostering a positive studio culture. In contrast, smaller teams may struggle to create a supportive work environment, with limited resources focused primarily on development, resulting in less flexibility for building team dynamics [4].

2.2. Disadvantages

In AAA game development, a large budget and team do not guarantee successful game development. The pressure to deliver for a sizable team and player base can be significant and requires individuals to understand the development plan and schedule before committing to a project. However, the risk of excessive overtime or "crunch" is present, making it essential to seek out companies that prioritize reasonable work schedules.

There is a debate surrounding the length and scope of a project, as some individuals prefer shorter turnaround times while others enjoy spending more time working on a project as part of a larger team. It is crucial to consider these factors and align them with an individual's preferences and work style before committing to a project, as working on a more extended project with a large team can pose its own set of challenges.

For some developers, the size of a team on an AAA project may feel overwhelming, making it necessary to assess if this type of environment is conducive to productivity. To optimize team size and communication, limiting the team to a specific number of people, such as 120, can foster a positive culture and promote teamwork. When team members are unfamiliar with each other, maintaining empathy and effective communication can prove difficult [5].

Key Takeaways:

- AAA game development offers the chance to be part of a large-scale team effort and contribute significantly to game projects.
- As employees climb the career ladder in AAA companies, they may transition to managerial roles with less hands-on involvement in game development.
- Advantages of working in AAA game companies include financial stability, comprehensive benefits (medical, dental, sick days, flexible schedules), and the ability to handle complex projects due to ample financial resources.
- Collaboration with skilled professionals across various fields enhances skill development for AAA employees.
- AAA projects benefit from substantial marketing budgets and multi-platform releases, broadening audience reach and revenue potential.
- Large budgets in AAA studios support the development of massively multiplayer games and continuous learning opportunities for employees.
- Challenges in AAA game development include the pressure of working on large-scale projects, risk of excessive overtime, and the need to match individual work preferences with project length and scope.
- Large team sizes in AAA projects can be overwhelming, necessitating careful consideration of team dynamics and communication strategies.

3. Developing indie games

In the realm of game development, working on indie games with small teams can offer developers greater autonomy and flexibility in their creative process. This is because indie game developers are often not subject to the bureaucratic decision-making processes and financial constraints that can be present in larger organizations. This freedom can allow indie game developers to focus on bringing their creative visions to life and to have greater control over the final product.

While indie game companies may not have the resources to hire full-time writers, writing can still play a critical role in many games, particularly in RPGs and other immersive experiences. Therefore, indie game developers may rely on team members with strong writing skills or outsource writing tasks to freelance writers.

Given their limited budgets, indie game developers may only hire new team members when there is a specific need for them, rather than hiring simply based on available resources. As a result, job seekers should be mindful of this when applying for positions with indie game companies, as there may not always be open positions available.

The popularity of indie games has been on the rise in recent years, and this can be attributed to a couple of factors. Firstly, universities encourage their students to pursue innovative and original ideas for gameplay, as they are unable to compete with the graphical capabilities of AAA games, where a large team of artists is typically involved. Secondly, the prevalence of digital marketplaces for purchasing games, such as Steam for PC or the digital stores for Xbox and Playstation, has eliminated the need for shipping and disc manufacturing costs, making it easier for indie games to reach a wider audience.

In an article published by Forbes in 2008 entitled "Indie Game Developers Rise Up," game designer and professor Chris Swain stated that the rise in popularity of indie games can be attributed to these factors [6].

Key Takeaways:

- Indie game development offers developers greater autonomy and flexibility in their creative process, free from bureaucratic and financial constraints of larger organizations.
- Indie developers often have more control over their creative vision and the final product.
- Writing is crucial in indie games, especially RPGs, and may involve team members with writing skills or freelance writers.
- Indie game companies hire new team members based on specific needs, not just available resources.
- The popularity of indie games has increased due to factors like encouragement from universities for original gameplay ideas and the inability to compete with AAA graphics.

- Digital marketplaces like Steam, Xbox, and Playstation have made it easier for indie games to reach a broader audience by eliminating shipping and disc manufacturing costs.
- The rise in indie game popularity is linked to these innovative approaches and marketplace changes, as noted by game designer Chris Swain.

4. The AAA model

The AAA game development model operates similarly to other business models, with a primary focus on generating profits. This emphasis on profit stems from the considerable financial investments required for the development, testing, and marketing of a single project, given the large scale of these games.

4.1. Funding and costs

In the current gaming industry, having a sufficient budget is crucial not only for the initial development of a game but also for its ongoing support and engagement with players. With the rise of the "games as a service" model, community engagement has become more critical than ever, and game developers require enough funding to support their games with many new updates for an extended period of time, while also ensuring stable careers for their teams. The ongoing support and evolution of a game are crucial to its success. However, the high cost of game development is largely attributed to the wages of staff. As games become more complex and require larger teams, studios must hire more people with specialized skills, such as sound designers, testers, and artists. Even independent developers who possess multiple skills may need to hire additional help to fully realize their vision.

Another significant expense for game developers is securing the rights to their own intellectual property (IP). Protecting IPs is essential to prevent others from stealing elements of the game, such as artwork, music, and character designs. If a developer fails to claim the copyright, someone else might do so and potentially profit from the success of the game. Therefore, it is crucial for developers, particularly first-time developers, to protect their IPs and become familiar with the process.

Marketing is an often-overlooked aspect of game development, but it is essential for the success of any game. Effective marketing requires a variety of skills and resources, from copywriting to campaign management to social media strategy. Even the best games may not receive the attention they deserve without adequate marketing. The development cost of Modern Warfare 2 was $50 million, but its marketing budget was $200 million, highlighting the importance of marketing in the game development process.

Cyberpunk 2077, released in 2020, is the most expensive game ever released with a development cost of $174 million and a marketing budget of $142 million. Despite its high

production costs, the game's rushed development cycle led to numerous glitches, bugs, and graphical errors upon release. As a result, the publisher, CD Projekt, faced significant financial loss due to refund requests and a 73% drop in share prices.

4.2. Graphics & Technology

In the video game industry, it is crucial to stay up to date with the latest technology to offer customers the best possible experience. One important aspect of this is the game engine that the game is built on, which determines the game's graphics, physics, and overall performance. Historically, many game development companies have developed their own in-house engines, such as Ubisoft's Snowdrop and Electronic Art's Frostbite, over the past two decades.

However, a trend has emerged in recent years to use third-party game engines, such as Epic Games' Unreal Engine or Unity, instead of investing in costly in-house engine development. While using third-party engines eliminates the high upfront development costs, game developers must pay royalties to the engine developers. It is worth noting that although powerful technologies, such as free rendering engines in Unity or Unreal Engine, are available in 2022, the AAA industry still has access to more expensive tools than the indie game industry, allowing for more realistic and immersive effects.

4.3. Franchising

In the current AAA game development model, companies often prefer to follow a risk-averse strategy by focusing on the concept of "franchising". This involves developing multiple sequels to successful games, such as Ubisoft's Assassin's Creed, Rockstar's Grand Theft Auto, and EA's FIFA, based on the popularity of the original titles. By utilizing the brand recognition of previous titles, companies increase the likelihood that players will associate the success of the franchise with a new iteration, regardless of how much the new version differs from the original.

Key Takeaways:

- AAA Game Development Focus: Prioritizes profit generation due to substantial investments in development, testing, and marketing.
- Funding Necessity: Sufficient budget is crucial for both initial development and ongoing support, including community engagement and regular updates.
- Staffing Costs: Large teams with specialized skills like sound designers, testers, and artists increase development costs.
- Intellectual Property Protection: Essential for preventing theft of game elements and securing revenue from the game's success.

- Marketing Importance: A critical, often overlooked aspect; requires substantial investment for a game's success, sometimes exceeding development costs.
- High Production Risks: Examples like Cyberpunk 2077 illustrate potential financial losses from rushed development and technical issues.
- Technology and Game Engines: Staying current with technology, like game engines, is vital for performance; trend towards using third-party engines to save on development costs.
- Franchising Strategy: AAA companies often develop sequels to successful games to leverage brand recognition and reduce risk.

5. The indie model

In contrast to AAA games that require millions of dollars, indie games are typically developed with significantly lower budgets, typically in the thousands of dollars range. Consequently, most indie game developers operate under resource constraints, often performing multiple roles such as artist, programmer, and designer.

5.1. Funding and costs

When it comes to indie game development, obtaining sufficient funding can be a challenging task. However, there are various strategies that developers can adopt to address this issue, including:

5.1.1. Bootstrapping

In the realm of indie game development, self-funding is a prominent and straightforward approach to acquiring financial support. This method typically involves obtaining monetary assistance from relatives or engaging in alternative sources of income, such as part-time or full-time employment. Although a part-time occupation can provide financial independence, it can also prolong the development timeline of the project. Therefore, switching to full-time game development may be precarious if there are insufficient funds saved for at least a year of expenses. In essence, launching a game studio through self-funding is comparable to initiating a business, as careful allocation of time and resources is necessary. It is imperative to acknowledge that self-funding can result in debt if not executed prudently, thus highlighting the significance of recognizing potential risks along the way.

5.1.2. Crowdfunding

Crowdfunding is a method of financing a project by soliciting small contributions from a large number of individuals, typically in exchange for digital goods. Indie game developers often utilize crowdfunding platforms such as Kickstarter and Patreon. Success on these platforms is often driven by an early focus on the game's design and visually appealing art. Some platforms also offer digital goods or physical merchandise in exchange for contributions. One of the main benefits of this method is the ability to build a community prior to the game's release, increasing the likelihood of future profits.

5.1.3. Publisher Funding

In the video game industry, a game publisher is a company that specializes in financing, marketing, and distributing video games. Indie game developers can benefit from partnering with a game publisher, as they can provide resources and support to help reach a larger audience. This partnership typically involves the publisher paying for the development costs of a game in advance, with the expectation that these costs will be recouped from future revenues. After the game is released, the publisher will also receive a share of ongoing revenues generated by the game. In exchange for funding the development of the game, the publisher typically provides marketing and promotion services to help attract players. It is worth noting that developers usually retain their intellectual property rights to their game, allowing them to create sequels or other related projects. However, it is important for developers to understand that this model of funding may require a trade-off between long-term rewards and upfront cash.

5.2. Graphics & Technology

A restricted budget can potentially lead to a greater emphasis on innovation or clever design rather than realistic graphics in indie game development due to the lack of guaranteed success for each title in a market with limited indie franchises. Nevertheless, 2022 appears to be a promising year for indie developers in terms of technology as several tools previously only accessible to large companies are now more affordable or even free. For example, motion capture animations can be achieved with free facial capture apps on smartphones that integrate well with popular game development software, eliminating the need for expensive setups.

5.3. Marketing Push

The allocation of budgets in game development is not always proportional to the total amount invested, as exemplified by Activision's Call of Duty franchise where the marketing budget surpassed that of the game itself, exceeding $100 million. In contrast, indie games tend to have more variable budgets depending on the scale of the release and available

resources of the development team. These games often rely on community building and word-of-mouth promotion rather than paid advertising, which allows for a larger proportion of the budget to be dedicated to the actual development process. Alternatively, some indie companies may choose to partner with a publisher to handle the marketing and promotion, which may lead to increased popularity but also may result in higher costs for the developers. Ultimately, the decision to self-promote or partner with a publisher requires careful consideration of the associated financial and marketing risks.

5.4. Franchising

In indie games, franchising is not a widespread occurrence, and only a select few highly successful games have been able to achieve this. Nonetheless, recent years have demonstrated that this possibility is indeed viable, as exemplified by the successes of franchises such as Five Nights at Freddy's, Hello Neighbor, and Hollow Knight. In contrast to the AAA game development model, it is atypical for indie games that do not meet their projected revenue to be granted sequels.

Key Takeaways:

- Indie Game Development Budgets: Indie games are developed with significantly lower budgets, often in the thousands of dollars, unlike AAA games that require millions.
- Multiple Roles in Indie Development: Indie developers frequently assume multiple roles such as artist, programmer, and designer due to resource constraints.
- Funding Challenges for Indie Games: Obtaining sufficient funding is a major challenge in indie game development.
- Bootstrapping: A common funding strategy is self-funding, which can involve personal savings, support from relatives, or income from other jobs, but carries the risk of debt and extended development timelines.
- Crowdfunding: Platforms like Kickstarter and Patreon are used for raising small amounts from many contributors, often in exchange for digital goods, and help in building a community before the game's release.
- Publisher Funding: Partnering with a game publisher provides resources and support for reaching a larger audience, with the trade-off being a share of ongoing revenues and marketing control.
- Graphics and Technology Constraints: Limited budgets in indie game development often lead to a focus on innovation over realistic graphics, but recent technological advancements have made more tools accessible to indie developers.
- Marketing StrategiesIndie games typically rely on community building and word-of-mouth instead of large-scale paid advertising, but some may partner with publishers for marketing, affecting budget allocation.

- Franchising in Indie Games: Franchising is rare in indie games, but recent successes like Five Nights at Freddy's show its viability. Unlike AAA games, indie games without significant revenue typically don't receive sequels.

6. Team size

In the realm of AAA game development, the size of development teams has grown considerably over the years. These teams often comprise over 100 individuals, and the largest companies in the industry, such as Rockstar Games and Activision, can employ over 2,000 and 9,200 individuals respectively. The trend towards increased team size has been driven by a growing need for specialized expertise in areas such as lighting, programming, and game design. However, some experts caution against overly specialized teams, arguing that this approach can lead to inefficiencies and mistakes. Specifically, Dan Vávra, a noted game designer, has critiqued the so-called "bloat" in the industry, pointing out that dividing tasks among multiple specialists can increase the likelihood of errors and communication breakdowns.

In contrast, indie games are typically developed by smaller teams, which may range from a single individual (e.g., Undertale) to a group of approximately 15 individuals. The size of the indie team is typically based on the project's scope, complexity, and available resources. For instance, a very small indie team may only consist of one developer responsible for all programming and technical art, and a second individual responsible for most of the artistic requirements. Additionally, many indie teams rely on freelancers or outsource certain tasks to other studios, such as music production if no one on the team specializes in music composition [7].

Key Takeaways:

- AAA teams are large, often over 100 people, with major companies employing thousands.
- Growing AAA team sizes driven by need for specialized skills in various development areas.
- Over-specialization in AAA teams can lead to inefficiencies and errors.
- Indie teams are much smaller, typically ranging from one to 15 members.
- Indie teams may rely on freelancers or outsource tasks like music production.

7. Development statistics and success rate

Based on a report on games published on Steam, it has been found that a significant number of developers have released or announced their games on the platform. As per the report, there are approximately 44,000 game developers who have collectively created nearly 70,000 games on Steam. However, 75% of these developers have only released one game,

while the remaining developers have released multiple games. In fact, 443 developers have released more than 10 games, and four developers have released over 100 games each on the platform, which is an impressive feat [8].

Despite the significant number of developers on Steam, most game developers struggle to generate significant revenue on the platform. This is evidenced by the fact that a large percentage of developers, 57%, haven't made even $1k in gross revenue, and mostly consist of those who have released only one game. However, there are 1600 developers whose games have generated more than $1m in gross revenue, with 600 being large studios with big teams and development budgets. On the other hand, over 1,000 indie developers have generated over $1m through their games, despite having small teams and low to no budgets. Although the data supports the perspective that indie developers struggle to make money, it is important to note that success in indie game development is complex, and there are various factors at play beyond the number of indie game developers in the market.

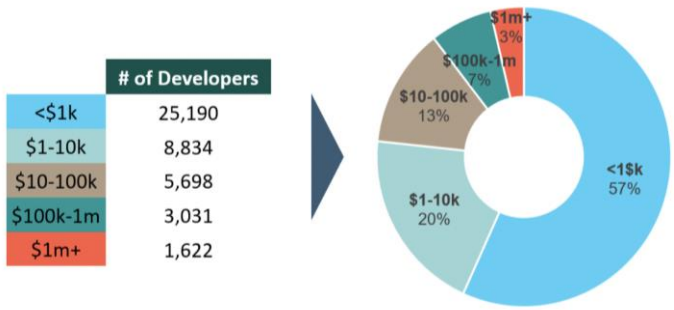

Figure 1. VG Insights – Number of Developers by lifetime gross revenue in February 2022 [9].

Despite the obstacles faced by indie game developers, their industry remains robust. Thousands of developers have released multiple games, and a considerable number have garnered considerable earnings from their creations. Although the market may seem oversaturated with the release of 30-40 games on Steam each day, many of these releases originate from amateur developers, who are improbable to be direct competitors. By considering only those developers producing games for commercial purposes, the number of actual competitors becomes much more reasonable. The indie game development industry appears to be in a sound state overall, with no discernible sign of an imminent crisis.

Key Takeaways:

- About 44,000 developers on Steam have created 70,000 games.
- 75% of these developers released only one game.
- A few developers (443) have released more than 10 games.

- 57% of developers haven't earned $1k; 1600 have earned over $1m.
- Over 1,000 indie developers made more than $1m, despite low budgets.
- Success in indie development depends on various factors.
- The indie game industry remains strong, with no signs of crisis.
- Daily, 30-40 new games are released on Steam, mostly by amateurs.

8. Future Investing

Investing in the gaming industry has become a common practice for many individuals, particularly given the industry's rapid growth. The global gaming market is expected to generate annual revenues of US$218.8 billion by 2024. Investors often purchase shares of a video game company in order to share in its profits and losses. However, this can require relinquishing some control over the company's intellectual property or decision-making processes. Investors may also negotiate revenue-sharing or royalty agreements, which may provide them with a percentage of a game's sales. Investing in Triple A games often involves purchasing stocks in specific companies. Alternatively, investing in the industry may be accomplished through an ETF, which provides diversified exposure and is often considered less risky. Major game developers, such as Activision Blizzard, Rockstar Games, and EA, control a significant portion of the industry, and investing in their stocks provides exposure to all of their products and business ventures.

Typically, investors exit a project before the game's launch to cash out on their investment. If a game is successful, some investors may choose to stay invested to capitalize on its ongoing revenue. Large companies tend to prioritize predictable profits and provide accurate revenue projections, aiming to satisfy shareholders. In contrast, indie game development is unpredictable and may not be sustainable in the long term. Investing in indie games is a high-risk endeavor with a low probability of success. However, indie developers may create unique games with innovative themes, mechanics, and aesthetics that large studios may overlook, potentially resulting in a hit game.

Given the current economic climate, investing in video game companies may be attractive as people may choose to spend less and stay indoors to play games rather than participate in other activities. The video game industry continues to grow, and advancements in technology may lead to more advanced and engaging games, attracting new players and investors.

Key Takeaways:

- Global gaming market expected to reach US$218.8 billion by 2024.
- Investors buy shares in gaming companies for profit-sharing and decision influence.
- Alternative investments include revenue-sharing or royalty agreements.

- Investing in AAA games often means buying stocks in major companies like Activision Blizzard, Rockstar Games, and EA.
- ETFs offer diversified, lower-risk gaming industry investments.
- Investors typically exit before game launch but may stay if the game is successful.
- Large companies offer predictable profits; indie game investment is high-risk but innovative.
- Economic trends increase the attractiveness of gaming investments.
- Technological advancements drive industry growth and investor interest.

9. Survey

In the early weeks of January 2023, a survey was conducted in order to determine the preferences of individuals regarding video games. The survey yielded 115 participants, consisting of 34 students (30%), 48 individuals aged 11 to 18 (48%), and 33 working adults aged 30 to 60 (22%). The survey included the following questions:

1. *How many hours per week do you spend playing indie games?*
2. *How many hours per week do you spend playing AAA games?*
3. *Which type of game (indie or AAA) do you prefer to play, and why?*
4. *On a scale of 0 to 5, how important are graphics and visual effects to you when playing a game?*
5. *On a scale of 0 to 5, how important are the story and characters to you when playing a game?*
6. *On a scale of 0 to 5, how important is the multiplayer aspect of a game to you?*

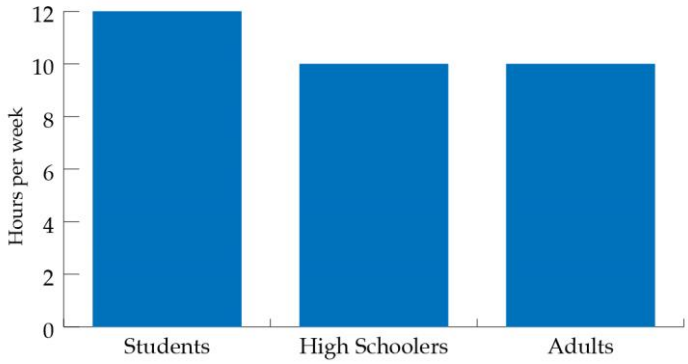

Figure 2. Responses to Question 1: How many hours a week do you play indie games?

The findings of our study indicate that the mean number of hours per week that students spend playing indie video games is approximately 12 as shown in Figure 2, whereas high

schoolers tend to spend slightly fewer hours, approximately 10, playing these types of games. However, adults devote a comparable amount of time to playing indie games. These results suggest that the target audience for indie video games is highly heterogeneous.

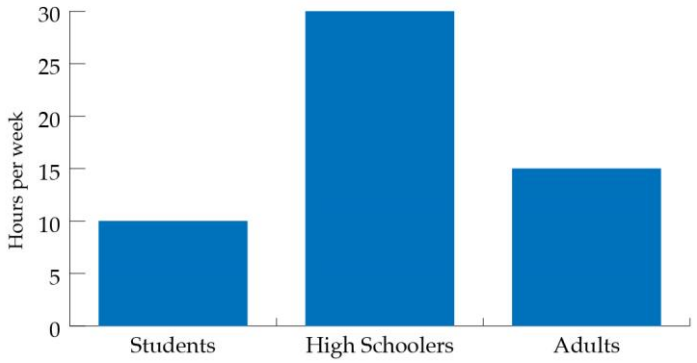

Figure 3. Responses to Question 2: How many hours a week do you play AAA games?

The second question of the survey produced notable outcomes that diverged from those of the previous inquiry. The average weekly hours that students devote to playing AAA video games diminished to approximately 10 hours, whereas individuals between 11 and 18 years of age spent thrice as much time, averaging 30 hours per week. Meanwhile, the adults' mean value of weekly AAA game time amounted to 15 hours, indicating a higher preference for this game genre. The findings suggest that the marketing strategy of AAA games tailored towards younger audiences has been efficacious, considering that children represent the primary consumer group for such games.

Question 3 aimed to investigate the definitive preference of the three participant groups, and the obtained outcomes are consistent with the findings of questions 1 and 2. The student group exhibited a greater inclination towards indie games, as indicated by more than twice the number of respondents favoring this category over AAA games (24 versus 10). Conversely, high schoolers favored AAA games to a greater extent than indie games (30 versus 18). The adult group, on the other hand, demonstrated a relatively balanced preference, with 19 respondents indicating a preference for AAA games and 13 expressing a preference for indie games. Regarding the open-ended portion of the question, the most prevalent reason for the popularity of indie games was their distinctive art style, whereas, for AAA games, the ability to engage in numerous player-versus-player (PvP) encounters was the primary factor.

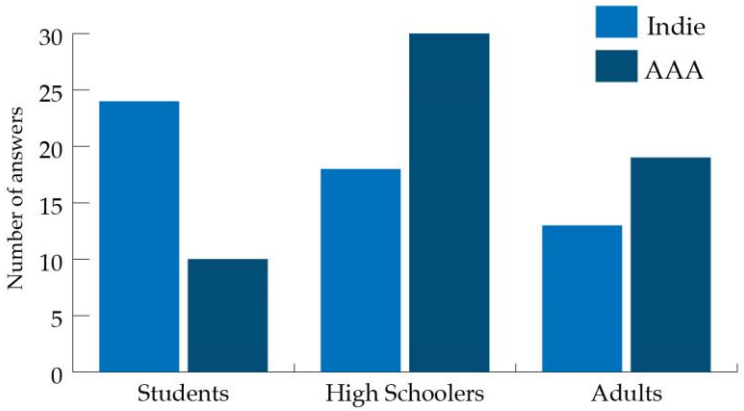

Figure 4. Responses for Question 3: Which type of game (Indie/AAA) do you prefer to play and why?

The following question yielded a conclusive outcome, as nearly 40 respondents indicated that graphics and visual effects are significant factors in their gaming experience, regardless of game type as is shown in Figure 4. The remaining 75 respondents predominantly provided moderate ratings between 2-3 on the scale of importance, with 45 answers falling within this range. These findings suggest that developers should prioritize the development of captivating visual design, whether it be a realistic approach for AAA games or a distinctive one for indie titles.

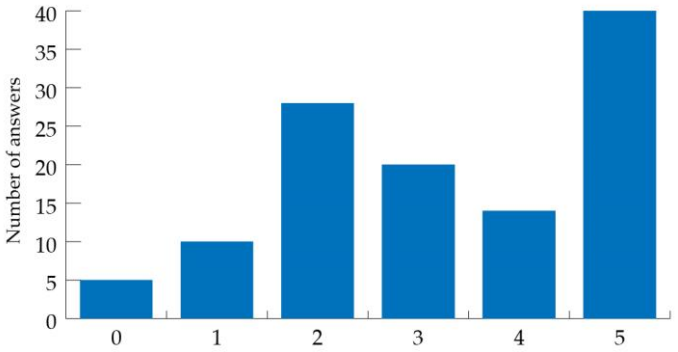

Figure 5. Responses to Question 4: How important are graphics and visual effects to you when playing a game?

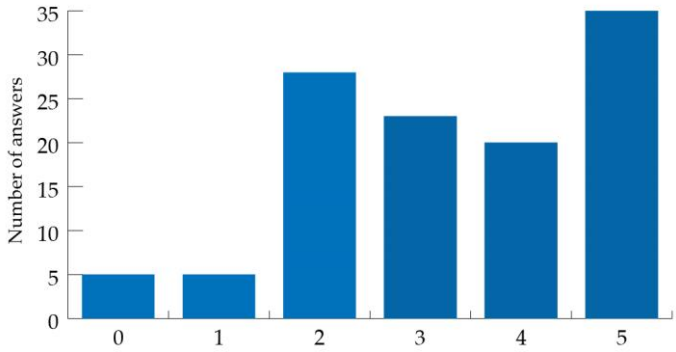

Figure 6. Responses to Question 5: How important are story and characters to you when playing a game?

Question 5 elicited responses that were more evenly distributed across the rating scale, with a slight shift towards the lower end of the scale compared to Question 4. Specifically, 35 respondents indicated that the story and characters of a game are of high importance (rating of 4 or 5 on the scale), while 28 respondents expressed uncertainty or a lower level of importance (rating of 2 or 3 on the scale). These results suggest that while story and characters are an essential aspect of gaming for some, they are not as universally valued as graphics and visual effects.

Question 6 elicited mixed responses from the participants, similar to the previous question. Of the 115 respondents, 30 indicated a strong preference for the multiplayer aspect of video games, while 25 expressed little interest in it. The remaining 60 respondents fell somewhere in between, suggesting that the importance of multiplayer functionality is highly subjective and depends on the individual gamer. Therefore, it is recommended that game developers consider the inclusion of multiplayer elements in their games, without making it a mandatory feature that detracts from the solo experience.

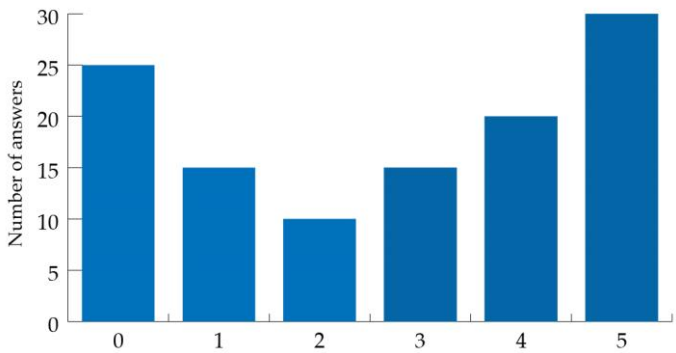

Figure 7. Responses for Question 6: How important is the multiplayer aspect of a game to you?

Question 7 yielded intriguing outcomes, with popular responses already featuring prominent indie games like "Stardew Valley" and "Hollow Knight". Respondents desire indie games to gain more recognition in the AAA world, with titles like "Celeste" contending against Ubisoft or Rockstar games. Nevertheless, such a scenario is improbable, but it is compelling that most individuals perceive accomplished indie games as "underrated" relative to their AAA equivalents.

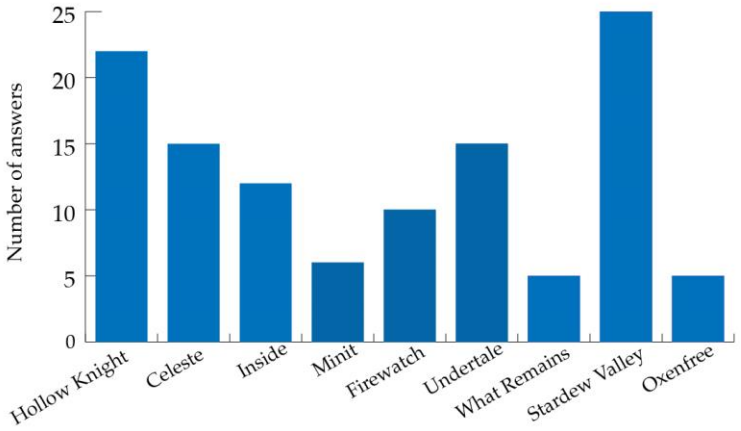

Figure 8. Responses for Question 7: Have you ever played an indie game that you believe should have been as popular as an AAA game?

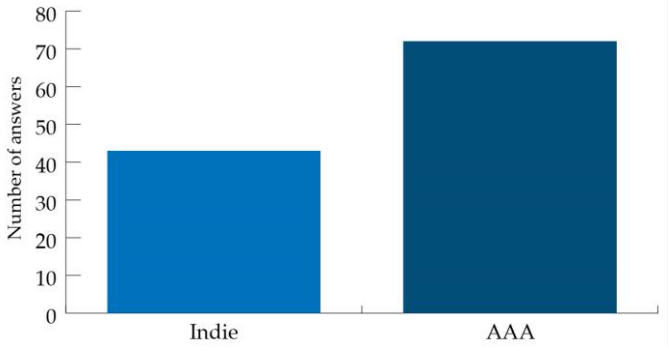

Figure 9. Responses for Question 8: Are you most likely to recommend an indie game or AAA game to a friend?

Question 8 represents a pivotal inquiry, given that personal recommendations from acquaintances are influential in shaping one's gaming preferences. The survey data highlights that 72 respondents would suggest an AAA game, compared to 43 recommending

an indie game. This outcome may reflect the perception that indie games cater to a more specialized audience, whereas AAA games strive to attract a broader range of players. As such, promoting an AAA game appears more likely to result in a favorable response from the recommended party, especially in the context of multiplayer games.

Key Takeaways:

- Diverse Indie Game Audience: Students, high schoolers, and adults all devote significant time to playing indie games, indicating a heterogeneous target audience for indie video games.
- High Schoolers Prefer AAA Games: High school-aged individuals spend considerably more time on AAA games (30 hours per week) compared to indie games.
- Student Inclination Toward Indie Games: Students show a greater preference for indie games, with more than twice as many favoring them over AAA games.
- Balanced Adult Preferences: Adults demonstrate a relatively balanced preference between AAA and indie games.
- Importance of Game Art Style: The distinctive art style is a key reason for the popularity of indie games, while PvP encounters drive the appeal of AAA games.
- Graphics and Visual Effects Are Crucial: A significant portion of respondents, regardless of game type, rate graphics and visual effects as important in their gaming experience.
- Story and Characters Vary in Importance: While some gamers value story and characters highly, these elements are not as universally important as graphics and visual effects.
- Mixed Views on Multiplayer: Opinions on the importance of multiplayer aspects in games are varied, suggesting it should be an optional rather than mandatory feature.
- Indie Games Seen as Underrated: Many respondents view successful indie games like "Stardew Valley" and "Hollow Knight" as underrated compared to AAA games.
- AAA Games More Likely to Be Recommended: A majority of respondents are more likely to recommend AAA games to friends, possibly due to their broader appeal and multiplayer features.

10. Conclusions

Success in any project is not solely determined by the budget or team size, but rather by one's determination and perseverance. Our survey has highlighted the contrasting opinions between indie and AAA games, indicating that there is no universal solution to achieve success in the industry. It is evident that even large-scale titles are not immune to financial failure, while many smaller titles fail regularly. Although AAA game development may be

considered a safer option, as established design formulas are often adopted, indie game development may be more suitable for budgetary constraints. Nevertheless, independent developers must create innovative game development and marketing approaches to compete with established AAA game studios in the highly saturated market. Launching a new IP can be challenging, particularly with a limited budget, emphasizing the importance of a comprehensive marketing strategy that maximizes available resources to stand out in the competitive field.

Key Takeaways:

- Success in projects depends on determination and perseverance, not just budget or team size.
- There's no one-size-fits-all approach to success in the gaming industry, as highlighted by contrasting opinions between indie and AAA games.
- Large-scale AAA titles can still face financial failure, and many smaller indie games fail regularly.
- AAA game development, often relying on established design formulas, might be seen as safer but is not always financially successful.
- Indie game development can be more suited to limited budgets but requires innovative approaches in both development and marketing.
- Independent developers face challenges in competing with AAA studios in a saturated market.
- Launching a new intellectual property (IP) is difficult with a limited budget, stressing the need for an effective marketing strategy to stand out.

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MULTI-CRITERIA DESIGN OPTIMIZATION OF PITCH BEARING FOR WIND POWER GENERATION SYSTEM APPLYING ARTIFICIAL INTELLIGENCE TECHNIQUES FOR ENHANCED RELIABILITY

Prasun BHATTACHARJEE[1]

Somenath BHATTACHARYA[2]

Abstract

Profligate industrial development and incompetent handling of hydro-carbon-based fuels have led to global warming. The unusual heating of the surface air has consistently deteriorated the ecosystem comprehensively through erratic weather patterns and consequential upsurge of sea water level. The worsening conditions of the environment have triggered socio-economic disasters and compelled the international community to enforce the Paris Agreement of 2015 to constrain the emission of greenhouse gases. The power generation sector is one of the leading contributors to worldwide greenhouse gas emanation. Pertinent growth of renewable energy techniques such as wind power can help power generation businesses to lessen greenhouse production substantially. Globally, a considerable portion of the operating time of wind power generation systems is wasted every year owing to mechanical malfunctions of its several parts. Pitch bearing is an imperative component of the wind power generating unit which facilitates the wind turbine blades to maintain the appropriate alignment required for achieving the maximum power generation capability. In this paper, the design of the pitch bearing has been optimized using artificial intelligence methodologies like Genetic Algorithm and JAYA Algorithm. Objectives like L10 life and static load factor have been deemed for maximization whereas the bearing frictional torque has been considered for minimization. The optimal designs achieved using the aforementioned artificial intelligence techniques have been contrasted. The JAYA Algorithm is more beneficial than the Genetic Algorithm for enriching the reliability of operation for the wind turbine pitch bearing.

Keywords: Bearing Life, Design Optimization, Frictional Torque, Genetic Algorithm, Jaya Algorithm, Static Load Factor, Wind Turbine

JEL Classification: -

1. Introduction

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The unremitting expulsion of greenhouse gases to the ecosystem attributable to an assortment of societal commotions is accelerating global warming and aberrant meteorological conditions. Unsustainable usage of hydrocarbon-based non-renewable fuels is furthering the greenhouse impact and is momentously accountable for the atypical upsurge of global warming.

To inhibit the catastrophic outcome of climate change, a record number of associates of the United Nations have approved to authorise an intercontinental accord in Paris in 2015. This pact directs the competent handling of renewable supplies of electricity like wind power to impede the emanation of greenhouse gases all through the Planet.

Figure 1: Global Yearly CO_2 Emissions (Per Capita) Tonnes Per Person

Because of the wide-reaching trepidation for the impeded supply of non-renewable fuels, renewable power generation technologies impart abounding replacements. The percentage of renewable power in general power generation has broadened in the past three decades progressively which is a realistic sign of worldwide leaning in the direction of low-carbon substitutes of energy means.

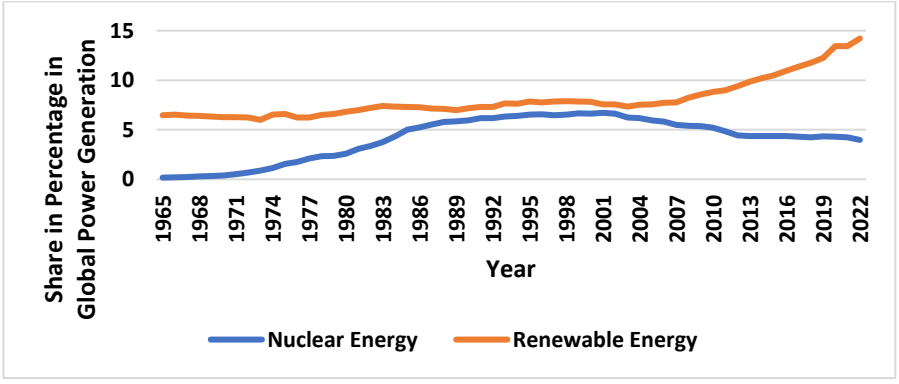

Figure 2: Share of Primary Energy of Renewable and Nuclear Sources

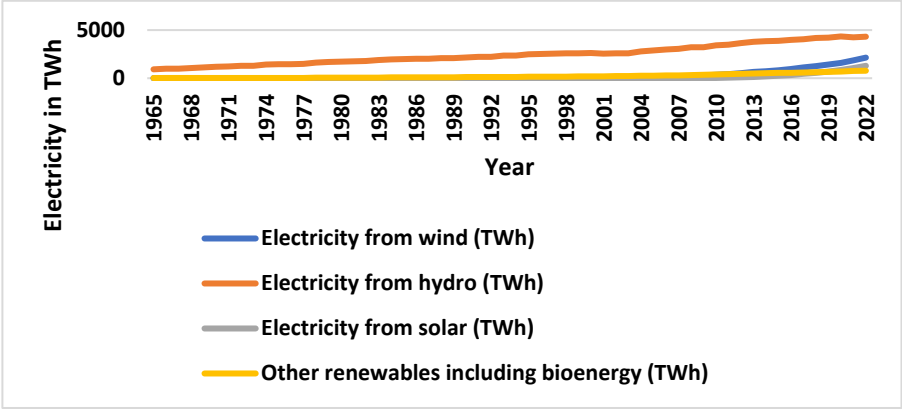

Figure 3: Growth of Renewable Energy Generation from Different Sources

In consort with the minimal emanation lead, renewable power techniques such as wind power are entailed to remain sustainable with insinuating cost-effective generation charge as a result of exceptional reliability and nominal charge. Consequently, apposite emphasis is required to be upheld throughout the wind turbine design stage to minimize the possibility of interruption through the operative cycle.

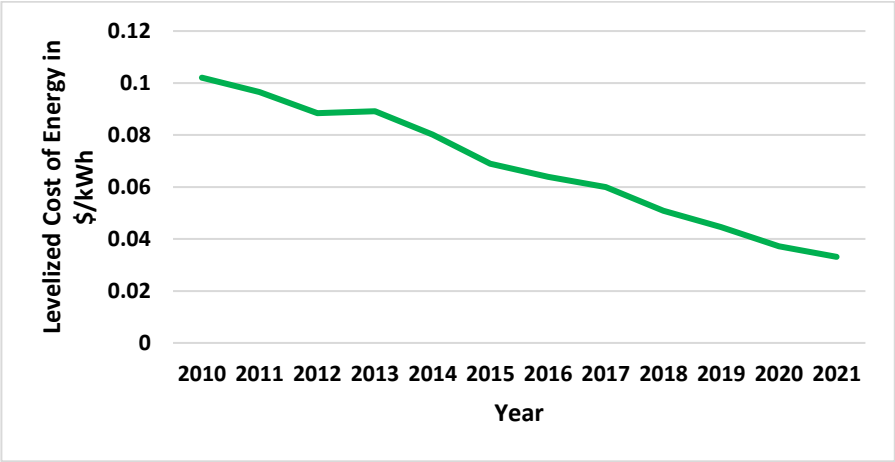

Figure 4: Decline of Levelized Cost of Energy for Onshore Wind Power (2010-2021)

Market studies testify that mechanical malfunctions of wind turbines are responsible for nearly 56% of the entire charge of insurance petitions and 33% of the overall number of demands listed for wind turbines. The income deficits borne by wind power businesses because of turbine breakdown can fluctuate from 200 M€ in Spain or 700 M€ in the whole

area of Europe to 2200 M€ in other parts of the Globe. These forfeitures can soar to three times if the operative overheads are considered.

Van Bussel and Zaaijer (2001) studied numerous facets of the operation and upkeep of wind turbines. They estimate 2.20 breakdowns per year for a wind turbine. They observed that the pitch system has a higher vulnerability for failure. The pitching mechanism was accountable for 0.28 malfunctions per year. Tavner et al. (2005) evaluated the malfunction frequencies of German and Danish turbines applying the reliability data and power law technique. They detected that Germany-manufactured turbines had to some extent higher chance for failure and were expected to have similar breakdown rates of Denmark-made turbines after 7 years. Shokrieh and Rafiee (2006) offered a three-dimensional finite element prototype for the fatigue breakdown of composite wind turbine rotor blades. Because of the unpredictability of the airflow configuration, a stochastic procedure was involved in planning the software scheme. Echavarria et al. (2008) analysed the failure of a 250 MW wind turbine using a test database. They perceived that the failure rates were lessening with time. Chen and Kam (2011) reported a malfunction assessment of composite wind turbine blades utilizing ANSYS. They utilized the finite element analysis to observe the stress dispersal and whiffle-tree technique for modelling the wind loads. Afterwards, the computed extreme load was confirmed for breakdown scrutiny. Gallego-Calderon et al. (2015) considered the impact on reliability for both cylindrical and tapered roller-type planetary bearings of wind turbine gearboxes. They utilized MATLAB codes and normal design load cases for computing the reactions at numerous speeds. The tapered roller-type arrangement confirmed superior reliability and dynamic load rating. Stammler et al. (2018) studied the effect of oscillation on the damage lifetime of pitch rolling bearing of wind turbines. They utilized time series data and stochastic airflow form. It was resolved that cycle counting is more competent than the rain flow counting technique. Schwack et al. (2020) examined the consequence of grease lubricants on the abrasion of the wind turbine pitch bearing. The grease lubricants with nominal base oil viscosities and elevated bleeding rates were recommended for better performance.

In the present paper, the multi-criteria design optimization of the pitch bearing of the wind turbine has been performed. Maximization of L_{10} life, minimization of the bearing frictional torque and maximization of static load factor have been considered as the objectives. Due to the complexity of the deemed problem, artificial intelligence techniques have been utilized. Meta-heuristic methodologies such as the Genetic Algorithm and JAYA algorithm have been employed to optimize the deemed objectives. The solutions attained through both artificial intelligence methods have been compared to find out the better technique for optimizing the design of the wind turbine pitch bearing.

2. Objective Construction

Pitch bearing, which is on the other hand recognized as blade bearing, is that element of the wind turbine which ties the hub and blade of the rotor. It enables to handle the loads and power of the turbine by allowing the essential oscillation. The pitching procedure is applied to uphold the WT rotor blade to the necessitated setting by regulating the aerodynamic angle of attack.

Rolling element bearings utilized in the pitching system are impacted by radial and axial forces and turning moments concomitantly. The bearings are manufactured utilizing two ring-rolled forged components forming the exterior and interior conduits.

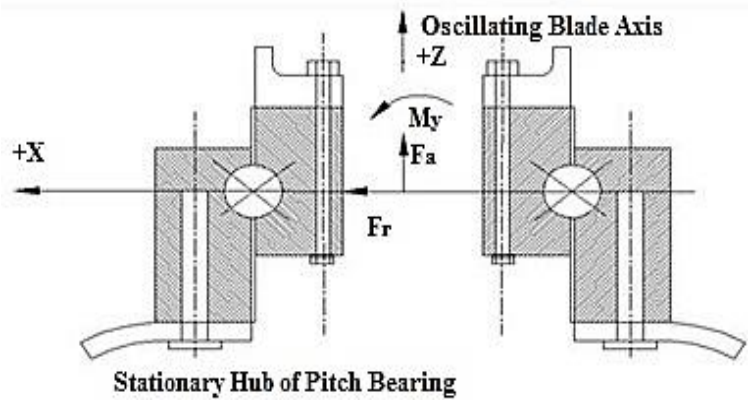

Figure 5: Pitch Bearing of Wind Turbine

Rolling element bearings are of uncomplicated exterior geometry but their internal geometry can have enormous significance on numerous factors like permitted stress and load dispersal.

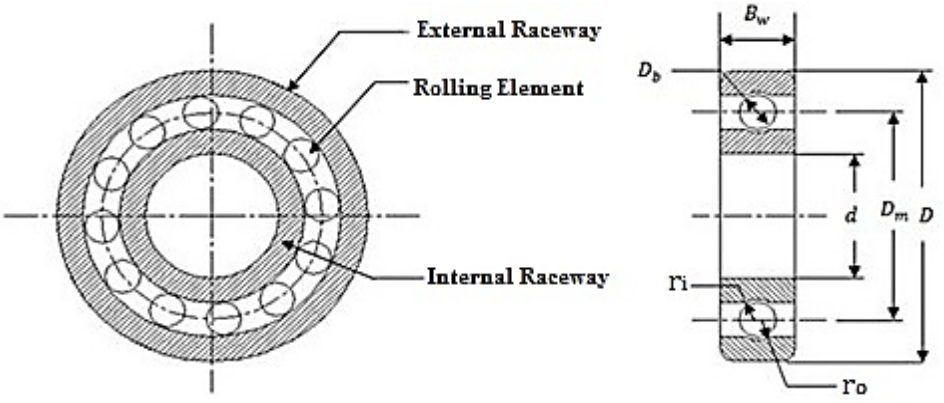

Figure 6: Rolling Bearing Design

The terminology of variables employed in the current research work with their explanation has been shown in Table 1.

Variable Symbol	Description
B_w	Bearing Width, mm
c_1, c_2	Parameters to Calculate Contamination Factor, dimensionless
d	Bore Diameter, mm
D	Outer Diameter, mm
D_b	Rolling Element Diameter, mm
D_m	Pitch Diameter, mm
e	Parameter for Rolling Element Mobility Consideration, dimensionless
$f_i\ (=\frac{r_i}{D_b})$	Curvature Co-efficient of Inner Raceway, dimensionless
$f_o(=\frac{r_o}{D_b})$	Curvature Co-efficient of Outer Raceway, dimensionless
i	Number of Rows of Rolling Elements
$K_{D\,max}$	Maximum Ball Diameter Limiter, dimensionless
$K_{D\,min}$	Minimum Ball Diameter Limiter, dimensionless
l_e	Roller Effective Length, mm
r_i	Inner Raceway Curvature, mm
r_o	Outer Raceway Curvature, mm
z	Number of Rolling Element per Row
α	Contact Angle, degree
ɧ	Raceway Hardness, HRC (Rockwell C Scale Hardness)
ε	Parameter for Outer Raceway Strength Concern, dimensionless
ζ	Parameter for Rolling Element Diameter Calculation considering Bearing Width, dimensionless
κ	The measure of Sufficiency of Lubrication, dimensionless

μ	Co-efficient of Friction, dimensionless

Table 1 Terminology of Variables

2.1 Modified L_{10} Life According to ISO Standard 281 (L_{ISOm})

The lifespan of a bearing is considered as the number of revolutions one of the bearing conduits finishes for the other race before the preliminary symptom of fatigue being imperilled in the material of one of the conduits or spinning components. L_{10} lifespan can be computed in hours of working as per Eq. 1.

$$L_{10}\,(in\ hr) = \frac{L_{10}.10^6}{N.60} \tag{1}$$

Following the ISO standard 281, bearing fatigue lifespan with the ball in millions of revolutions has been stated in Eq. 2.

$$L_{ISOm} = a_1 a_{ISO} \left(\frac{C_a}{P_{ea}}\right)^3 \tag{2}$$

a_1 and a_{ISO} are geometry-dependent parameters.

2.2 Bearing Friction Torque (T)

The frictional torque of the bearing is a crucial design factor for assessing the shortfall of the transferred power besides for the management of the revolving system. Frictional torque is caused because of friction between two surfaces in connection and its appropriate computation for the pitch system is crucial for fabricating the drive and actuator mechanism. Bearing friction torque for the pitch system can be calculated as per Eq. 3.

$$T = \mu \frac{D_m}{2}\left(\frac{4.4M}{D_m} + 2.2F_r + F_a\right) \tag{3}$$

2.3 Static Load Factor (SF)

The static load factor has been defined as the ratio of the permissible load to the existent load. It must be greater than 1 to guarantee some allowance of safety concerning the static capacity. The static load factor for ball bearing is computed as per Eq. 4-6.

$$SF = \left(\frac{4000}{S_{max}}\right)^3 \tag{4}$$

$$S_{max} = \frac{1.5Q_{max}}{\pi ab} \tag{5}$$

$$Q_{max} = \left(\frac{2F_r}{z\cos\alpha} + \frac{F_a}{z\sin\alpha} + \frac{4M}{D_m z\sin\alpha}\right) \tag{6}$$

Where, F_r, F_a and M are transferred radial load, thrust load and moment respectively.

3. Constraints

The constraints of an optimization conundrum split the viable parameter area, where every constriction is satisfied, from the unfeasible space where nonetheless one of the restraints is confronted. This research paper implemented the restraints demarcated by Duggirala et al. (2018) and they have been defined as per Eq. 7 - 17.

$$\phi_0 = 2\pi - 2\cos^{-1}\frac{\left[\left\{\frac{(D-d)}{2}-3\left(\frac{T}{4}\right)\right\}^2+\left\{\frac{D}{2}-\left(\frac{T}{4}\right)-D_b\right\}^2-\left\{\frac{d}{2}+\left(\frac{T}{4}\right)\right\}^2\right]}{2\left\{\frac{(D-d)}{2}-3\left(\frac{T}{4}\right)\right\}\left\{\frac{D}{2}-\left(\frac{T}{4}\right)-D_b\right\}} \tag{7}$$

$$T = D - d - D_b \tag{8}$$

$$g_1(X) = \frac{\phi_0}{2\sin^{-1}\left(\frac{D_b}{D_m}\right)} - z + 1 \geq 0 \tag{9}$$

$$g_2(X) = 2D_b - K_{D_{min}}(D-d) \geq 0 \tag{10}$$

$$g_3(X) = K_{D_{max}}(D-d) - 2D_b \geq 0 \tag{11}$$

$$g_4(X) = \zeta B_w - D_b \leq 0 \tag{12}$$

$$g_5(X) = D_m - (0.5-e)(D+d) \geq 0 \tag{13}$$

$$g_6(X) = (0.5+e)(D+d) - D_m \geq 0 \tag{14}$$

$$g_7(X) = 0.5(D - D_m - D_b) - \varepsilon D_b \geq 0 \tag{15}$$

$$g_8(X) = 0.515 \leq f_i \leq 0.52 \tag{16}$$

$$g_9(X) = 0.515 \leq f_o \leq 0.53 \tag{17}$$

4. Multi-Objective Genetic Algorithm (MOGA)

The planned MOGA to locate non-dominated resolutions for multi-objective design optimization of wind turbine pitch bearings has been offered as:

1. Prepare the factors of MOGA.

2. Set the populace at random.

3. Calculate the appropriateness of each chromosome.

4. Accomplish the arithmetic crossover process.

5. Complete the mutation method.

6. Check the suitability of the fresh individuals.

7. Implement the ascendency test.

8. If the passable number of entities indispensable for Pareto optimal front creation is accomplished, then conclude, or continue.

9. Choose the most exceptional bargained resolution consistent with the decision maker's penchant.

5. Multi-Objective JAYA Algorithm (MOJAYAA)

MOJAYAA is a relatively novel Teaching-Learning Based Optimization (TLBO) algorithm instituted on enhanced Strength Pareto Evolutionary Algorithm and the steps of the algorithms have been presented below.

1. Prepare the population of solutions randomly.

2. Evaluate the objective functions for each solution in the population.

3. Perform non-dominated sorting to categorize the solutions into different Pareto fronts.

4. Calculate the crowding distance for each solution in a Pareto front.

5. Select solutions for the next generation based on a combination of non-dominated sorting and crowding distance.

6. Apply exploration and exploitation operators to the selected solutions.

7. Update the population with the newly generated solutions, maintaining the desired population size.

8. Check if the termination criteria are met.

9. Return the Pareto front solutions as the final set of trade-off solutions.

6. Results and Discussions

In the existing research, the optimal design limitations of pitch bearings have been investigated with the aid of MOGA along with MOJAYAA. Comparable parametric limits and restrictions have been considered for each optimization algorithm and have been shown in Table 2.

$B_w \sim \{30, 75\}$

$c_1 \sim \{0.00617, 0.0864\}$
$c_2 \sim \{0.6796, 4.06\}$
$d \sim \{325, 2988\}$
$D \sim \{495, 3675\}$
$D_b \sim \{0.15(D-d), 0.26(D-d)\}$
$D_m \sim \{0.5(D+d), 0.6(D+d)\}$
$e \sim \{0.02, 0.1\}$
$f_i \sim \{0.515, 0.6\}$
$f_o \sim \{0.515, 0.6\}$
$K_{D_{max}} \sim \{0.6, 0.7\}$
$K_{D_{min}} \sim \{0.4, 0.5\}$
$l_e \sim \{24.4, 44\}$
$z \sim \{40, 280\}$
$\varepsilon \sim \{0.3, 0.4\}$
$ɧ \sim \{25, 64\}$
$\kappa \sim \{0.0758, 0.4601\}$
$\zeta \sim \{0.60, 0.85\}$

Table 2 Parametric Limits

The Pareto fronts attained using MOGA have been shown in Fig. 7 and 8.

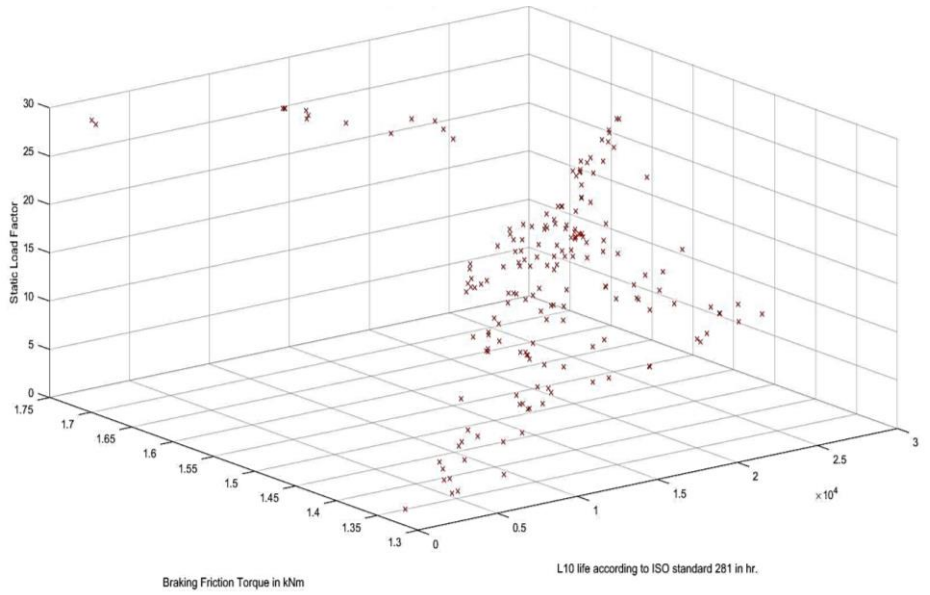

Figure 7: Pareto Front Attained by MOGA for 45º Contact Angle

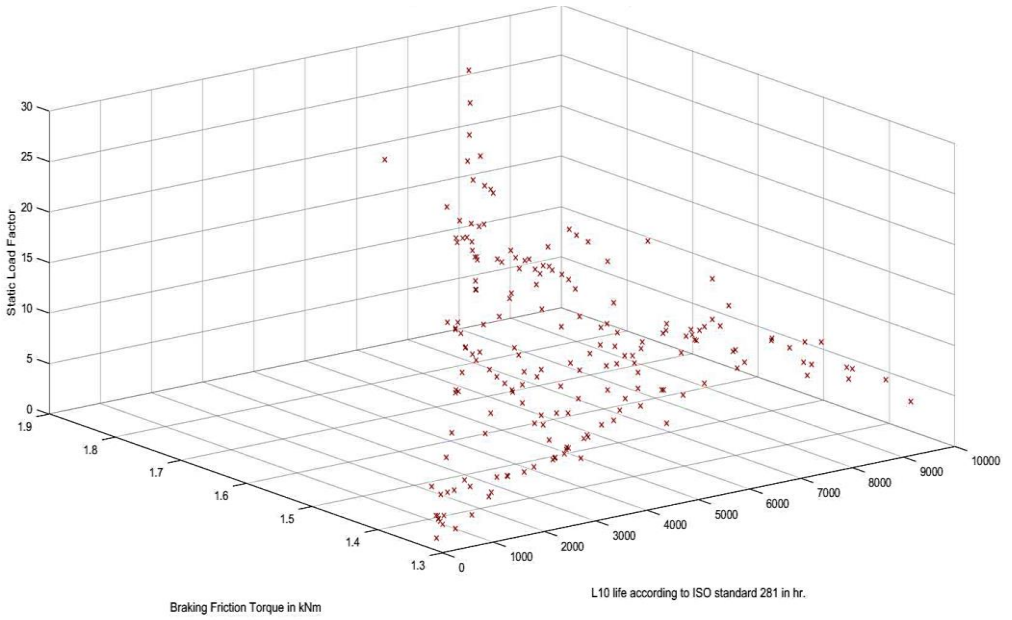

Figure 8: Pareto Front Attained by MOGA for 60º Contact Angle

The Pareto fronts attained using MOJAYAA have been shown in Fig. 9 and 10.

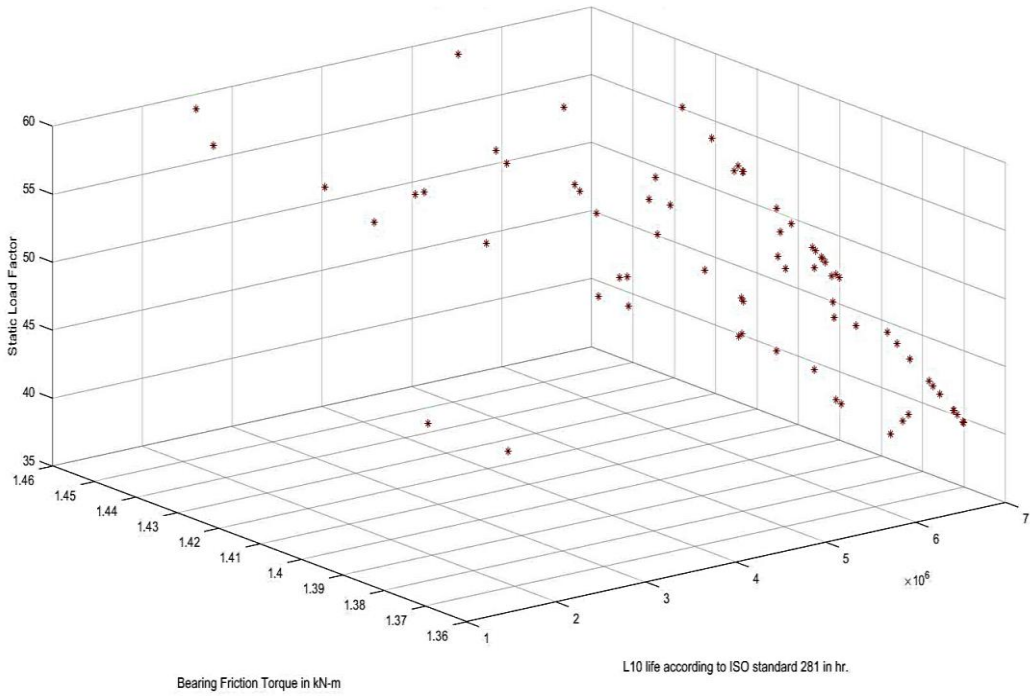

Figure 9: Pareto Front Attained by MOJAYAA for 45° Contact Angle

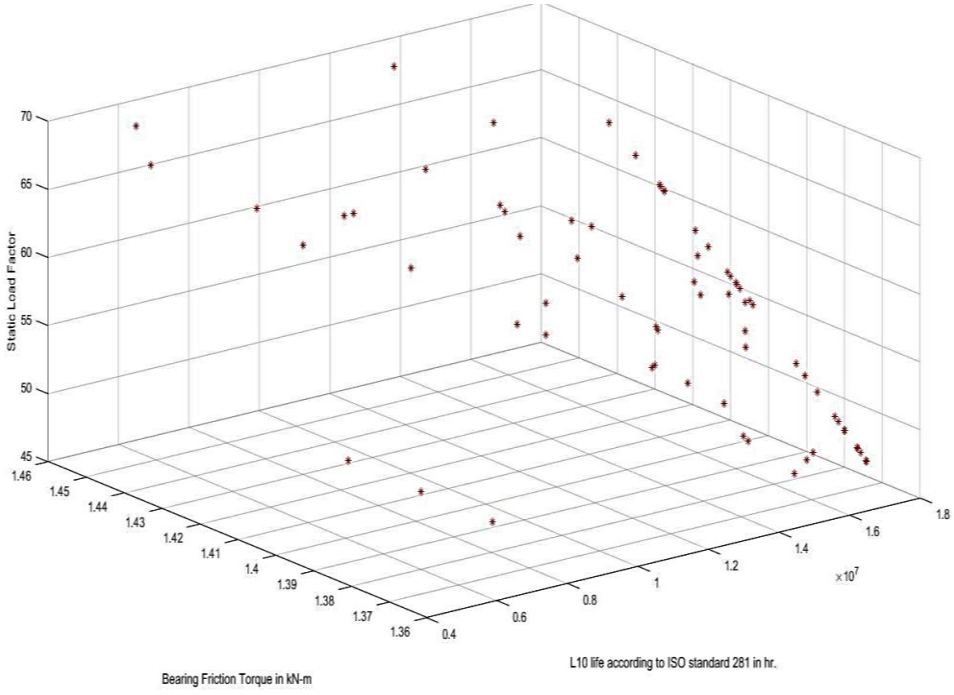

Figure 10: Pareto Front Attained by MOJAYAA for 60° Contact Angle

The optimized solutions have been presented in Table 3.

	MOGA Solution		MOJAYAA Solution	
	45° Contact Angle	60° Contact Angle	45° Contact Angle	60° Contact Angle
Maximum L_{10} Life in hr.	30000	10000	70000	180000
Minimum Bearing Friction Torque in kN-m	1.75	1.9	1.46	1.46
Maximum Static Load Factor	29	26	59	69

Table 3 Comparison of Results Attained by MOGA and MOJAYAA

The results shown in Table 3 show the superiority of MOJAYAA for optimizing the design of wind turbine pitch bearings. The improved design enhances the reliability of performance and minimizes the generation cost of wind power.

7. Conclusion

The study attempted to expand the performance of a wind power generation system by enhancing the design of pitch bearing. MOGA and MOJAYAA have been applied to optimize the considered objectives. The study confirms the efficiency of MOJAYAA over MOGA for the current research work.

6. Acknowledgement

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THE CRUCIAL IMPORTANCE OF THE EUROPEAN UNION AI ACT AS THE WORLD'S FIRST REGULATION ON ARTIFICIAL INTELLIGENCE

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Grațiela Doina GHIOALDĂ LUȚĂ[2]

Abstract

Artificial Intelligence (AI) is on everyone's lips because it's the technology that will shape the future of mankind for better or for worse. It is considered to be the newest technology that Computer Sciences offered humanity, but only the connoisseurs know that AI is not as new as it seems and that it has been used for more than 50 years in research and in governmental institutions. Because developers are making Artificial Intelligence grow stronger and stronger every day it became necessary to regulate it. The European Union was the first big power that took the bull from the horns and elaborated an act – The EU AI Act – that is trying to regulate AI technology. Regulating a domain that is in continuous change and evolution is a very hard thing to do, these rules must be adaptable along the way and changeable when needed.

Keywords: EU, AI, Act, Artificial Intelligence, European Union, Regulation

JEL Classification: K33

1. Introduction

Artificial Intelligence is considered to be a very important technology that has an enormous potential in changing the life of all the living creatures on this planet and on other planets if humans start to colonize the space. Its importance comes from the fact that it can be used to solve a very wide variety of problems.

We are using Artificial Intelligence every day and some of us don't even know it. From search engines to language translation software, from Internet of Things to online advertising and even cybersecurity, from self-driving vehicles to flying drones and to the manufacturing robots from the smart factories all this state-of-the-art technology uses AI to operate.

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Artificial Intelligence can revolutionize the following domains: healthcare, automobile industry, public transport systems, green and circular economy, machinery, farming, fashion, tourism, sales, production and services, energy, smart homes.

The most important thing is that Artificial Intelligence can and must be used in doing labours that are very hard or even impossible to be realised by human beings: mining, working in toxic environments, extinguishing fires, searching and rescue missions, exploring the space, exploring the oceans and other locations where is a harsh climate.

AI's results are influenced by the way the programmer designed it and what data he used as input. For example, in an application made for HR in order to choose the best candidate for a job if the developer uses as input data for the query the following attributes: white, male, single, between 30 - 40 years old, with bachelor's degree in chemistry AI will choose a candidate with these specifications. Even if the best candidate for this job may be a woman of 45 years old, married, with a master's degree in molecular chemistry.

A lot of people are afraid that Artificial Intelligence may take their jobs. That is a possibility in the near future. But in our opinion the real danger is the usage of AI in the military, in controlling the population, in spying and harming individuals, in the manipulation and stealing of elections and in the judiciary system.

We must never forget a very important thing: that AI (like every discovery in the scientific world) can be used in doing good things or in doing bad things. In order to prevent bad things to happen European Union, United States, China and all the other important global powers must regulate the Artificial Intelligence through their legislative assemblies.

The first time we heard about the need to regulate AI was in an interview with Elon Musk the CEO of Tesla that circulated on the Internet some years ago. On June 16th, 2023, at the Paris VivaTech event he reaffirmed his conviction that is necessary to take a „pause" on the development of Artificial Intelligence and that the AI sector needs to be regulated. Musk said that „there is a real danger for digital superintelligence having negative consequences" and that he is „in favour of AI regulation" (Aloisi et al., 2023).

Musk is not the only one that is sounding the alarm signal. Sam Altman the chief executive of OpenAI testified in Congress in May 2023 and said that is time for the legislative power to regulate and to start to put some limits on powerful AI systems. Altman declared that „If this technology goes wrong, it can go quite wrong," claiming it could do „significant harm to the world". Many of those who are concerned about the possibility that Artificial Intelligence can get out of control and do damage, including developers like Altman are urging lawmakers to regulate this domain (Downes and Levin, 2023).

On the other hand, Marc Andreessen (co-creator of the Mozilla Internet browser) claims that the big companies are using fear to push AI regulation in order to protect their economic interests. He says that big companies have the necessary resources to meet the requirements of AI regulations, while smaller companies and start-ups don't (https://www.csis.org/blogs/strategic-technologies-blog/ai-regulation-coming-what-likely-outcome).

2. Problem Statement

Some people are questioning the necessity of implementing regulation to this new revolutionary technology nicknamed AI. But they don't know the fact that Artificial Intelligence is not so new.

Some Artificial Intelligence technologies have been around for more than 50 years, but in the last decade AI developed at an incredible pace due to the advances in computing power, the availability of enormous quantities of data and new algorithms (https://www.europarl.europa.eu/news/en/headlines/society/20200827STO85804/what-is-artificial-intelligence-and-how-is-it-used).

European Union member states are at the forefront of the digital industry with a high-quality digital infrastructure that helps them designing top business-to-business applications. If EU institutions will be able to create an efficient regulatory framework for AI that protects the privacy and the freedom of the European citizens, European Union could become a global leader in the data economy and its applications (https://www.europarl.europa.eu/news/en/headlines/priorities/artificial-intelligence-in-the-eu/20200918STO87404/artificial-intelligence-threats-and-opportunities).

The EU's AI Act will apply to all European companies and also to all non-EU companies that are delivering AI technology and services in Europe. This act of crucial importance will set a precedent that will be followed soon by other countries (https://www.csis.org/blogs/strategic-technologies-blog/ai-regulation-coming-what-likely-outcome).

The problem is that the European law-makers must regulate AI in a very unique way making the rules adaptable along the way because Artificial Intelligence is a technology that is very likely to change rapidly and it has the power to spread widely throughout an area or in a group of people (https://www.csis.org/blogs/strategic-technologies-blog/ai-regulation-coming-what-likely-outcome).

To better understand the necessity of regulating Artificial Intelligence we must first of all give a definition of the term and afterwards show the operating principles of this technology. We also present the domains in which AI can make a difference without entering in detail.

The author Enamul Haque in his book „The Ultimate Modern Guide to Artificial Intelligence Including Machine Learning, Deep Learning, IoT, Data Science, Robotics, The Future of Jobs, Required Upskilling and Intelligent Industries" states that there isn't a strict definition of AI (Haque, 2023, p. 31).

Haque explains that the term Artificial Intelligence is used in our days „for almost all advanced analytics solutions based on Machine Learning that automate decision-making". The definition variates from researcher to researcher, but AI is defined in a general manner as „a concept or technology for artificially imitating the intellectual work performed by the human brain with a computer" or stated in a simple way: „the ability of a machine to mimic human reasoning". John McCarthy explains that AI is „the science and engineering of making intelligent machines, especially intelligent computer programs" (Haque, 2023, p. 31).

Haque says that Artificial Intelligence can also be defined as:

- „Artificially created reality with intelligence."
- „Artificially created system for intelligent behaviour."
- „A system that simulates human brain activity to the limit."
- „A new world of intelligence created artificially."
- „A structured system for imitating, supporting and transcending the intellectual behaviour of people" (Haque, 2023, p. 31).

AI is used „to increase the efficiency of operations with intelligent processes or to replace human labour with automation completely". Artificial Intelligence which is analytics based on Machine Learning is not a new discovered technology. Haque informs us that advanced analytics has been done in data-centric industries for a long time, but now we are using it in our daily life as technologies that we all use evolve rapidly (Haque, 2023, p. 31).

Haque states that AI is a scientific discipline which is composed from a collection of concepts, problems and methods for solving them. Artificial Intelligence is the subdivision of Computer Science that „deals with the automation of intelligent behaviour" (Haque, 2023, p. 32).

Jerry Kaplan in his book „Artificial Intelligence What Everyone Needs to Know" explains that machines are able to perform a lot of tasks that are impossible for human beings to do and these performances are perceived as displays of intelligence. Kaplan gives the following example: „a drug discovery program may propose a novel admixture by finding a previously unnoticed pattern of molecular arrangements in successful cancer treatment compounds" (Kaplan, 2016, p. 4).

In „Artificial Intelligence Foundations of Computational Agents" David L. Poole and Alan K. Mackworth state that AI is „the field that studies the synthesis and analysis of computational agents that act intelligently" (Poole and Mackworth, 2017, p. 3).

The authors explain that when an intelligent system is built the developers have to decide which „sources of intelligence" need to be programmed in and which can be learned, because it is impossible (at least for now) to build an agent that has no inputs and learns everything as it goes. But we must have in mind that the most „interesting and useful intelligent agents learn to improve their behaviour" (Poole and Mackworth, 2017, p. 7).

Bernard Marr in his book „Artificial Intelligence in Practice: How 50 Successful Companies Used AI and Machine Learning to Solve Problems" says that „AI is the most powerful technology available to mankind today and the biggest mistake anyone can make is to ignore it." World leaders and business owners are sensing „the magnitude of opportunities" that Artificial Intelligence brings and also the risks of „being left behind" in the race of AI development (Marr and Ward, 2019, p. 2).

Marr defines Artificial Intelligence as being „the ability of computer systems or machines to display intelligent behaviour that allows them to act and learn autonomously." In other words, the basic form of AI works in the following way: the data is taken, some calculation rules or algorithms are applied to the data and then decisions are made, or outcomes are predicted (Marr and Ward, 2019, p. 3).

The author explains that just like humans learn how to recognize a face with the help of their network of neurons from the brain in the same way Artificial Intelligence replicates this process with its artificial neural networks. But in using AI the machines are let to create the rules themselves instead of having developers programming the rules, just like human brain is learning from experience. This process is called machine learning (Marr and Ward, 2019, p. 4).

In machine learning Artificial Intelligence is trained by giving it large quantities of data, which the computer takes and then creates its own algorithm either independently or with the help of developers. When machine learning uses multiple layers of artificial neural networks in order to learn from training data and become more powerful it is called deep learning. Deep learning is responsible for the recent advances in AI like recognizing humans in images or videos or understanding and reproducing written text or spoken words learning (Marr and Ward, 2019, p. 5).

Just like humans learn and improve from personal experience the same way Artificial Intelligence „uses reinforcement learning algorithms to determine the ideal behaviour based upon feedback from the environment". Reinforcement learning gives the ability to the machines (robots, drones, self-driving cars) to walk, fly or drive autonomously (Marr and Ward, 2019, p. 6).

There are three ways in which businesses can use AI:

- Customer service - „change the way they understand and interact with customers",
- Smarter products and services - „offer more intelligent products and services",

- Automate processes - „improve and automate business processes" (Marr and Ward, 2019, pp. 6-7).

Using Artificial Intelligence in business can lead to a business model refresh or even to a complete transformation of the business approach making it relevant for the fourth industrial revolution (Marr and Ward, 2019, p. 7).

The book written by Bernard Marr is very well documented and it gives a lot of examples and case studies that demonstrate the extended level of AI usage in today businesses: IT, industry, production of goods, services, food industry, financial services, healthcare, automotive, aerospace, manufacturing, and mass-media.

In his book „Artificial Intelligence A Primer" Harry Katzan Jr. says that Artificial Intelligence „is more concerned with intelligence in general and less involved with human thought in particular" (Katzan, 2023, p. 3).

The author stated that the developments of AI through the years tried to mirror natural systems, emphasizing on the most important senses humans have natural language, vision and locomotion (Katzan, 2023, p. 11).

Artificial Intelligence is seen by Vinod Chandra and Anand Hareendran as the most „rapidly growing field, which provides more and more insights into how to make the human life easy" (Chandra and Hareendran, 2020, p. xiii).

We presented briefly the definitions of AI, its base principles and the domains in which it can be utilised in order to „make human life easier". Now we continue with the research questions that this article is trying to answer.

3. Research Questions/Aims of the research

The questions we would like to find answers for in this research paper are the following:

Is important to regulate artificial intelligence?

Can AI be regulated?

European Union through its institutions is capable of regulating artificial intelligence?

We believe the answer to all the above questions is affirmative.

The objective of this article is to demonstrate that regulating AI is imperative if we want not to have unpleasant surprises in the future. A super intelligence can be used in doing good things or in doing bad things depending on who is the individual that has the power of control over it. Another issue is the possibility that AI may become so powerful that it can develop a self-awareness and it can get out of control. European Union is the first world

power that initiates a legislative procedure meant to elaborate a regulation act for artificial intelligence. AI is too important and has the potential of becoming very powerful not to be regulated and above all to be regulated well.

4. Research Methods

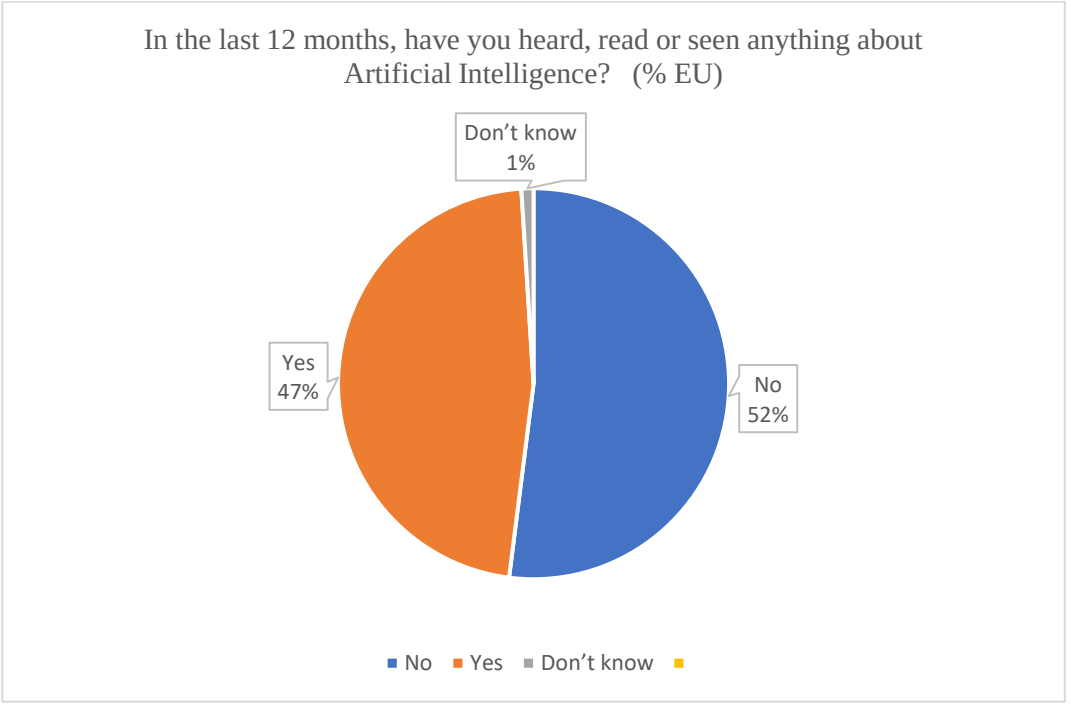
In this article we used mainly the qualitative method in order to obtain the extensive data about the importance and the necessity of regulating artificial intelligence. Quantitative analysis is also used, particularly with regard to statistical data. The techniques used here are a case study on the European Union AI Act, and the analysis of the theoretical works in the AI field.

5. Findings

The idea of the EU officials to regulate Artificial Intelligence didn't come from the thin air. This proposal is based on research studies and statistical data that show the opinion of the European Union citizens on AI and robots.

In May 2017 the European Commission has published a Eurobarometer survey presenting European citizens' opinions on the impact of digitisation and automation on daily life. The fieldwork was done in March 2017 and the Special Eurobarometer Report has a whole chapter – chapter IV that touches the subject of Artificial Intelligence and Robotics (https://op.europa.eu/en/publication-detail/-/publication/ce5d5948-6778-11e7-b2f2-01aa75ed71a1/language-en).

In March 2017 when the Eurobarometer survey was made European citizens had to answer the following question: „In the last 12 months, have you heard, read or seen anything about Artificial Intelligence?" From the total number of respondents 52% said „No", 47% said „Yes" and 1% answered „Don't know" (Special Eurobarometer 460 Attitudes towards the impact of digitisation and automation on daily life Report, March 2017, p. 55).



Base: All Respondents (N=27,901)

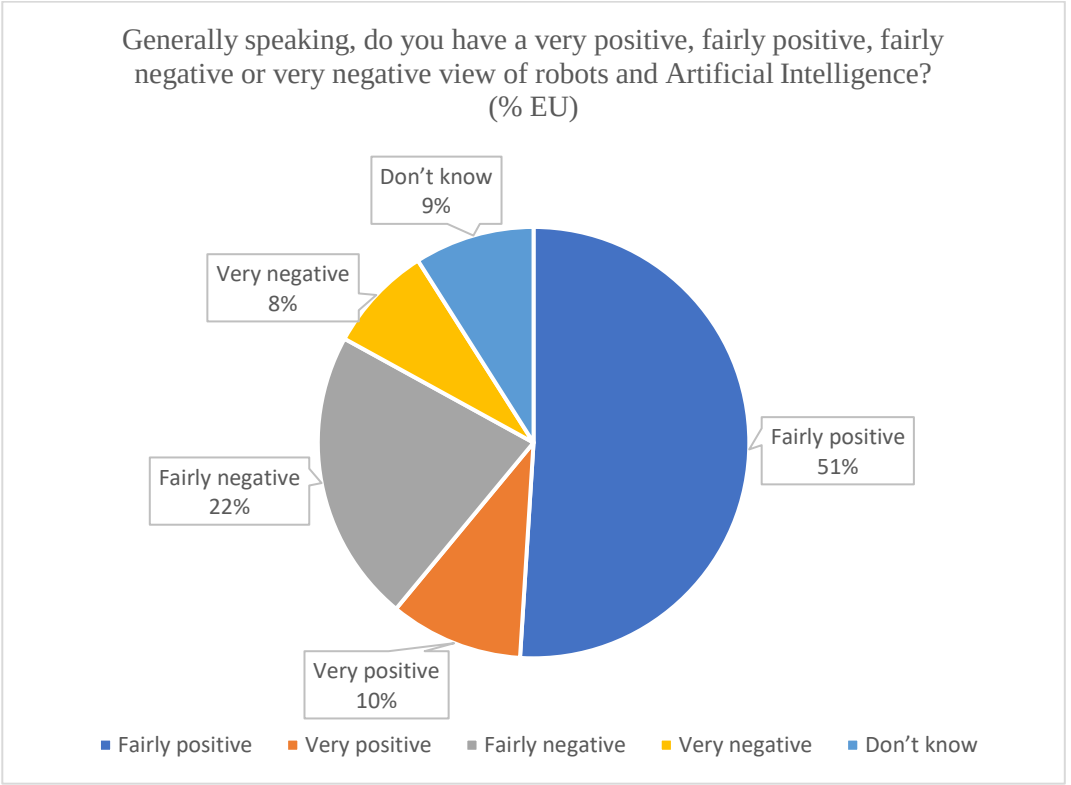
Graphic 1. European citizens' knowledge about Artificial Intelligence.[3]

Respondents residing in the countries from the Northern areas of the European Union are generally the most likely to have heard, read or seen something about AI in the last 12 months, while those who live in the states situated in the Eastern areas of the EU are generally the least likely to have done so (Special Eurobarometer 460 Attitudes towards the impact of digitisation and automation on daily life Report, March 2017, p. 56).

In terms of the attitude that European citizens have towards robots and AI it seems that the majority have a positive view about these revolutionary technologies.

At the question „Generally speaking, do you have a very positive, fairly positive, fairly negative or very negative view of robots and Artificial Intelligence?" the answers were the following: 51% responded „Fairly positive", 10% - „Very positive", 22% - „Fairly negative", 8% - „Very negative", 9% - „Don't know" (Special Eurobarometer 460 Attitudes towards the impact of digitisation and automation on daily life Report, March 2017, p. 59).

[3] Source: Special Eurobarometer 460 Attitudes towards the impact of digitisation and automation on daily life Report, March 2017, p. 55.



Base: All Respondents (N=27,901)

Graphic 2. European citizens' views on robots and Artificial Intelligence.[4]

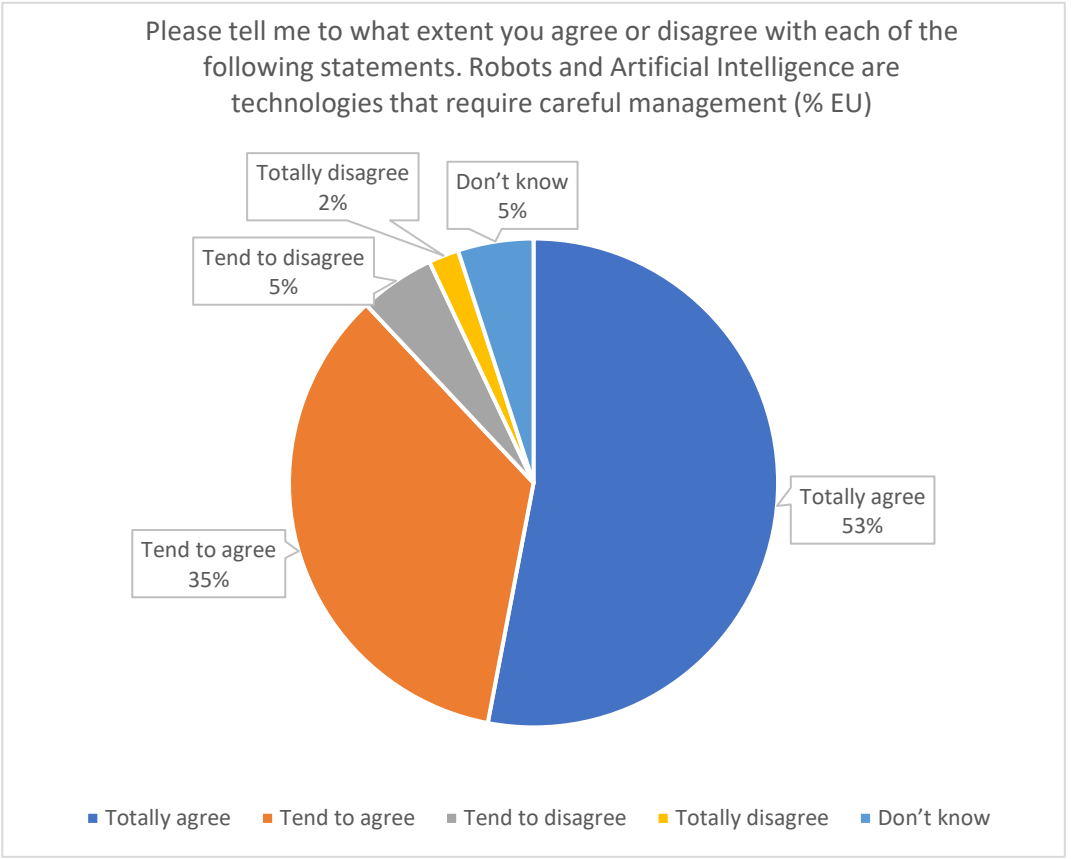
The North – East cleavage is maintaining, and the South is joining in this battle too. The citizens from the North have a positive view of robots and AI, and the countries that have a not so positive view about this technology are from the Southern and Eastern Europe (Special Eurobarometer 460 Attitudes towards the impact of digitisation and automation on daily life Report, March 2017, p. 59).

The answers given by the European citizens to the following question show the level of precaution they have when AI and robots are involved. The majority of the respondents (88%) agree that Artificial Intelligence and robots are technologies that require careful management (Special Eurobarometer 460 Attitudes towards the impact of digitisation and automation on daily life Report, March 2017, p. 62).

To the question „Please tell me to what extent you agree or disagree with each of the following statements. Robots and Artificial Intelligence are technologies that require

[4] Source: Special Eurobarometer 460 Attitudes towards the impact of digitisation and automation on daily life Report, March 2017, p. 59.

careful management" 53% have responded that they „Totally agree", 35% - „Tend to agree", 5% - „Tend to disagree", 2% said that they „Totally disagree" and 5% - „Don't know" (Special Eurobarometer 460 Attitudes towards the impact of digitisation and automation on daily life Report, March 2017, p. 62).



Base: All Respondents (N=27,901)

Graphic 3. European citizens' opinions on the careful management of robots and Artificial Intelligence.[5]

At least three quarters of respondents from each of the Member States agree Artificial Intelligence and robots are technologies that require careful management. The numbers are the following: Netherlands – 96%, Greece – 94%, Sweden – 93%, Italy – 83%, Hungary – 80%, Romania – 75%. In almost all the EU countries a relative majority was formed that „Totally agrees" with the „careful management" of AI and robots (Special Eurobarometer

[5] Source: Special Eurobarometer 460 Attitudes towards the impact of digitisation and automation on daily life Report, March 2017, p. 62.

460 Attitudes towards the impact of digitisation and automation on daily life Report, March 2017, p. 62).

This survey shows some interesting results. Respondents that have a positive view of Artificial Intelligence and robots are more likely to agree AI and robots are technologies that require careful management. The same tendency applies to the respondents that have read, heard or seen something about Artificial Intelligence in the last 12 months (Special Eurobarometer 460 Attitudes towards the impact of digitisation and automation on daily life Report, March 2017, p. 64).

We believe that this survey and especially the above-mentioned question is the starting point of the idea that AI needs to be regulated. This idea led to the birth of EU AI Act the first regulation on Artificial Intelligence.

European Commission's „Proposal for a Regulation of The European Parliament And Of The Council – Laying Down Harmonised Rules On Artificial Intelligence (Artificial Intelligence Act) And Amending Certain Union Legislative Acts" from 21 April 2021 establishes the following specific objectives:

- ensure that AI systems placed on the Union market and used are safe and respect existing law on fundamental rights and Union values;
- ensure legal certainty to facilitate investment and innovation in AI;
- enhance governance and effective enforcement of existing law on fundamental rights and safety requirements applicable to AI systems;
- facilitate the development of a single market for lawful, safe and trustworthy AI applications and prevent market fragmentation." (European Commission's Proposal for a Regulation Of The European Parliament And Of The Council – Laying Down Harmonised Rules On Artificial Intelligence (Artificial Intelligence Act) And Amending Certain Union Legislative Acts, 2021, p. 3).

The proposal sets a robust but at the same time a flexible legal framework with mechanisms that enable it to be adapted in concordance with the evolution of the technology and the situations that will emerge in the future (European Commission's Proposal for a Regulation Of The European Parliament And Of The Council – Laying Down Harmonised Rules On Artificial Intelligence (Artificial Intelligence Act) And Amending Certain Union Legislative Acts, 2021, p. 3).

This legal framework is comprehensive in its regulatory choices especially in all the principle-based requirements that AI systems should comply with. It is thought to be „a proportionate regulatory system centred on a well-defined risk-based regulatory approach that does not create unnecessary restrictions to trade". Where legal intervention takes place only in „those concrete situations where there is a justified cause for concern or where such concern can reasonably be anticipated in the near future" (European Commission's

Proposal for a Regulation Of The European Parliament And Of The Council – Laying Down Harmonised Rules On Artificial Intelligence (Artificial Intelligence Act) And Amending Certain Union Legislative Acts, 2021, p. 3).

The Commission's preferred option is a regulatory framework only for the high-risk AI systems, all providers of non-high-risk AI systems having the possibility to follow a code of conduct. It is stated that the requirements will concern the quality of data, documentation and traceability, provision of information and transparency, human oversight and robustness, accuracy and cybersecurity and would be obligatory for high-risk AI systems. And all the IT companies that may introduce codes of conduct for other Artificial Intelligence systems would do so voluntarily. The high-risk AI systems are listed and classified in the annexes of the Proposal (European Commission's Proposal for a Regulation Of The European Parliament And Of The Council – Laying Down Harmonised Rules On Artificial Intelligence (Artificial Intelligence Act) And Amending Certain Union Legislative Acts, 2021, p. 9).

The remarkable thing is that EU has the possibility to classify as high-risk AI technology all the foreign AI technology that may affect European citizens and can take some measures against it and even prohibit it. AI systems that have the capacity to distort human behaviour – to manipulate, to exploit and to use social control practices are forbidden. In EU the use of AI technologies for social scoring is prohibited (European Commission's Proposal for a Regulation of The European Parliament and Of The Council – Laying Down Harmonised Rules On Artificial Intelligence (Artificial Intelligence Act) And Amending Certain Union Legislative Acts, 2021, pp. 20-21).

Unfortunately, the AI Act won't regulate the Artificial Intelligence systems used in military purposes. Also, the AI systems used in law enforcement are in some specific situations excepted from the interdiction mentioned in the regulation. For example the use of „real-time" remote biometric identification systems in public places is allowed when an individual or a group constitutes a real threat to society and only after it is obtained a specific authorisation by a judicial authority or by an independent administrative authority of a Member State (European Commission's Proposal for a Regulation Of The European Parliament And Of The Council – Laying Down Harmonised Rules On Artificial Intelligence (Artificial Intelligence Act) And Amending Certain Union Legislative Acts, 2021, pp. 20-23).

The regulation was made to ensure that the high-risk Artificial Intelligence systems don't pose a threat to EU interests or have a significant harmful impact on European citizens' health, safety or fundamental rights. All AI systems are classified as being of high-risk if they can have an adverse impact on the following fundamental rights: children's rights, „the right to human dignity, respect for private and family life, protection of personal data, freedom of expression and information, freedom of assembly and of association, and non-discrimination, consumer protection, workers' rights, rights of persons with disabilities,

right to an effective remedy and to a fair trial, right of defence and the presumption of innocence, right to good administration" (European Commission's Proposal for a Regulation Of The European Parliament And Of The Council – Laying Down Harmonised Rules On Artificial Intelligence (Artificial Intelligence Act) And Amending Certain Union Legislative Acts, 2021, p. 24).

Artificial Intelligence systems used for the management and operation of critical infrastructure – road traffic and the supply of water, gas, heating and electricity – are classified as high-risk because their failure or malfunctioning can put at risk the life and health of large groups of people and can affect economic and social activities (European Commission's Proposal for a Regulation Of The European Parliament And Of The Council – Laying Down Harmonised Rules On Artificial Intelligence (Artificial Intelligence Act) And Amending Certain Union Legislative Acts, 2021, p. 26).

AI systems that are also considered of high-risk are the ones which are used in education and in vocational training because if they are improperly designed and used may violate the right to education and training and can create discriminatory situations (European Commission's Proposal for a Regulation Of The European Parliament And Of The Council – Laying Down Harmonised Rules On Artificial Intelligence (Artificial Intelligence Act) And Amending Certain Union Legislative Acts, 2021, p. 26).

Another high-risk Artificial Intelligence systems are the ones used in employment, workers management and access to self-employment because it is considered that they have the capacity to impact future career prospects and livelihoods of people (European Commission's Proposal for a Regulation Of The European Parliament And Of The Council – Laying Down Harmonised Rules On Artificial Intelligence (Artificial Intelligence Act) And Amending Certain Union Legislative Acts, 2021, p. 26).

AI systems used to evaluate the credit score, or creditworthiness of citizens are also high-risk because „they determine those persons' access to financial resources or essential services such as housing, electricity, and telecommunication services". Another high-risk Artificial Intelligence systems are used in the emergency services to dispatch or establish the priority in the dispatching of emergency in first response services. They are extremely important because „they make decisions in very critical situations for the life and health of persons and their property" (European Commission's Proposal for a Regulation Of The European Parliament And Of The Council – Laying Down Harmonised Rules On Artificial Intelligence (Artificial Intelligence Act) And Amending Certain Union Legislative Acts, 2021, p. 27).

High-risk AI systems are also used in law enforcement for prevention, detection, investigation and prosecution of criminal offences, migration, asylum and border control management, administration of justice and democratic processes (European Commission's Proposal for a Regulation Of The European Parliament And Of The Council – Laying Down

Harmonised Rules On Artificial Intelligence (Artificial Intelligence Act) And Amending Certain Union Legislative Acts, 2021, pp. 28-29).

It is important for the EU to have information on how high-risk AI systems have been developed and how they perform through their lifecycle in order to verify compliance with the requirements under the Regulation. Such information must include „the general characteristics, capabilities and limitations of the system, algorithms, data, training, testing and validation processes used as well as documentation on the relevant risk management system" (European Commission's Proposal for a Regulation of The European Parliament and Of The Council – Laying Down Harmonised Rules On Artificial Intelligence (Artificial Intelligence Act) And Amending Certain Union Legislative Acts, 2021, p. 30).

In our humble opinion the most important provision of this Regulation is the following: high-risk Artificial Intelligence systems should be designed and developed in such a way that humans must be able to oversee their functioning. The appropriate human oversight measures must be built into the AI system before it is put on the market and into service. These measures must guarantee that the AI system is „subject to in-built operational constraints that cannot be overridden by the system itself and is responsive to the human operator, and that the natural persons to whom human oversight has been assigned have the necessary competence, training and authority to carry out that role" (European Commission's Proposal for a Regulation Of The European Parliament And Of The Council – Laying Down Harmonised Rules On Artificial Intelligence (Artificial Intelligence Act) And Amending Certain Union Legislative Acts, 2021, p. 30).

Another vital thing for the high-risk AI systems is their technical robustness and cybersecurity. These AI systems must be „resilient against risks connected to the limitations of the system (e.g. errors, faults, inconsistencies, unexpected situations) as well as against malicious actions that may compromise the security of the AI system and result in harmful or otherwise undesirable behaviour". AI systems must be able to protect themselves and to reject cyberattacks that are trying to exploit their vulnerability (European Commission's Proposal for a Regulation of The European Parliament and of The Council – Laying Down Harmonised Rules On Artificial Intelligence (Artificial Intelligence Act) And Amending Certain Union Legislative Acts, 2021, p. 30).

6. Conclusion

If we think about it the sole purpose of developing AI technology should be exactly the above mentioned desiderate: to make people's lives easier and more beautiful we should add. Unfortunately, not all humans are driven by positive principles and a powerful AI technology controlled by an individual or a group of people that want to have unlimited power over all humanity and all its resources can wreak havoc.

In order to prevent this to happen AI must be regulated at all costs. The first step in doing that was made by the European Union. We believe that EU's AI Act has the power to regulate Artificial Intelligence technologies because it is an innovative legal framework that has the distinct property to change and to adapt at the same time with the evolution of AI.

An important thing is that the foreign providers of AI technology must respect the AI Act requirements if they want to sell their products on the EU market and that means that European Union has the power to influence and to change the AI technologies by imposing its regulation.

The EU AI Act hasn't been adopted yet. The EU tripartite (Commission, Council and Parliament) must reach an agreement on the final text including the amendments, but it is expected to be adopted by the end of the year 2023 with a transition period for the final implementation and compliance.

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ALGORITHM EFFICIENCY, A SIDE-BY-SIDE COMPARISON

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Abstract

This study presents a comparative analysis of the efficiency of classic sorting algorithms, including Merge Sort, Quick Sort, Heap Sort, Bubble Sort, Selection Sort, Counting Sort and the enigmatic Bogo Sort. Through a series of rigorous tests on arrays of varying sizes, we measured the time complexities of each algorithm and examined their performance characteristics. Our findings reveal distinctive patterns in the behavior of these algorithms, highlighting their relative strengths and limitations in handling different data structures. By evaluating factors such as time complexity, stability, and adaptability, we provide insights that aid in the informed selection of sorting methodologies for diverse computational challenges. This study contributes to a nuanced understanding of algorithmic efficiency and provides valuable guidance for practical implementation in real-world applications.

Keywords: Efficiency, Sorting, Analysis, Complexity, Algorithms, Performance, Comparison

JEL Classification: C63

1. Introduction

Efficiency is a cornerstone in computer science, which determines how effective and efficient an algorithm is. The search for efficiency in ranking algorithms has led to the development of various methods, each with its own strengths and limitations.

This review aims to shed light on the comparison of efficiencies among classical sorting algorithms through their performance analysis under different conditions. By investigating the time complexity and practicality of algorithms, we try to find the most appropriate methods for different data structures and large arrays.

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The main contenders in this search are the time-tested algorithms Merge Sort, Quick Sort, Heap Sort, Counting Sort, Bubble Sort, Selection Sort, Counting Sort and the fun Bogo Sort. Previous research has shown that the run time complexity is strongly influenced by the programming language [1]. The present research, with rigorous testing and statistical analysis evaluation, will provide a comprehensive understanding of the misbehavior of these algorithms with respect to time complexity, stability, adapt to different data distributions.

By considering factors such as these, we try to provide valuable insights that can suggest better strategies than the best configuration methods for specific computational challenges will provide. In this comparative study, we examine the efficiency of each algorithm on arrays of different sizes, delve into the nuances of their performance that reveal the underlying complexity of their performance metrics, and target them so to provide a comprehensive review of these classic sorting algorithms, the strengths of their relatives. Let us highlight weaknesses.

2. Algorithms

2.1 Merge Sort

Merge Sort is an algorithm that is known for its efficiency and stability in sorting large lists or arrays. It is a divide-and-conquer algorithm, and it operates by recursively dividing an input array into smaller subarrays. It does this operation until each subarray consists of a single element. All of the subarrays are then merged back together in a sorted order. The main step in Merge Sort is the merging process, in which the algorithm compares the elements of the divided subarrays, and it arranges them in a sorted order.

Merge Sort has a time complexity of O(n log n) in all cases and it is very efficient, as it guarantees consistent performance. Its space complexity is O(n), ‘n’ being the number of elements in the array, but the algorithm has a stable and predictable nature that makes it a preferred choice for sorting tasks, as stability and predictability are essential for those types of tasks [2].

2.2 Quick Sort

Quick Sort is a very efficient sorting algorithm that is widely used in sorting tasks. It also follows the divide-and-conquer paradigm, and it selects a pivot element from the starting array and then it partitions the rest of the elements into two subarrays. It does this split

according to whether they are less than or greater than the pivot. The subarrays are then recursively sorted, and the process is repeated until the entire array is sorted.

The Quick Sort algorithm has the ability to sort-in-place, meaning that it doesn't require additional memory, and this is why it is very efficient. Its average time complexity is O(n log n), which makes it one of the fastest sorting algorithms. However, in the worst-case scenario, its complexity can become O(n^2), when the pivot selection is unbalanced. There are different optimization techniques like choosing the pivot strategically, contributing to mitigating the risk for improving its overall performance [3].

2.3 Heap Sort

Heap Sort is a sorting algorithm that is comparison-based. It utilizes a binary heap data structure, and it begins by creating a heap from the input array. The largest element (for a max-heap) or the smallest element (for a min-heap) is placed at the root. This element is then swapped with the last element in the heap, which is then removed from the heap and placed in the sorted array. The heap is updated, and the process repeats until we sort the entire array.

Its time complexity is O(n log n) in all cases. This makes Heap Sort an efficient and stable sorting algorithm, as it has an in-place sorting nature. It does not have the need for significant extra memory, and this is why it is a preferred choice for large data sets. However, it does not perform as well as other sorting algorithms because it has slower constant factors. Heap Sort is a valuable algorithm in situations where the data is presented as a binary heap [4].

2.4 Bubble Sort

Bubble Sort is a very simple and easy to understand algorithm. It is comparison-based and it repeatedly steps through the array, compares each pair of adjacent items and swaps them if they are in the wrong order. It repeats the passing through the array until it is sorted.

This method doesn't make it a very efficient algorithm for large arrays. In the worst-case, its average time complexity is O(n^2), making it a slow algorithm compared to more advanced ones. For small datasets and short arrays, Bubble Sort is a practical option due to its simplicity and ease of implementation [5].

2.5 Selection Sort

Selection Sort is a comparison-based algorithm that divides the input array into a subarray of items that are already sorted and a subarray of items remaining to be sorted. It is a simple algorithm that finds the smallest (or largest, depending on the order) element from the unsorted subarray and swaps it with the leftmost unsorted element. It repeats the process until the entire array is sorted.

Like Bubble Sort, it is easy to understand and implement, but it is not considered efficient for large arrays. It has a time complexity of O(n^2) which makes it slow compared to other algorithms. However, it has the advantage of minimizing the number of swaps and it is useful in situations where the cost of swapping elements is very high [6].

2.6 Counting Sort

Counting Sort is a linear-time, non-comparative algorithm. It operates by counting the number of occurrences of each element in the input array. The input needs to consist of integers within a known range and the algorithm creates an auxiliary array that is the counting array. This counting array stores the count of each distinct element. With these counts, the algorithm determines the correct position of each element in the sorted output.

It has three phases:

- the counting phase: in which it reads the input and counts the occurrence of each element and then saves it in a counting array.
- the accumulation phase: in which it modifies the array to represent the cumulative count of elements. At this phase it ensures that each element's sorted position is accurately determined.
- sorting phase: in which it populates the output by placing each element in its correct sorted position. It does this based on the information stored in the counting array.

It has a time complexity of O(n+k), 'n' being the number of elements in the input array and 'k' being the range of possible integer values. The algorithm is efficient when the range of input values is not larger than the number of elements. Counting Sort is not suitable for sorting non-integer data or data with a wide range of values [7].

2.7 **Bogo Sort**

Bogo Sort is an algorithm that has been made for fun. It is highly inefficient and impractical, as it relies on pure luck and sheer randomness. It repeatedly shuffles the elements of the

array, and it checks if they are sorted. If the array is sorted, then it stops. If it is not sorted, it does it again.

Bogo Sort is notorious for its abysmal performance. It has an average-case time complexity of O((n+1)!), but it grows factorially with the number of elements. Because of this, it is very slow and not practical for any sorting task. It is an example of how not to sort data [8].

3. Testing Methodology

To prevent bias, we chose to test all algorithms on multiple machines in a batch of one hundred tests that will be measured and stored in an external database. This test covers all 7 algorithms presented earlier and has 5 phases where an array is generated by custom method who generates random numbers based on the size of the output array, into an array that will be used il almost all algorithms. The size of an array is calculated by this formula **10^Phase Number**. The only exception is Bogo Sort, because it is an algorithm with an unclear predict rate of complexity starting with a time complexity of O (1) that can become O (∞). Based on this consideration, Bogo Sort will be run with a smaller chunk of values starting from 3 and growing up by 1 on every phase. In this scenario the formula for the size of the array is **3 + Phase Number**.

Besides this organizational part, our solution has multiple key components that facilitate the entire process from start to finish.

- C# code that executes the testing batch.
- Dataverse & Power Platform for storing and visualizing raw data.
- Power BI report to prepare data for analyzing and reporting.

3.1 C# Code

In this study we chose C# as programming language because C# is a relatively easy language to learn and use. This makes it a good choice for people who want to understand and extend the idea behind this project.

Another key point for using C# is the fact that this programming language is a strongly typed one and a compiled language too, who can help us in developing more robust code and we can also be sure that anything can be planed and tackled from the development part of the app.

In addition to these general benefits, C# also has several specific features like delegates and support with SDK for other Microsoft products like databases or web services.

3.1.1 Tracking Time

For testing we created a dedicated class where we store all the algorithm implementation, we implement a method called *TrackTimeInTicks()*. It takes four parameters:

- **action**: A delegate that points to the code that you want to measure the execution time of.
- **inputArray**: An array of integers that will be passed to the action delegate. This array is generated by a custom method created by us and will be discussed soon.
- **executedAlgorithm**: The name of the algorithm that you are measuring the execution time of. This is necessary because we need to identify the algorithms in the second phase of this article.
- **phase**: The phase of the algorithm that you are measuring the execution time of. Like execution algorithms, this information is necessary for identification of the execution phase of the algorithm.

The *TrackTimeInTicks()* method works by first creating a new Stopwatch object and starting it. Then, it calls the action delegate with the inputArray parameter that is generated using a dedicated function for that. Once the action delegate has finished executing, the Stopwatch object is stopped, and the elapsed time is calculated.

The elapsed time is then saved to a database using the DatabaseStorage class. Then, we need to serialize the inputArray parameter to JSON before saving it to the database.

Finally, the *TrackTimeInTicks()* method prints the elapsed time to the console to make it easier to watch the progress during the execution. At the end of the method, we use the built in Garbage Collection Mechanisms from C# to be sure that unused memory after execution is cleared and cannot affect other tests. In the figure below the code associated with this explanation can be seen.

```
public void TrackTimeInTicks(
  Action<string> action,
  int[] inputArray,
  string executedAlgorithm = "Unknow Algorithm",
  int phase = -1)
{
    Console.WriteLine($"[Alghoritm : {executedAlgorithm}]\n");
    Stopwatch stopwatch = new Stopwatch();
    stopwatch.Start();

    action(executedAlgorithm);
    stopwatch.Stop();

    DatabaseStorage databaseStorage = new DatabaseStorage();
    string inputArrayJSON = JsonConvert.SerializeObject(inputArray);
    databaseStorage.SaveInDataverse(
      executedAlgorithm,
      (decimal)stopwatch.ElapsedTicks,
      inputArrayJSON,
      phase
    );

    Console.WriteLine($"[Execution time: \x1b[1m{stopwatch.ElapsedTicks} Ticks\x1b[0m]\n");
    GC.Collect();
}
```

Figure 1 – Track Time in Ticks Method

3.1.2 Generating Values

The previous figure was the most important part of the project and the starting point of benchmarking a couple of classic sorting algorithms. We observed that we use another 3rd party function and classes and now we will discuss every important bit.

To generate that number, we have created a method to generate an array of numbers based on the size of the array. Numbers are generated between 0 and 900.000.000. We implemented sorted flags to generate sorted arrays for debugging purposes.

In the figure below we can see how this generation is implemented.

```
public static int[] generateArray(int size, bool sorted = false)
  {
      Random randomGenerator = new Random();
      int[] generatedArray = new int[size];
      generatedArray[0] = randomGenerator.Next(0, 900000000);

      for (int i = 1; i < size; i++)
      {
          if (sorted)
          {
              generatedArray[i] = generatedArray[i - 1] + randomGenerator.Next(0, 900000000);
          }
          else
          {
              generatedArray[i] = randomGenerator.Next(0, 900000000);
          }
      }
      return generatedArray;
  }
```

Figure 2 – Generate Array Method

3.1.3 Saving and storing tests

To have consistent data to be analyzed, we decided to store information into an external database because we want to run these algorithms in parallels to be efficient from time perspective and to prevent possible misleading information from reading and transferring data from console output to another data storage source. To do this we used Power Platform SDK to interact with Microsoft Dataverse as a data storage environment. Figure 3 presents how we tackled this implementation in our code.

```
public void SaveInDataverse(string alogrithmName, decimal executionTime, string inputArray, int phase) {
        ServiceClient serviceClient = new(connectionString);

        Entity dbEntity = new Entity("cre3f_algorithmrun");
        dbEntity["cre3f_name"] = alogrithmName;
        dbEntity["cre3f_executiontime"] = (double) executionTime;
        dbEntity["cre3f_elapsedtimeinmiliseconds"] = (decimal) executionTime / (decimal) TimeSpan.TicksPerSecond;
        dbEntity["cre3f_os"] = Environment.OSVersion.ToString();
        dbEntity["cre3f_cpu_identifier"] = Environment.GetEnvironmentVariable("PROCESSOR_IDENTIFIER");
        dbEntity["cre3f_cpu_architecture"] = Environment.GetEnvironmentVariable("PROCESSOR_ARCHITECTURE");
        dbEntity["cre3f_numberofprocessors"] = Environment.GetEnvironmentVariable("NUMBER_OF_PROCESSORS");
        dbEntity["cre3f_phase"] = phase;

        serviceClient.Create(dbEntity);

}
```

Figure 3 – Storing data in Dataverse.

3.1.4 Test Batch and running conditions

The last piece of our puzzle is the testing batch that contains all algorithms executed through the *TrackTimeInTicks()* method. This method uses the generation function to create the initial arrays than execute each algorithm. To be sure that all algorithms are executed with the same data set we need a second array where we store the original array through execution. In Figure 4 generatedArray is the original array and usedArray is the middleman between executions. This middleman is overwriting after every execution using function method from Array class.

```
    public void Run() {
      int currentPhase = 0;
      ExecutionTimeTracker executionTimeTracker = new ExecutionTimeTracker();

      Console.WriteLine("\n\n\nTESTING PHASE STARTED");

      do {
        Console.WriteLine("=============================================================================================");
        Console.WriteLine($"PHASE #{currentPhase++} Array Dimension 10^ {currentPhase}");

        int[] generatedArray = new int[(int) Math.Pow(10, currentPhase)];
        int[] usedArray = new int[(int) Math.Pow(10, currentPhase)];
        generatedArray = Utilities.generateArray(generatedArray.Length, false);

        Array.Copy(generatedArray, usedArray, generatedArray.Length);

        executionTimeTracker.TrackTimeInTicks(
          (string algo) => Sorting.BubbleSort(usedArray), usedArray, "Bubble Sort", currentPhase);

        Array.Copy(generatedArray, usedArray, generatedArray.Length);

        executionTimeTracker.TrackTimeInTicks(
          (string algo) => Sorting.SelectionSort(usedArray), usedArray, "Selection Sort", currentPhase);

        Array.Copy(generatedArray, usedArray, generatedArray.Length);

        executionTimeTracker.TrackTimeInTicks(
          (string algo) => Sorting.CoutingSort(usedArray, usedArray.Max()), usedArray, "Counting Sort", currentPhase);

        Array.Copy(generatedArray, usedArray, generatedArray.Length);

        executionTimeTracker.TrackTimeInTicks(
          (string Algo) => Sorting.MergeSort(usedArray, 0, usedArray.Length - 1), usedArray, "Merge Sort", currentPhase);

        Array.Copy(generatedArray, usedArray, generatedArray.Length);
        executionTimeTracker.TrackTimeInTicks(
          (string Algo) => Sorting.Quick_Sort(usedArray, 0, usedArray.Length - 1), generatedArray, "Quick Sort", currentPhase);

        Array.Copy(generatedArray, usedArray, generatedArray.Length);
        executionTimeTracker.TrackTimeInTicks(
          (string Algo) => Sorting.heapSort(usedArray), generatedArray, "Heap Sort", currentPhase);

        int[] generatedBogoSortArray = new int[3 + currentPhase];
        int[] usedBogoSortArray = new int[3 + currentPhase];
        generatedBogoSortArray = Utilities.generateArray(3 + currentPhase);

        Array.Copy(generatedBogoSortArray, usedBogoSortArray, generatedBogoSortArray.Length);
        executionTimeTracker.TrackTimeInTicks(
          (string Algo) => Sorting.bogosort(usedBogoSortArray, usedBogoSortArray.Length), generatedBogoSortArray, "Bogo Sort",
currentPhase);

      } while (currentPhase <= this.batchPhase);
    }
```

Figure 4 – Testing batch run method

Our program executes this test batch 100 times to ensure a large quantity of data to obtain pertinent values for further analysis.

3.2 Dataverse & Power Platform Ecosystem

After we presented the code part for generating results, now it's time to show the infrastructure that facilitates storing of items and visualizations of them.

For storing data, we use Dataverse from Microsoft Power Platform. We chose this option because it is strongly linked with Power BI, another component that we chose for this project to manipulate and visualize data.

Another reason for choosing this approach is the free tier offered to developers which involves a database with a size of 2GB, always online for us. This tier is available for all organizations that have any Microsoft 365 License active.

To store data, we created a table called algorithm runs and added some key attributes to capture the relevant information of every run.

In the table below we have the name of the attribute, data type and the logical name. A logical name is the identifier that helps us in code to map the information in the storage environment.

In table 1 are presented the attributes added to our Dataverse column to support the application.

Name	Type	Logical Name
Algorithm Run	GUID - ID	cre3f_algorithmrunid
CPU Architecture	String	cre3f_cpu_architecture
CPU Identifier	String	cre3f_cpu_identifier
Elapsed Time in Seconds	Decimal	cre3f_elapsedtmeinseconds
Name (of the run algorithm)	Decimal	cre3f _name
Number of Processors	String	cre3f_numberofprocessors
OS (Operating System)	String	cre3f_OS
Phase	String	cre3f_Phase

Tabel 1 – Dataverse columns to facilitate the application

Because we want the testing batch to send data automatically, we created an Azure App Registration, and we use that as a S2S4 User.

To monitor data submitted by the end user we also used the benefits from Power Platform free tier. We created a small **model driven app** to be able to navigate easier through the data that we collected. We have a grid for visualizing all data and a form to view and edit, if necessary, the selected data. In the figures below we have the front-end of the actual power app.

[4] S2S - Software 2 Software

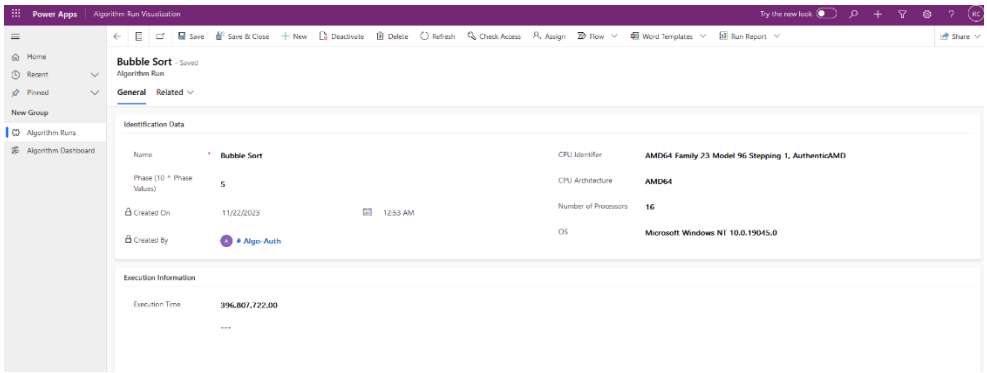

Figure 5 – Power App Form for data modification

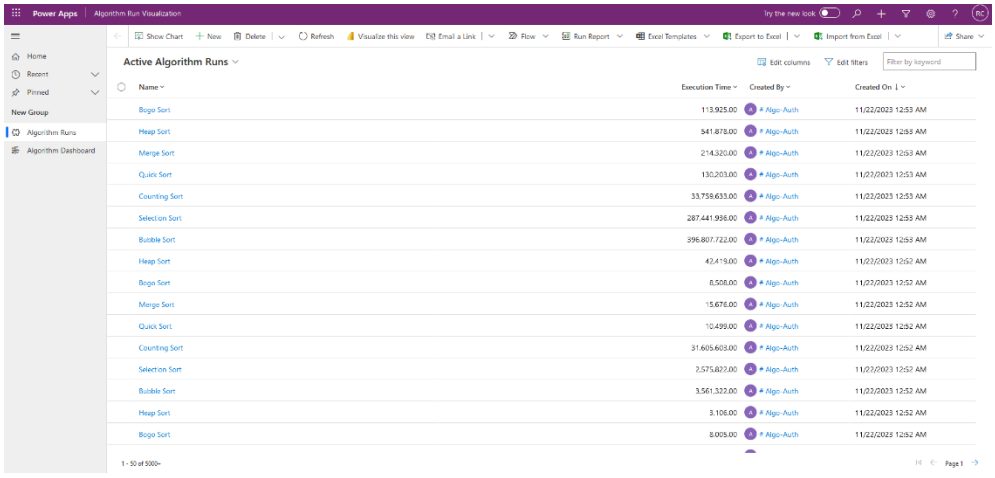

Figure 6 – Power App Grid for data visualization

3.3 Reporting using Microsoft PowerBI

Power BI is a must-have tool for analyzing and visualizing data. Its robust and user-friendly features empower you to integrate with simple data sources, including those generated by your algorithms, and transform raw data into complex visualizations.

The platform offers several customizable visualization options like interactive dashboards, you can dynamically search for patterns, trends and outliers within your data, fostering a deeper understanding of an algorithm performance.

Because Power BI is in the same product family as Power Apps and Dataverse we have seen an opportunity to use it as an instrument for data cleaning and visualization.

In the figure below you can see how our PowerBI Report is built.

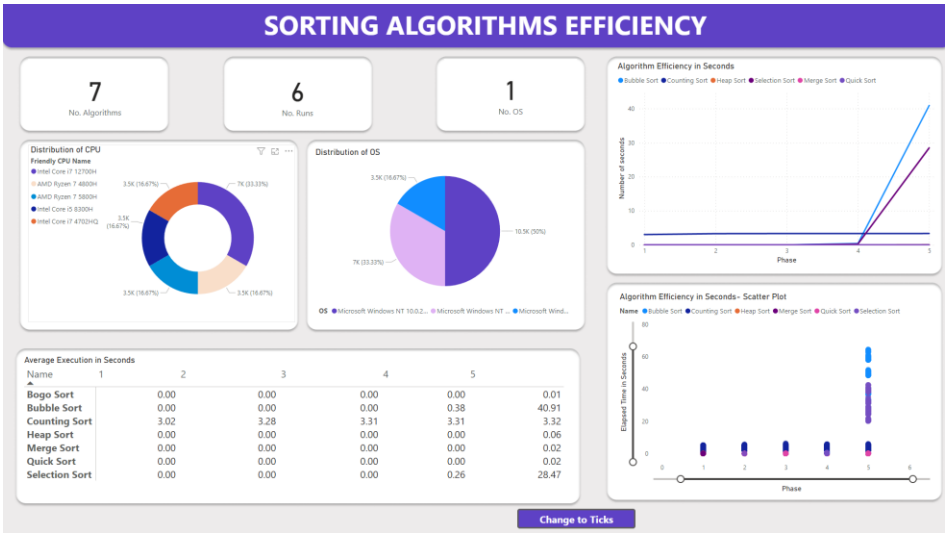

Figure 7 – Power BI report for seconds

To achieve that we need to make some transformations first. We managed to create some custom columns in PowerBI model in order to not affect the original data. To do that we have 2 alternatives **DAX** and **Power M Query** Languages. We chose to work with DAX5 because it is very similar with Microsoft Excel Formula.

One example of these modifications can be a custom column to display a more friendly name of the CPU name, because our code extract from target computer operating system from internal CPU naming offered by the manufacturer.

In figure 8 is the DAX code to do that. It's a simple SWITCH function that assigns a friendly name for the CPU identifier.

```
1 Friendly CPU NAME =
2 SWITCH (
3     cre3f_algorithmrun[cpu_identifier],
4     "AMD64 Family 23 Model 96 Stepping 1, AuthenticAMD", "AMD Ryzen 7 4800H",
5     "AMD64 Family 25 Model 80 Stepping 0, AuthenticAMD", "AMD Ryzen 7 5800H",
6     "Intel64 Family 6 Model 154 Stepping 3, GenuineIntel", "Intel Core i7 12700H",
7     "Intel64 Family 6 Model 158 Stepping 10, GenuineIntel","Intel Core i5 8300H",
8     "Intel64 Family 6 Model 60 Stepping 3, GenuineIntel","Intel Core i7 4702HQ"
9 )
```

Figure 8 – DAX Code for Friendly CPU Name column

[5] DAX - Data Analysis Expressions

Another interesting example is creating dedicated columns for creating individual controllable graph lines to interact with other elements of the report.

In figure 9 is the DAX code. In this context we look for "Bubble Sort" in the name of the run and assign elapsed time in seconds for that item, else it will set the cell as blank. We do that to prevent wrong average calculations and increase interaction capabilities.

```
BubbleSortElapsedTime =
IF (
    cre3f_algorithmrun[Name] = "Bubble Sort",
    cre3f_algorithmrun[Elapsed Time in Seconds],
    BLANK ()
)
```

Figure 9 – DAX Code for Bubble Sort Elapsed Time column

4. Results

After a long journey, our results are here. Because we chose to track time in ticks in figure 10, we have all recorded values in ticks and in figure 11 the same values in seconds.

According to Microsoft Documentation, a tick is 100 nano seconds, so we obtain the value in seconds creating a custom column using DAX where we apply this formula. $Value\ in\ Seconds = Value\ in\ Ticks * 10.000.000$.

Name	1	2	3	4	5
Bogo Sort	1,692.31	5,222.07	6,616.29	15,808.14	91,502.44
Bubble Sort	36.14	485.42	37,483.08	3,788,551.27	409,118,839.21
Counting Sort	30,172,428.40	32,795,220.03	33,121,229.23	33,089,364.84	33,223,902.08
Heap Sort	92.84	313.98	3,889.85	48,966.46	573,933.13
Merge Sort	86.23	205.50	1,850.68	19,337.90	246,347.93
Quick Sort	46.54	116.81	1,218.71	13,920.71	158,777.52
Selection Sort	36.99	344.64	22,699.07	2,551,176.93	284,686,360.72

Figure 10 – Results in Ticks

Name	1	2	3	4	5
Bogo Sort	0.00	0.00	0.00	0.00	0.01
Bubble Sort	0.00	0.00	0.00	0.38	40.91
Counting Sort	3.02	3.28	3.31	3.31	3.32
Heap Sort	0.00	0.00	0.00	0.00	0.06
Merge Sort	0.00	0.00	0.00	0.00	0.02
Quick Sort	0.00	0.00	0.00	0.00	0.02
Selection Sort	0.00	0.00	0.00	0.26	28.47

Figure 11 – Results in Seconds

These values are the result of 6 runs executed in different system configurations on Windows Operating Systems for computer in a range of 8 years from release date from the manufacture and cover the most significant players in CPU markets (Intel & AMD), and covers three generations of RAM6 memory, from DDR3 to DDR5.

One of our challenges was the similarity between Intel Core i9 12900H and Intel Core i7 12700H, because they are created on the same CPU wafer and have the same identical name. This makes our identification process almost impossible in this actual scenario, so we assimilate the Intel Core i9 12900H as Intel Core i7 12700H.

In Figure 12 we have the distribution of CPUs in our test batch.

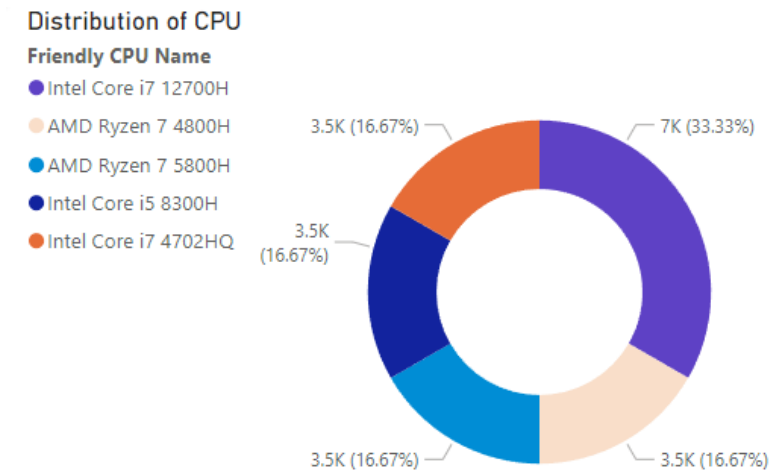

Figure 12 – Distribution of CPUs in our test batch

Also, for a better understanding of the data we attach in figure 13 and 14 there is an execution graph where are all algorithms compared. The graph has on OX axes the phase number and on OY, the number of ticks for that current execution. We can observe that in the first phase of sorting, where we have a number of 10 values, the most efficient algorithm is Bubble Sort, and the least efficient algorithm is Counting Sort. These results are in figure 13.

[6] RAM – Random access Memory

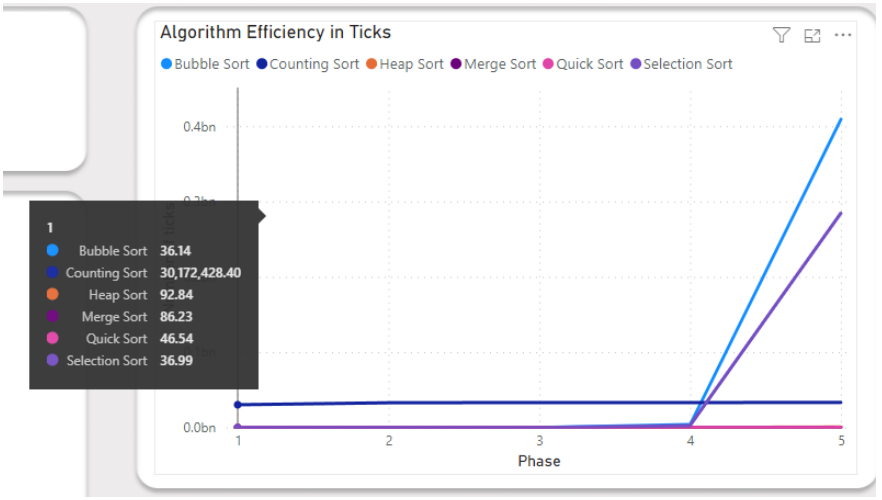

Figure 13 – Results in Seconds

In the last phase we observed a dramatic change in execution time. The fastest algorithm in phase one, now is the most inefficient, and the most effective algorithm is Quick Sort, followed by Merge Sort and Heap Sort.

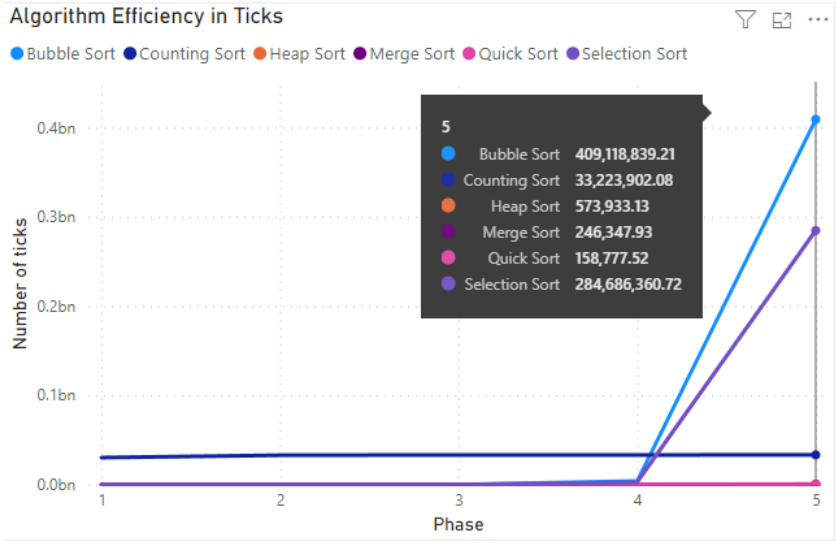

Figure 14 – Results in Seconds

If we want to compare all algorithms to the fastest one for the last phase, we observed an enormous difference between algorithms. In table 2 we have all algorithms compared one to the fastest one, Quick Sort.

Algorithm	Bubble Sort	Counting Sort	Heap Sort	Merge Sort	Quick Sort	Selection Sort
Result	257668	20924.81	361.47	155.15	100	179298.9

Tabel 2 – How slower are rest of the algorithm compared to the fastest one (in percentage)

5. Conclusions and Future Work

The presented research aimed to analyze the efficiency of some classical sorting algorithms considering a range of criteria, in order to contribute to the advancement of algorithmic understanding and to the informed selection of sequential selection methods for computational tasks.

Because our test batch was quite small, from the number of devices point of view, we can't come with pertinent conclusions for operating systems perspective and processor performance against algorithms.

We want in future to come back with an extended version of this paper in order to have more data to analyze and a more comprehensive testing and analyzing policy, with a large set of analyzed algorithms and an even distribution of operating systems. In this project we encountered lots of problems and managed to tackle and bring back some lessons learned from this process.

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A LITERATURE REVIEW ON THE IMPACT OF IMMIGRANTS' SOCIAL AND ACCULTURATIVE MOBILITY IN THE HOST NATION

Elena Raluca CRISTIAN[1]

Abstract

Relocating to a new country entails several adjustments and changes for the individual concerned, including stress related to the immigrants' accommodations in the new nation. Moving abroad entails not only leaving behind one's family and place of origin, but also enduring an exhausting and taxing process of institutional and societal integration into a new culture. Following the Covid-19 epidemic, a new wave of Muslim immigrants arrived in Western Europe. These immigrants had to deal with the harsh austerity policies of the governments and political parties in the nations that welcomed them the most—Germany, France, and Italy. These policy changes only served to limit immigrants' access to the labour market and to reasonably priced food establishments prior to 2020, which in turn limited their access to social welfare benefits. The sociological and economic theories of international migration begin with the identification of the causes that explain the migration phenomenon, the factors that contribute to the emergence and scope of the phenomenon, as well as the manner and cultural, social, religious, and linguistic integration, and the consequences that immigrants face, both in the country of destination and the country of origin of the person involved.

Keywords: Assimilation of culture (acculturation), immigrants, social mobility, social welfare, social inequality

JEL Classification: I24, J15, J61, O15, R23.

1. Introduction

Globalisation affects human civilizations in many ways, influencing chances for progress but also posing threats to personal safety. It leads to free trade, which is beneficial to society, but it also leads to drug use and trafficking, organised crime, terrorism, the spread of diseases, and unchecked pollution.[2]

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[2] Pescaru, C. M. (2014). International migration and European integration – factor of globalization. Migratia internationala si integrarea europeana-factor al globalizarii. Regionalizare si politici regionale, Iasi, Romania: Editura Lumen, p.188

It is challenging to provide a comprehensive response to the effects of globalisation on people because of the ensuing contradictory image regarding economic performance, regionalization and regional policy, the persistence of inequality, environmental degradation, and poverty*".* [3]

Globalisation has resulted in a multitude of complicated personal motivations and grounds for movement, making international migration an ever-present phenomenon across all nations. The primary factors influencing international migration are shifts in global social, political, religious, xenophobic, and economic institutions.

In specialised literature, the notion of international migration changes based on the present global environment in which it is processed and understood at the micro (individual) and macroeconomic levels, with diverse political, economic, social, religious, xenophobic, and cultural overtones. Regardless of academic perspectives or individual (immigrant) motivations, the entire phenomenon is founded on two elements that determine international migration: time and space. Internal migration (inside a country) and international migration (population mobility between countries) are defined by these two variables (time and space).

The worldwide phenomena and repercussions of labour migration are heavily influenced by the policies implemented and pushed by the states concerned, both globally and nationally. It is critical that the world's states discover genuine, concrete solutions to stop or diminish the migration phenomenon, as well as less explanations and theoretical arguments on the causes of the migration problem's emergence.

Two primary drivers of migration are the need for survival and the desire for personal growth and family accomplishment. Therefore, whether permanent or circular, external migration is a component of development strategies as opposed to survival strategies. The propensity to enrol in a circulatory migration course increases with the amount of social capital or relationship resources. The proximity of the place of residence to the nation's borders, the urban/rural environment, the level of development of the area, and the ethnic composition of the population are among the many ecological elements that have a particular impact on the migratory phenomena.[4]

Whether we are discussing lifetime mobility (intra-generational mobility) or the shift in a person's socio-economic circumstances, social mobility refers to the interaction between an immigrant and his parents (intergenerational mobility).

In other words, social mobility refers to the degree to which people leave with the same chances of succeeding in life, regardless of their parents' socioeconomic background, gender, age, sexual orientation, race, ethnicity, religion, place of birth, or other independent

[3] Stoica, Ionel, (2011). Tentaţia migraţiei. Necesitate şi oportunitate într-o lume globalizată, Bucureşti: Editura Militară, p.47

[4] Andreea Arsene, (2010), Travellers into the Giant Space of Globalization – Migration Phenomenon and its Implications at the Family Level, Revista de Administraţie Publică şi Politici Sociale Anul I, Nr. 2 / Martie 2010, p.36

factors. Social mobility is primarily related to the equality of opportunities between individuals who settle within the same community.

Individuals' social mobility and equality of opportunity can be measured in terms of their earnings, income, or social class, but they can also have distinct relationships with well-being, health, and education.

Inequality in a person's birthplace eventually results in inequality in opportunities later in life.

When they are young adults, the jobs available in the labour market vary a lot based on where they reside, where they are from, and how developed the cities are economically.

Social mobility is a constant struggle, particularly for people with low-quality positions in the labour market and those with little opportunities to quite temporary or low-paying professions. The chances of those with less education may also be restricted, leaving them with fewer options for career advancement or retraining. The term "acculturation" describes the process by which individuals from various cultural backgrounds interact directly, continuously, and over an extended period with members of a distinct demographic in a particular nation. In the end, circumstances force immigrants to assimilate the culture, language, and customs for a better collective and social integration on the labour market and beyond. This is specific to immigrants who come from completely different environments and cultures and who come into permanent contact with the native population.

Anthropology is the source of the theory of collective integration, commonly known as assimilation or acculturation. The anthropological notion of acculturation, as acknowledged in specialised literature, is attributed to Redfield, Linton, and Herskovits. Immigration integration is a protracted, intricate process that is influenced by a variety of objective and subjective economic, ethnic, psychological, and other factors. [5]

2. Immigrants' perspectives on acculturation

Acculturation is the result of a mass phenomenon in which groups of people from various cultures come into direct, long-term contact, with subsequent modifying impacts in one or both groups' original cultural patterns. Several types of acculturation models are reported in the specialised literature. The unidimensional model of acculturation, which was historically motivated by European immigration to the United States in the nineteenth and early twentieth centuries.[6]

[5] Rumbaut R.G. (1999). Assimilation and Its Discontents: Ironies and Paradoxes, in: The Handbook of International Migration: The American Experience, ed. by C. Hirschman, P. Kasinitz & J. De Wind. New York: Russell Sage, p. 172.

[6] Ecaterina Zubenschi, (2018), Teoriile Sociologice ale Migrației, Csei Working Paper Series, Issue 10, December 2018, p.49.

According to the first acculturation model (of total absorption), the process of acculturation can be understood as a series of adaptations to the new environment, with the ethnic legacy being gradually lost.[7]

The new immigrants eventually adjusted to the new environment completely. Religion was typically unaffected by the process of acculturation. Some people believe that the process of adaption happened over a period of three generations. The first generation to relocate was this one. There were two cultures in the second generation. The new cultural framework was fully assimilated to by the third generation.[8]

Table 1. The primary means of assimilating immigrants in the destination or host country

Integration components	Assimilation	The mutual co-existence of cultures
Civil integration	Naturalization Lack of restrictions on territorial mobility The possibility of realizing the requested rights The exchange of ethnic identity with civic identity	Acquisition of Naturalisation No limitations on the movement of territory The potential for obtaining the desired rights. The potential to identify oneself with a certain social group, such as a particular ethnicity, religion, or territory.
Economic integration	Opportunities include: - finding employment - earning a wage commensurate with that of the local people The potential to get any of the following social advantages - recognising one's capacity for entrepreneurship -	Opportunities include: - finding employment - earning a wage commensurate with that of the local people The potential to get any of the following social advantages - recognising one's capacity for

[7] Gordon M. M. (1964). Assimilation in America Life: The Role of Race, Religion, and National Origins. New York: Oxford University Press

[8] Portes A., Fernarndez-Kelly P., Haller W. (2005). Segmented assimilation on the ground: The new second generation in early adulthood, Ethnic and Racial Studies, (28), p. 1037.

	investing in real estate and doing exercise property rights	entrepreneurship - investing in real estate and utilising one's property rights
Ecological integration	Satisfaction regarding the natural and geographical conditions and characteristics of the territory of the host country; Satisfactory health	Satisfaction regarding the natural and geographical conditions and characteristics of the territory of the host country; Satisfactory health
Social-psychological integration	Free access to education Knowledge and fluency in the language of the host country	Possibilities: - to learn and speak in the mother tongue; - to obtain traditional national studies; - to live compactly, together with his compatriots from the ethnic group
Religious integration	Accepting the new society's predominant religion	Ability to profess previous religion requested
Cultural integration	Accepting the culture of the host country Denying national traditions	The possibility to: - develop and propagate national art and culture; - share the national traditions of the country of origin

Source: Reproduced from Sociological Theories of Migration by E. Zubenschi*, 2018, p.50*[9].

To start again and integrate fully into the community in the destination or host country is a driving force behind this kind of acculturation. Many Western European countries exhibit a similar trend of complete absorption of migrants into the host nation, as seen by the full integration of Jewish immigrants from Southern and Eastern Europe into Dutch ethnic languages and customs.[10]

[9] Ecaterina Zubenschi, (2018), Teoriile Sociologice Ale Migrației, Csei Working Paper Series, Issue 10, December 2018, p.49.

[10] Klein J., Fontan J. (2004). La mobilisation du capital socio-territorial: le cas du technopôle Angus. Lien social et Politiques, (52), p.143.

According to the model, an immigrant is connected to both the culture of his or her home country and the culture of the country they are living in. The extent of the immigrant's assimilation into the new culture is mostly determined by his or her level of knowledge and desire to fit in.

Cultural and social integration is the process of assimilating into the dominant culture while yet maintaining one's ethnic heritage. Thus, integration is the encounter between the immigrant's own culture and a new one; it is up to the immigrant to determine how much of his own culture he absorbs and what he keeps in mind from cultural assimilation. According to recent studies on acculturation, immigrants' most common option is integration[11]

E. Zubenschi claims that immigrants continue to live their lives in accordance with the peculiarities of their ethnicity in their new nation. For example, Muslim women who have lived in Western Europe for decades are unable to speak the language of their new country. Over the years, their cultural, linguistic, and psychological component has remained constant. When immigrants reside in an area where they are the only foreigners in that country, separation might cause issues of isolation. However, separation is a feasible choice when immigrants live in a context with many of their fellow citizens. Assimilation, the reverse of separation, is the total loss of ethnic culture and total absorption into the host culture. One might use the one-dimensional acculturation model as a model to understand what assimilation entails.[12]

Immigrants must continuously blend and mix elements of their ethnic culture with the prevailing culture to fully integrate into their new country. When the attitudes and behaviours of the immigrants are fully assimilated, both cultures are equally represented.

The two-dimensional model seems to be implicitly based on the quality of acculturation. It's important to keep in mind that immigrants prefer to live their lives separately in every way. The vast range of individual and group characteristics that are reflected in how immigrants maintain their ethnic culture and/or embrace the majority culture are not adequately captured by the idea of acculturation as a quality.[13]

The most well-known representative of the movement, Michael Joseph Piore (1979), contends that the result of labour demand characteristic of developed economies is international migration. According to the author, structural inflation, hierarchical motivational barriers, economic dualism, and demographic shifts in the labour force reserve are the four main causes of the need for immigrant labour.

At the macroeconomic level, the labour market in developed and emerging nations is primarily dual, with two sectors: primary and secondary. In contrast to the secondary market, which is made up of inexpensive, unskilled labour, the primary sector employs

[11] Pajares M. (2007). Inmigrantes de un pais de la unión europea: red social, inmigración irregular y acceso al empleo de los inmigrantes rumanos. Migraciones nr. 21., p.197.

[12] Ecaterina Zubenschi, (2018), Teoriile Sociologice Ale Migrației, Csei Working Paper Series, Issue 10, December 2018, p.51.

[13] Ecaterina Zubenschi, (2018), Teoriile Sociologice Ale Migrației, Csei Working Paper Series, Issue 10, December 2018, p.51.

skilled labour, people with higher education (both undergraduate and graduate), better working conditions, and higher wages. We will encounter a lot of immigrants, mostly in the secondary sector, who are underqualified for the positions they may find in their new nation, whose working circumstances frequently leave them unsatisfied, and whose earnings barely cover the minimum wage.

Due to low pay, unstable employment, and the low status and prestige of secondary sector occupations, native workers frequently avoid entering this labour market. In this scenario, foreign immigrants are frequently forced to accept "low-paid jobs and jobs considered to be shameful" as a last resort to find employment and integrate into society in the host nation.

3. Impacts of immigrants' social mobility on the host nation

The classic theory defines social mobility as any change in a person's socioeconomic status that happens during their life, either in relation to their parents or independently of them. This type of mobility is known as intra-generational mobility.

There is a distinction between migration and spatial mobility. Mobility is a broader term that include migration. It is a social construction to transform the status of a citizen from one of mobility to one of migration. A community that defines migration narrowly is likely to produce more transient residents, tourists, foreign students, temporary labourers, and other mobile individuals rather than migrants.[14]

As we saw from the specialised literature analysis, the term of mobility encompasses a wider range of individuals than labour migration, including researchers, scientists, businesspeople, and those who go to see their temporarily placed relatives abroad.

However, the education of individuals who have travelled abroad, whether permanently or temporarily, as well as their professional background, are crucial to their integration not only into the host nation but also into the workforce.

We believe that states that are experiencing a large-scale immigration wave should consider their policies regarding migration, particularly regarding labour mobility.

More accommodating immigration laws are desperately needed in order to draw in inhabitants of other third-world nations who have a certain set of competencies, professional abilities, or professional certifications in specific fields of endeavour.

If students from third countries have the opportunity to find job after completing their studies, their increasing mobility as a labour force has a direct impact on the labour market, particularly when we discuss the "brain drain" or "brain migration".

Reworking Ravenstein's laws in 1966 to emphasise internal (or push) forces, sociologist and demographer Everett S. Lee added the idea of obstructive factors (obstacles to migration) as variables that interfere and influence the volume and distance of migration. Using four types of factors—obstacles separating the two places, factors related to the

[14] Pescaru, C. M. (2014). International migration and european integration – factor of globalization [Migratia internationala si integrarea europeana-factor al globalizarii]. In Rogojanu, D. C. (coord.) (2014). Regionalizare si politici regionale, Iasi, Romania, p.189

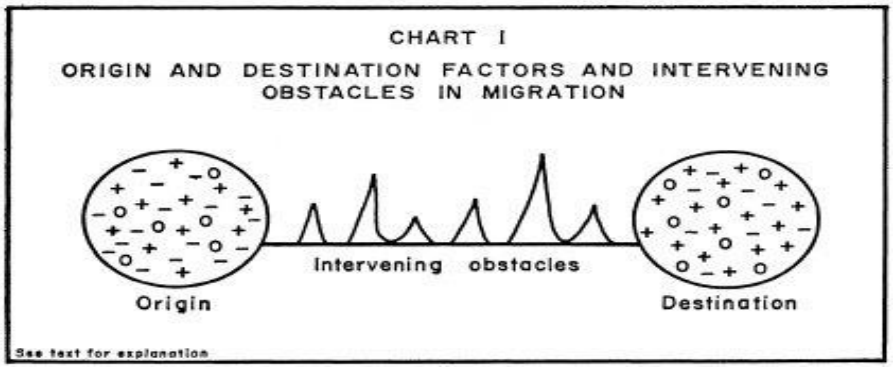
origin area, factors related to the destination area, and personal characteristics—he attempts to create a basic scheme for migration. [15]

The writers Raveinstein and Lee's theoretical approaches to migration fall within the category of "gravitational models of knowledge of labour migration" in the specialised literature, with the origin and destination countries serving as their starting points. The concept of intervening obstacles (i.e., barriers that must be surmounted prior to migration) was first proposed by Everett S. Lee. The amount and distance of migration are influenced by these variables. Both the migrant's country of origin and destination are viewed differently by everyone based on personal traits such as professionalism, capabilities, and opportunities. The ability to overcome migration difficulties is influenced by a variety of characteristics, including age, education, gender, all forms of belongings, social class, marital status, familial ties, and degree of knowledge of the receiving community.

These factors operate through mediation rather than direct action.[16]

In Figure 1 we find the Push&Pull type factors elaborated by Everett S.Lee (1966), representing the factors that intervene between the country of origin and destination for immigrants.

Figure 1. Push & Pull Factors of Migration According to Everett S. Lee's Theory (1966)



Source: Diagram of Pull & Push factors by Everett S. Lee (1966)[17]

Everett S. Lee found a correlation between these parameters and people's mental health and life stages. "Some people oppose moving, but they don't want to go through the nerve-

[15] Ecaterina Zubenschi, (2018), Teoriile Sociologice Ale Migrației, Csei Working Paper Series, Issue 10, December 2018, p.47.

[16] Ecaterina Zubenschi, (2018), Teoriile Sociologice Ale Migrației, Csei Working Paper Series, Issue 10, December 2018, p.45

[17] Ryakitimbo, Crispin & Hossain, Babul. (2019). Factors of International Migration of Haitians to the Dominican Republic in 2010-2015. International Journal of Global Sustainability. 3. 88. 10.5296/ijgs. v3i1.15841.

wracking issues that others usually go through. Some people must have compelling reasons to migrate, whereas others only want modest incentives or assurances.[18]

Lee concludes that moving cannot be totally logical. Reason may occasionally be irrationally overshadowed by emotional and mental imbalances, depressive states, and unforeseen circumstances when deciding to relocate. As such, personal considerations are hard to interpret, even if they play a big part in the decision to immigrate. [19]

These factors are conceptualised by Everett Lee in relation to the decision to migrate and the migration process, and he divides them into four categories: personal, obstacle-related, and factors related to the country of origin or area of origin. Lee lists several traits of migrants in relation to the four categories of factors, including: When all migrants are considered together, selection for migration tends to follow a binary pattern; the degree of positive selection increases with the difficulty of the impediments; migration is selective; migrants who respond to positive destination factors tend to be positively selective; migrants who respond preferentially to negative factors at origin tend to be negatively selective. Destination migrants typically fall somewhere in between those of the local population in their place of origin and those of their destination. The selection made by migrants is influenced by their greater propensity to migrate at phases of their lives.[20]

O.D. Duncan proposed a hypothesis addressing the mobility of agricultural population in his book, The hypothesis, and Consequences of Farm Population Mobility. His theory is based on the interaction of microscopic and macroscopic active forces in the migration process.

According to Duncan, whatever consequences are induced by changes in the country's structural characteristics, the same effects are caused by migration. As a result, migration is the functional alternative to social change for achieving many structural goals.

In 1981, Standing Guy developed this thesis in his book Migration and Modes of Exploitation: The Social Origins of Immobility and Mobility. According to this theory, the magnitude and amount of migration are determined by the relationship between a society's production, the nature of wealth, the land ownership system, and the variables influencing the expansion of a society's production forces. He focused on migration that occurred during the transition period between the end of feudalistic production and the beginning of capitalistic production. In ancient times, whatever migration occurred was within a certain group, but migration in the present capitalistic system is primarily of a personal kind. There was no considerable migration in the feudalistic system since cultivators were under the

[18] Lee E. S. (1966). A theory of migration. Demography, 3(1), p.36.
[19] Ecaterina Zubenschi, (2018), Teoriile Sociologice Ale Migrației, Csei Working Paper Series, Issue 10, December 2018, p.47.
Idem, p.48
[20] Ș.C. Stanciu, A. Toma, (2020), Fenomenul Exodului De Creiere Și Migrația De Elită: Migrația Medicilor Români În Franța, Revista Transilvană de Ştiinţe Administrative 2(47) / 2020, p.98.

jurisdiction of feudal lords. There was no significant development of cities during this period, and there was no rural push migration. Whatever industrial development has occurred in the capitalistic system has been made feasible by migration. Migration ends the old types of class relations and gives birth to a new type of class structure, the capitalist labour class. Thus, Standing has described the migratory process in terms of diverse economic systems and forms of production, as well as the nature and flow of migration considering Karl Marx's Theory.

4. Theories about migration

Because of the shift in the migration flow over the past 30 years from being countries of emigration to countries of immigration (destination), the Southern European countries of Italy, Spain, Portugal, and Greece are regarded as genuine models for labour migration in the region, not just in specialised theory.[21]

According to theory, there are a few things that make being an immigrant stressful, including adjusting to a new culture and way of thinking, social and linguistic barriers, shifting economic circumstances, shifting workplace and employment norms in the destination nation, issues pertaining to the new social status of immigrants, and issues with xenophobia and religion.

A study carried out in 2006 on immigrants from Italy showed us that citizens of Tunisian origin are more stressed than citizens of Senegal and Pakistan.[22]

The percentage of immigrants' children born in a new nation, their ability to learn the language, and their level of social integration in schools all provide intriguing insights into the linguistic and cultural assimilation of these individuals. Nevertheless, in addition to all of this, analysis was done on school dropout rates, high unemployment rates, xenophobic and social prejudice, and violence in the border neighbourhoods where these immigrants reside.

Since the Second World War, the demographics of the European continent have dramatically changed. Europe has a high rate of population ageing and a low birth rate. The European nations (France, Germany, Great Britain, Spain, Italy) that have seen recent waves of immigration have had to accommodate and reconcile with the new immigrant populations. The native populace was compelled to accept immigrant children attending the

[21] C. Novara, M.J. Martos-M´endez , L. Gomez-Jacinto, I. Hombrados-Mendieta , L. Varveri a , C. Polizzi; The influence of social support on the wellbeing of immigrants residing in Italy: Sources and functions as predictive factors for life satisfaction levels, sense of community and resilience, International Journal of Intercultural Relations 92 (2023) 101743, http://www.elsevier.com/locate/ijintrel

[22] S. Toselli & E. Guardi-Russo, Psychosocial indicators and distress in immigrants living in Italian reception, 2008, Stresss health, 24, pp. 327-334, European Journal of Public Health, centreshttps://dx.doi.org/10.1002/smi.1195.

same educational system as their own and the knowledge that these factors will eventually lead to their assimilation into the labour market.

The initial research on labour mobility was conducted between 1950 and 2000 on diverse immigrant groups from Asia (China, Vietnam, Korea, India, Pakistan, Iran, Iraq) and Africa (Senegal, Somalia, Lebanon, Egypt, Tunisia, Algeria, Morocco) that were arriving in Western Europe. Rather, the studies concentrated mostly on the multicultural and linguistic aspects of these immigrants' offspring and how they themselves adopted another language and culture.

Their parents, who were also immigrants, had been hired for low-skilled positions in the construction, cleaning, transportation, and other related industries. Early research suggested that to comprehend the distinctions and parallels with social mobility among the descendants of the working class generally, it would be valuable to investigate the mobility processes among immigrants as well as their offspring.[23]

One citizen out of every ten legal residents in most Western European countries nowadays does not hold citizenship in the nation in which they currently reside. In terms of Western European nations, the range is as follows: 12% in France, 18% to 20% in Austria and Germany. A 2016 survey found that one in three French people have immigrated at some point, either through one or both of their parents.[24]

For all nations that take in cheap labour from outside, integrating migrants into the labour market is a critical issue. Topics that need to be taken seriously include the division of labour and raising labour productivity at the macro and microeconomic levels. The host population's mistrust of immigrants has only grown because of recent acts of terrorism and anti-xenophobia; this is a common worry shared by both groups.

The division of states in Europe based on economic models is a good example of how the states that receive many immigrants each year can be analysed. Denmark, Norway, Finland, and Sweden are known for their coordinated markets, which are based on the social-democratic welfare model, while Germany, Austria, and France adopt more conservative and restrictive immigration policies. Great Britain and Ireland are known for their liberal market model. Additionally, it was discovered that nations like France and Germany guarantee a greater level of integration for immigrants on the labour market.[25]

Numerous elements that can affect an immigrant's level of cultural, linguistic, and educational assimilation as well as their social mobility have been discovered in specialised

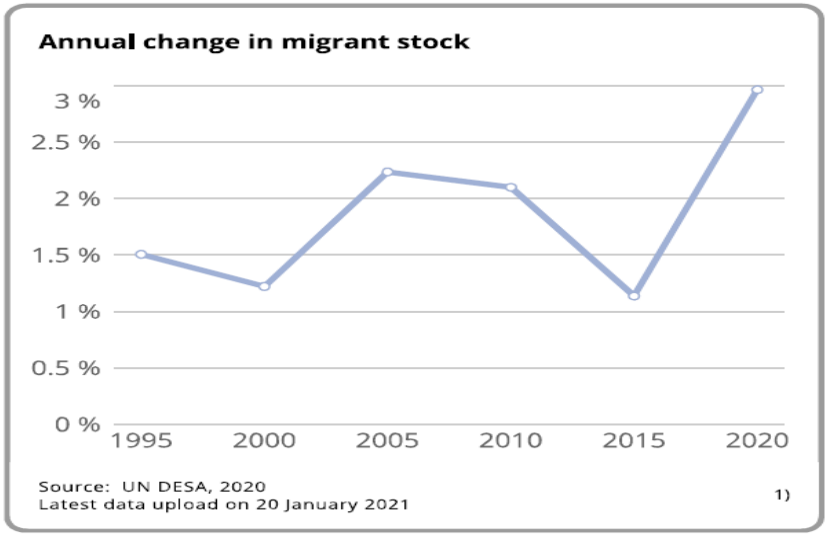
[23] Andreas Pott, Maurice Crul, and Jens Schneider, Producing Pathways to Success: New Perspectives on Social Mobility (2022), New Social Mobility Second Generation Pioneers in Europe.
[24] Beauchemin, Cris, Bertrand Lhommeau and Patrick Simon. (2016), "Histoires migratoires et profils socioéconomiques". In Trajectoires et origines: Enquête sur la diversité des populations en France, p.34.
[25] Juhyun Lee, A comparative study of eight European countries: how life course events affect female migrant labour market integration under the perspective of welfare and production regimes, 2022, Journal of International and Comparative Social Policy (2022), 38: 3, 254–274 https://doi.org/10.1017/ics.2022.17,

literature. The most significant ones among them are listed here[26]: Moral values- refer to integrity, general universalism, ethnic minority universalism, gender related universalism.

- Tradition values- refer to religion, politics, and ideology.
- Social values- refer to family, community, and social interaction.
- Instrumental values- refer to material values, educational values, competence, and achievement.
- Intrinsic values- refer to psychological and physical needs.

The immigration phenomena in many EU member states invariably leads to a host of social, political, and economic issues. Whether immigrants make "fair" contributions to the tax and social welfare systems of their new nation is still a major concern for both public opinion and legislators. Citizens of Europe are more and more likely to share the legitimate concerns of the indigenous community. [27]

Figure 2. Annual change in migrant stock in Europe[28]



Source: https://www.migrationdataportal.org/international-data?t=2022&i=refug_host

[26] López-Rodríguez, L., Vázquez, A., Constantin, A. A., Bonafonte, M., & Zagefka, H., (2023). The values we share: A multi-method approach to understanding how perceived outgroup values is related to attitudes towards immigrants. *British Journal of Social Psychology*, p 53, https://doi.org/10.1111/bjso.12583

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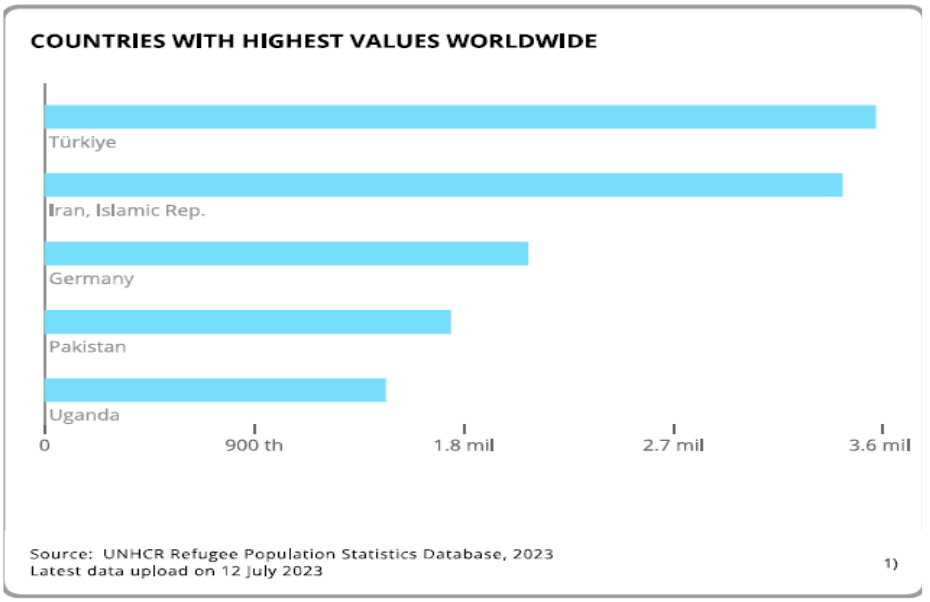
[28] Statistics refer to international migrant stocks. Stocks include all foreign-born residents in a country regardless of when they entered the country. For countries where data on the foreign-born population are not available, UNDESA uses data on foreign citizens. As such, the number of international migrants may not include second-generation migrants that were born in the country but have parents who migrated. Stock data should also not be confused with annual migration flow data (i.e., the number of migrants that entered or left a country within one year).

Figure 3. Total number of refugees in host country by the end of 2022[29]



Immigrants' process of cultural assimilation, or integration, is complicated and contentious in both academic literature and modern life. Lastly, there are other ways that cultural integration can be defined. More broadly, it might refer to knowledge and an emotional connection to the host community. More specifically, it can refer to immigrants' cognitive capacity to pick up a variety of skills.[30]

In France, for example, Maghreb immigrants from former French colonies in North Africa earn far less than other European immigrants. This is largely due to the French government's tight labour market laws and salary disparities. According to socioeconomic data in France, young Maghrebian or Turkish citizens are disproportionately unemployed. Although the minimum wage in France has grown in recent years, the government still has a racially discriminatory wage policy for both Maghreb and Muslim citizens.[31]

European governments have implemented labour market integration contracts as a means of assisting in the integration of diverse immigrant groups. The goal of these is to get immigrants to respect the moral, cultural, and religious values of the host society by means of language instruction, mandatory training, and civics classes. Despite their widespread use, there is insufficient empirical data to determine if they encourage integration or set off

[29] https://www.migrationdataportal.org/international-data?t=2022&i=refug_host
[30] D. Ch. Spies, S. J.Mayer, J. Elis, A. Goerres, (2022), Why do immigrants support an anti-immigrant party? Russian Germans and the Alternative for Germany, West European Politics, Volume 46:2, p.282, https://doi.org/10.1080/01402382.2022.2047544
[31] Ababacar S. Gueye, Nila Ceci-Renaud, (2022), The Dynamic of the Wage Gap between Natives and Descendants of Immigrants in France, French Ministry of Labor – DARES,Paris, France, p.37.

a violent or aggressive domino effect within a particular immigrant population that is adamant about maintaining their own identity, morals, and religion. Many immigrants failed to identify with the social and cultural norms of the host nation despite the state's best attempts.[32]

The demands of a changing society, where the expression of several identities takes the shape of solutions to the problems posed by the national state as well as the transnational and global arena, appear to be met by multiculturalism. Therefore, the process of globalisation forces us to continually recognise, accept, and affirm diversity. It also forces us to deal with the constant resettlement of majority/minority relations in real cultural contexts as well as globally.[33]

Intercultural communication - that which distinguishes the specifics of relationships between individuals with different socio-cultural identities, as well as the awareness of one's own identity within the integration process - is a daily reality, a practical way of life in society. The affirmation of the society's linguistic and ethnocultural plurality, typical of the concept of multiculturalism, entails the recognition of the fact of cultural coexistence and the legitimacy of this plurality, elucidates the increased degree of influence of other cultures and civilizations on national socio-cultural heritages. [34]

The European model of immigrant integration is distinguished by a trade-off between employment and job quality, which takes various forms throughout Southern and Central Europe. Migrants in Mediterranean nations have similar occupations and prospects as the native population, but they face a significant danger of falling into the lowest tiers of the occupational hierarchy. In continental Europe, the trade-off is reversed: migrants have fewer work prospects but face a smaller penalty in job quality once hired than immigrants from southern Europe. [35]

While some Muslim immigrants remain faithful to the moral, religious, and traditional values of their country of origin, defending their own social and ethnic identity; on the other hand, we can identify another group of foreign immigrants, primarily from African countries, namely the Maghrebs, who make efforts to integrate into the host country, assimilating their language, culture, and, to a lesser extent, their religious identity.

[32] Mathilde Emeriau, Jens Hainmueller, Dominik Hangartner, David D. Laitin, (2022), "Welcome to France." Can mandatory integration contracts foster immigrant integration? " National Science Foundation Grants No. 1624048 and 1627339, the European Research Council (ERC) under the European Union's Horizon.

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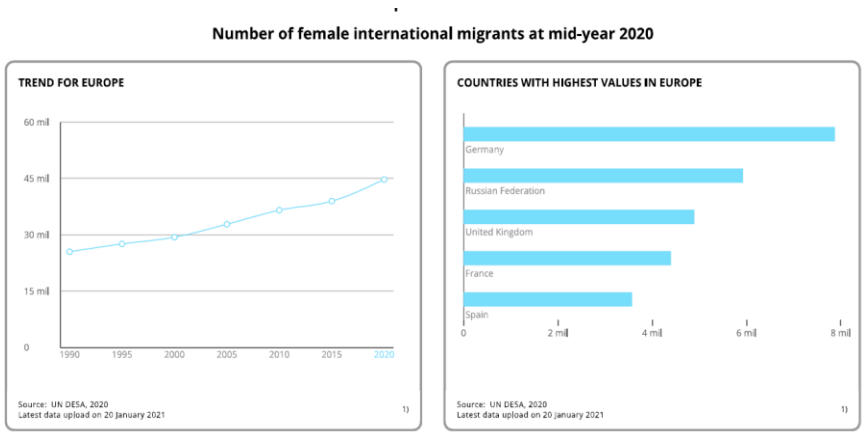
The countries of Western Europe (France, Germany, Austria) and Southern Europe (Italy, Spain, Portugal) have the highest immigrant populations of Muslim, African (Maghreb), and Jewish descent. Research indicates that the process of assimilating into a new culture, language, and "national-social identity" is less difficult for immigrant groups that originated as former colonies of the countries they are now living in. This assimilation is semi-natural, not forced, and occurs over several generations.

Figure 4. Number of female international migrants at mid-year 2020



Source: https://www.migrationdataportal.org/international-data?t=2020&i=stock_abs_female_[36]

5. Conclusions:

Modern globalisation has resulted in the global dissemination of knowledge in real time for all aspects of economic and social life. Individually, globalisation provides the opportunity for a better life for those qualified in the labour market, who are much more advantaged, but also for the unqualified, who can find jobs in other countries and fields of activity other than their country of origin, where there is more demand for work.

Stiglitz noted of globalisation in 2005 that it can be a factor of well-being for everybody everywhere in the long run, bringing several benefits in delivering riches to all, particularly the impoverished or countries with no economic prospects. While millions of migrants return to their home countries each year, not all of them are recorded. The COVID-19 pandemic caused significant hurdles to return migration in 2020 due to lockdowns, travel restrictions, limited consular services, and other containment measures, and slowed return activity.

Many countries eased travel restrictions in 2021, and various sorts of migration, including return migration, resumed, but not to pre-pandemic levels. Returns returned to pre-pandemic levels in 2022.

[36] https://www.migrationdataportal.org/international-data?t=2020&i=stock_abs_female_

A significant factor in the modern social developments is migration. It is a product of worldwide shifts as well as a catalyst for further changes in both the host and the country of origin. Currently, under the normal circumstances of a global society, one of the main issues facing the European Union at its external borders is migration management.
These countries are distinguished by a swift pace of economic, political, and social change, which has led to swift changes in the fundamental policies governing migrant integration. In addition to regularising and controlling migrant flows, migration management considers the social ramifications of newcomers' integration into the community and the establishment and development of efficient mechanisms for managing diversity in the insertion communities.
Migration management does not begin with the first immigrant. Thus, diversity management primarily considers the design and development of suitable instruments to support the preservation and manifestation of immigrant communities' beliefs, customs, and cultural practises. Most often, these traits take the shape of rights that serve as interculturality promotion and individual protection tools.

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NEUROMARKETING - MODERN TECHNIQUE FOR ANALYSING CONSUMER DECISION-MAKING

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Oana PREDA[2]

Abstract
Neuromarketing is a scientific discipline that unlocks the mystery of the human mind, answering why consumers prefer a particular product. It is a step ahead of other research methods because it can analyze consumer desires and provide more precise results. In this sense, cognitive neuroscience studies consumer behavior with the aim of gaining a better understanding of the brain mechanisms underlying certain functions such as reasoning, decision-making, emotion, and memory, providing relevant insights into areas such as advertising response and brand loyalty. Indeed, neuroscience is a field that seeks to understand the structure and function of the human brain, how it encodes and represents the environment and how it controls the body and provides theoretical frameworks to assess correlations between the brain and behavioral states, to understand the causal links between stimulus and response. Thus, neuroscience has carved out a place in marketing to study, with much greater precision, the neural mechanisms of individuals exposed to marketing actions and stimuli.

Keywords: neuromarketing, neuroscience, ethical responsibility, marketing research, consumer behavior

JEL Classification: D87, M31, O39

1. Introduction

In the digital age of information and communication, marketing has evolved considerably to adapt to new consumer demands and behaviors. One of the most exciting innovations in this field is neuromarketing or neuroscience in marketing. This complex concept combines marketing principles with neuroscience knowledge to better understand how the human brain responds to stimuli and to develop effective marketing strategies.

In this respect, a major challenge for the 21st century is to identify the optimal ways to satisfy consumers' needs and desires in a way that is economically profitable for companies. [4] Market research plays a major role in achieving this goal, and its methods, techniques

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and tools have continually evolved. They have given a significant boost to the depth and accuracy of research over the last two decades by incorporating neuromarketing methods and techniques.

The emergence of neuroimaging techniques and modalities has shown immense potential in various fields of research. [1] Imaging techniques are able to identify and map different brain regions in relation to their functions, which act as a key to various cognitive and neurophysiological research. In addition, a more comprehensive view of the human brain is achieved by combining anatomical and functional perspectives through hybridization (fusion). With technologies constantly improving, there have been many developments in fused imaging techniques in recent decades.

The global market for consumer products and services is a potential hotspot for researchers to demonstrate the applications of neuroimaging and brain mapping. Neuromarketing principles apply neuropsychology to marketing research and study subject response to marketing stimuli in terms of cognitive response with brain signals. Compared to traditional research methods, neuromarketing proves to be advanced, emerging, and advantageous as a research tool.

Source: https://www.dianysmedia.info

In this context, neuromarketing emerged as an extension of neuroeconomics research, the term having been introduced by Professor Ale Smitds of Erasmus University in Rotterdam to describe the application of neuroimaging techniques in market research. The main difference from traditional research methods stems from the fact that in neuromarketing research, subjects are not asked what they think about a particular topic. In other words, the declarative component is not taken into account, and results are obtained only from recordings of the brain activity of the participants in the experiment. By delving into the human subconscious, neuromarketing research makes it possible to identify the subjects' non-material reactions to the stimuli to which they are exposed - products, packaging, services symbolized by logos, visual, olfactory, tactile, gustatory or auditory elements specific to goods useful for satisfying needs [3].

The interrelationship between neuroscience and marketing has become imminent due to the limitations and drawbacks of traditional methods used in the study and observation of consumer behavior, based mainly on self-reported information from respondents. Researchers have therefore succumbed to the need to use a more efficient way to overcome these limitations, which could provide a better understanding of consumer behavior.

Indeed, neuroscience is a field that seeks to understand the structure and function of the human brain, how it encodes and represents the environment and how it controls the body and provides theoretical frameworks to assess correlations between the brain and behavioral states, to understand the causal links between stimulus and response. Cognitive neuroscience studies consumer behavior with the aim of gaining a better understanding of the brain mechanisms underlying certain functions such as reasoning, decision making, emotion and memory, these brain functions go hand in hand with marketing concepts such as advertising response, brand loyalty etc. Thus, neuroscience has carved out a place in marketing to study with much greater precision the neural mechanisms of individuals exposed to marketing actions and stimuli. [2]

The main premise of neuromarketing is that most purchasing decisions are not made consciously but are influenced by instinctive and emotional reactions in the brain. [5] Therefore, by using neuroscience techniques, one tries to understand these subconscious reactions and to create strategies that stimulate them in a favorable way. It also aims to better understand the impact of marketing stimuli by observing and interpreting human emotions.

The reason behind neuromarketing is that human decision-making is not primarily a conscious process. Instead, there is growing evidence that the desire to buy products and services is an emotional process in which the brain uses "shortcuts" to speed up the decision-making process. At the intersection of economics, neuroscience, consumer behavior and cognitive psychology, neuromarketing focuses on the emotions that are relevant to human decision-making and uses this knowledge to make marketing more effective.

As a result, neuromarketing is becoming a cutting-edge scientific discipline that defines the boundary between neuroscience and marketing, aiming to apply knowledge from the medical sciences about the workings of the human brain and its use in effective business strategies, while at the same time offering products and services so that buyer behavior is directed towards purchase [6] Neuromarketing is a scientific discipline that unlocks the mystery of the human mind, answering why consumers prefer a particular product. Because it can analyze consumer desires, it also provides more accurate results.

2. Neuromarketing targets

Source: https://www.dianysmedia.info

Neuromarketing is important in the process of selling products and services because of its objectives, which can bring many benefits: [9]

- ✓ Enhances the consumer experience
- ✓ Incentivizes customers to make the right decision for their needs
- ✓ Brand becomes present in consumers' minds and associations are made with your products and services
- ✓ Interacts with the perception of your product using sensory memory techniques
- ✓ An emotional connection is created between the consumer and the brand.

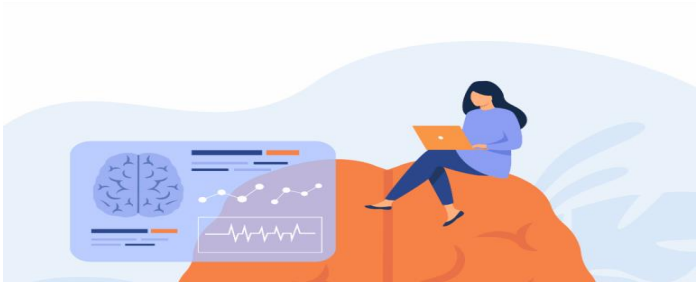
In neuromarketing there is a certain reluctance that is partly due to a general pessimism about the technique's ability to generate useful insights beyond what traditional marketing methods offer. Several academic studies have shown that brain data can predict future product success more accurately than traditional market research tools such as surveys and focus groups. For example, studies have found that after participants watched anti-smoking ads, the number of phone calls to quit lines increased. However, traditional surveys on the effectiveness of ads have not led in the same direction.

These experiments show the benefits of neuromarketing over traditional approaches, which have significant inherent limitations. In surveys or focus groups respondents are not always receptive about their memories, feelings, and preferences. Often people misremember, lie, or are embarrassed by the way a question is asked.

Neuromarketing is seen as a field of commercial marketing communications that applies neuropsychology to marketing research, studying the sensory-motor, cognitive and affective response of consumers to marketing stimuli. An example of neuromarketing is Coca Cola, which uses the color red to capture, make the brand memorable and instantly recognizable to consumers. The packaging of crisps is another example that uses the auditory sense through the noise made by the bag being associated with the crunchy sound of the crisps. From a visual point of view, we can see landing pages promoting "life-changing" products. These techniques are well thought out because the images and buttons

are positioned exactly where the eye will go. The design, color scheme and position of elements influence the consumer's buying decision. Social media ads are a good environment to use neuroscience. We encounter neuromarketing in videos, testimonials and images in social media posts that grab consumer attention through various triggers. Blogs stand out through tone of voice and illustrations, using neuromarketing with the aim of making the user better understand the message the author wants to convey, as well as attracting attention. Podcasts also play an important role in developing the relationship between brand and consumer through the auditory senses they rely on. Voice, can be a very good stimulus, which often, in this case, attracts.

2.1. Neuromarketing strategies for business development



Source: https://www.dianysmedia.info

The question that arises from a strategic point of view is whether everything in marketing is based on neuromarketing. Potential benefits for marketers include more effective and relevant marketing campaigns and strategies for consumers. It often involves manipulating people's real needs and wants to suit the needs and wants of marketing interests.

Marketing campaigns almost always try to produce some kind of brain activity that leads to the desired behavior. Neuromarketing is not inherently about manipulating the audience but rather about understanding people's real needs and wants. With this knowledge, marketers can develop better products and relevant, less wasteful advertising campaigns.

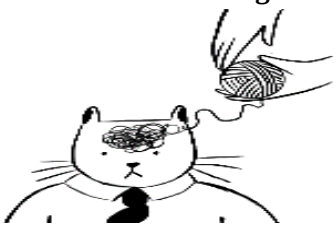
To optimize the neuromarketing strategy, it is advisable to address all five senses - visual, auditory, taste, smell and touch.

- ✓ **Visual sense** - keeping track of exactly in what order the consumer notices items on a web page, a product on the shelf or information displayed. This helps to see where users spend more time and where their activity is focused when interacting with the brand.
- ✓ **Auditory sense** - music is an example of an auditory strategy through which the brand can suggest consumption, relaxation, parties, to associate purchases with a certain mood.
- ✓ **Taste** - in supermarkets the big brands offer samples of cold meats, cheeses, etc. near the aisles for products in the same category; after testing, you are more likely to go to the shelf to buy that product.

✓ **Smell** - the use of a particular odorant to identify with its brand; therefore, smell can play an important role in the consumer's experience and therefore in the consumer's decision to purchase the product the brand is promoting.

✓ **Touch** - if a consumer prefers online shopping, then it is difficult for the brand to convince them by touch that it is the product they need; in the physical store it is much easier to approach consumers through the experience of actually interacting with your products.

3. Neuroimaging techniques used in neuromarketing



Neuromarketing is based on the use of neuroscience technologies and techniques to monitor and understand human brain responses to marketing stimuli. These technologies may include. [8]

✓ **Electroencephalogram (EEG):** This technique records electrical activity in the brain to measure emotional states and attention levels during exposure to marketing stimuli. Of interest to neuromarketing research are alpha and beta rhythms, with researchers looking at the degree to which alpha rhythms decline and are replaced by beta rhythms, which characterize volitional cognitive activity. The principle behind EEG investigations is called the Frontal Asymmetry Theory. [4]

✓ **Functional Magnetic Resonance Imaging (fMRI).** This provides real-time images of the brain and allows observation of brain activity in different areas during cognitive processes, including responses to marketing stimuli. It works by recording changes in the magnetic field adjacent to blood vessels that supply neurons. This change is induced by a decrease in blood oxygen concentration due to increased oxygen consumption in active neurons.

✓ **Biometric Measurements.** This can include monitoring pulse, facial expressions and skin reactions to gauge consumer emotions and interest levels.

✓ **Eye Measurements.** By tracking eye movements, you can evaluate how people process information in an advertisement or on a website. Eye-tracking (ET) equipment allows eye fixations to be measured by recording corneal reflections caused by infrared radiation. The equipment can be of two types: fixed (mounted on the screen on which the material to be investigated is projected) or mobile (in the form of glasses, which are attached to the

subject's head). The use of this device is based on the premise that mental attention is directed towards the object of visual attention.

✓ **The Galvanometer (GSR)** measures the variations induced by the activation of the vegetative nervous system (VNS) that occur in skin conductance. Given that activation of the VNS is an indicator of arousal, we can conclude that the GSR measures the degree of arousal induced by a stimulus and is thus a better predictor of market performance than declarative methods. GSR measurements are limited by the fact that they do not indicate the valence of emotional reactions, only their intensity. In other words, we cannot know whether the reaction captured is a positive or negative one, both of which may result in a similar recording on the GSR.

Although implementing such research is relatively expensive - in the order of tens of thousands of euros - the findings are significant. Using fMRI, eight of the nine regions investigated were found to be activated in the brains of subjects subjected to commercials. In other words, the brains of the individuals tested react in a certain way to the content of such advertisements.[7] Another, even more interesting, finding reveals that most purchasing decisions are made more arbitrarily, unconsciously, on the spot (probably also due to the existence of a large number of stimuli at the point of sale) than previously thought.

3.1 Neuromarketing Applications

✓ ***Advertising Optimization***. Neuromarketing can reveal which visual elements, text or colors are most attractive and effective in attracting attention and generating positive reactions. [10]

✓ ***Improving User Experience*.** Neuroscience research can help design websites and mobile apps to ensure a more enjoyable and intuitive user experience.

✓ ***Product Design***. By understanding emotional responses to different aspects of design, one can optimize the look and functionality of products to generate positive reactions.

✓ ***Pricing and Value Perception.*** Neuromarketing can reveal how pricing affects the perception of value of a product or service and guide more effective pricing.

✓ ***Buying Decisions***. Neuroscience studies can help understand the cognitive processes involved in making purchasing decisions and provide insights for persuasive strategies.

✓ ***Product and Concept Testing*.** Companies can use neuromarketing techniques to assess consumer reactions to new products or innovative concepts. This can help adjust products to better suit market preferences and needs.

✓ ***Creating Persuasive Messages***. Neuromarketing studies can reveal the words, phrases or wording that have the greatest impact on consumers' brains. These insights can be used to create persuasive and compelling messages.

✓ ***Audience Segmentation.*** By analyzing the brain's reactions to different types of stimuli, neuromarketing can help identify audience segments with similar preferences and responses. This allows for more precise and personalized segmentation in marketing strategies.

✓ ***Evaluating the Effects of Advertising Campaigns***. Using neuromarketing techniques, companies can evaluate the emotional impact and level of engagement generated by their advertising campaigns. This helps to adjust and improve future campaigns.

✓ ***Online Behavior.*** Neuromarketing can also be applied online to understand how consumers react to websites, online ads or social media content.

3.2. Market research ethics using neuromarketing

The ethical nature of the neuromarketing approach is one of the biggest and most sensitive challenges of its application in the field of market research. Since its inception, neuromarketing has been a controversial field, raising many ethical issues for researchers. [4] This reaction is due to the research methodology which is considered by some authors as having a high potential for intrusion into the mind of the subject. The feeling of distrust towards the new technology was amplified by the exaggerated approach of the media. Media reports spoke of the discovery of the "buy button" in the human brain. It would allow, to some extent, a "brainwashing" of individuals and thus a manipulation of their brains to make purchasing decisions in favor of a certain company or a certain benefit.

Neuromarketers claim to use these information, techniques, and processes to subtly influence people's buying decisions. For example, they might place a product in front of a person while they are looking at something else or play certain sounds in a shop to make people feel more positively about the products they see. Some people accept neuromarketing because they believe it helps companies sell more products without resorting to manipulative tactics such as false advertising. Others reject it because they believe it preys on people's vulnerabilities and exploits their subconscious desires.

Finally, there is the issue of accuracy. Neuromarketing research is still in its early stages, and scientists have not yet perfected the techniques needed to get accurate results. This means there is a chance that some of the data collected by neuromarketers may be inaccurate. Funding, regulation and accuracy are major issues that need to be addressed before neuromarketing truly reaches its potential. [9]

Despite its benefits, neuromarketing also raises ethical dilemmas. [10]. When such personal and intimate information is obtained about the reactions of an individual's brain, concerns about confidentiality and consent arise. Here are some issues to consider regarding ethics in neuromarketing.

✓ **Consent and Privacy.** Participants in neuromarketing studies should be informed of the data that will be collected and used and provide their voluntary consent. Ensuring data confidentiality is essential.

✓ **Manipulation and Excessive Persuasion.** Using neuromarketing techniques to manipulate or mislead consumers is unethical. Encouraging purchase decisions based on subconscious impulses can raise moral issues.

✓ **Transparency and Honesty**. Companies should be transparent about their use of neuromarketing techniques and not try to hide or manipulate information to gain unfair advantages.

✓ **Consumer Education**. Educating consumers on how neuromarketing techniques work can help them better understand the factors that influence their purchasing decisions.

✓ **Corporate Responsibility**. Companies using neuromarketing techniques should be responsible in their application and ensure that they use neuroscience knowledge to create authentic and valuable experiences for customers.

Conclusion

Neuromarketing is an exciting and innovative approach to marketing that uses neuroscience knowledge to understand and influence consumer behavior. By revealing subconscious reactions and emotional responses in the brain, companies can develop more effective and personalized marketing strategies. However, it is important to use these techniques ethically and responsibly in order to build trust and authenticity with customers. The dream of every entrepreneur is to miraculously increase their sales.

Whereas in the past a lot of money was spent on banners on busy streets, flyers, and other such promotional materials, now they are looking to reduce the budget dedicated to a marketing strategy and improve its effectiveness. This is where the concept of neuromarketing comes in. Neuromarketing techniques are very useful because they basically tap into the pleasure centers of buyers who will instinctively come to buy your products.

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ASANA – A PROGRAM FOR DIGITIZING TEACHING ACTIVITIES IN A UNIVERSITY

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Gabriel Eugen GARAIS[2]

Abstract

In recent years, but especially in the context of the Covid-19 pandemic, the education process has been severely affected, undergoing significant changes. Due to the efforts to curb the spread of the Sars-Cov-2 virus, countries worldwide implemented strict lockdowns, and those involved in the education process had to quickly adapt to a virtual environment with limited resources. Thus, it can be said that remote work and online education have become the preferred elements of the pandemic context, while in-person education remains secondary. In this sense, for all those involved in this process, it represented a significant challenge as they had to adapt to a digitized environment, leading to the emergence of new psycho-educational and social experiences for both educators and educational beneficiaries. If this digitization could be maintained, and the obligation for in-person education could be avoided, it would eliminate time and space barriers between teachers and students. The main purpose of this article is to present how the Asana program can be used in digitizing the teaching activities of students, especially practical assignments, and seminars throughout a semester.

Keywords: digitization, education, innovation

JEL Classification: I23; O3

1. Introduction

Despite the abrupt transition to this education system, the adaptation was smooth. In this regard, it can be appreciated that the activity of a group of students can be the subject of a project within a specific field of study. Through this, I aim to highlight the benefits of digitization in the context of face-to-face education.

Education was heavily impacted in the context of the pandemic, and the beginning of 2020 brought about changes both professionally and psychologically. If remote work had not

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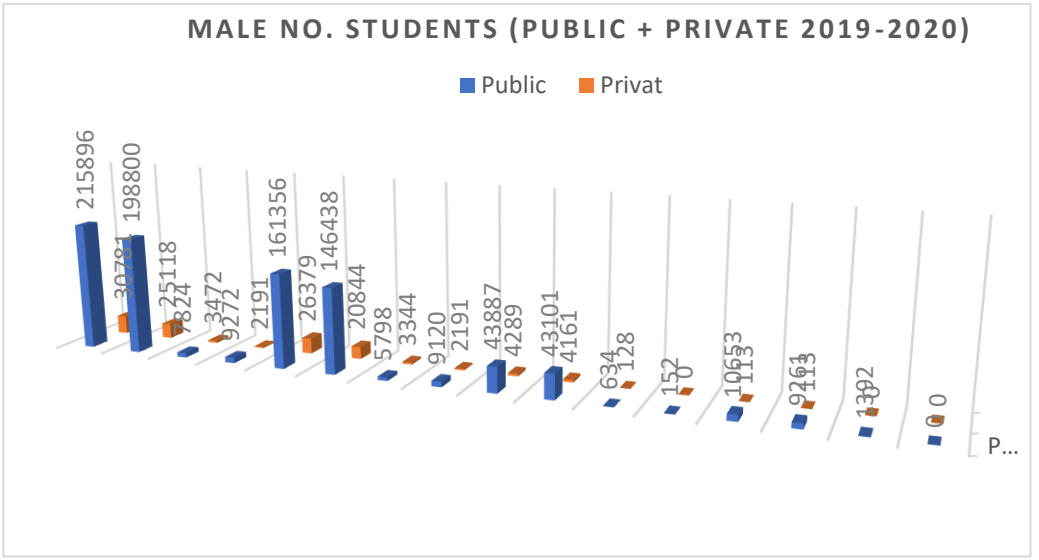
experienced significant development until now, it seems that during the pandemic, it became the norm for each of us.

There are several advantages to remote work, including the elimination of commuting time between home and the workplace, the reduction of certain additional costs for both employees and employers, and the opportunity to work in a friendly environment and be productive. Despite these advantages, there are also some disadvantages, such as the need for overnight adoption of teleworking, overlooking the importance of arranging home office space. Another negative aspect is the lack of social interaction, which can lead to long-term anxiety and depression. The process of working from home should be considered along with personal situations, which play a decisive role in assessing job satisfaction, such as education, age, gender, the number of dependent children, marital status, a positive attitude towards change, and the condition of the home office space.

In this context, both students and teachers in education were forced to use the online environment as the primary channel for providing and receiving various information.

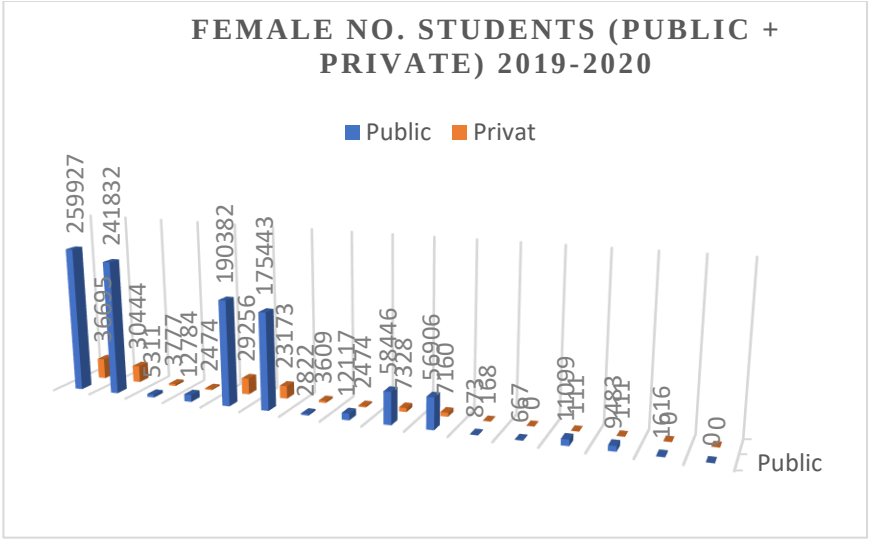
We will further analyze the impact that the pandemic had on the university education system based on the forms of education, gender, and ownership structures.

The graph below examines the proportion of male students in public and private education. As observed, public education dominates over private education, regardless of the form of education. An important aspect highlighted by this graph is that, in addition to traditional in-person education, distance education is gaining ground. However, it appears that the desire to pursue doctoral or postdoctoral studies decreases after completing master's studies, according to the graph.



Source: INS, Statistical research in the field of education, academic year 2019-2020.

We will continue the analysis with the number of female students in public and private education.



Source: INS, Statistical research in the field of education, academic year 2019-2020.

Asana is an application that provides easy project and task management for team collaboration. The free version allows a maximum of fifteen participants with no limit on projects and tasks. The user interface is intuitive, integrates with Dropbox, allows file uploads, sends email notifications for assigned tasks to each team member, informs us when a new task has been added, and allows comments to be added directly through the email inbox.

Globally, over 90,000 companies use this application. There are versions available for iOS, PC, and Android. The application allows integration with over a hundred apps, aiding the team in communication, collaboration, and coordinating work from the beginning to the end of the project.

2. Introduction to ASANA

Purpose and Functionality: ASANA is a multifaceted online project management tool designed to streamline team collaboration and work management. At its core, ASANA facilitates task management, enabling teams to create, assign, and track tasks through

various stages. Its central shared workspace is pivotal in allowing team members to stay informed and engaged, regardless of their location. The platform offers different work views, including a timeline view for project planning and management, as well as a Kanban board view which is useful for visualizing work progress.

Additionally, ASANA provides a project overview feature, giving users a comprehensive context of their goals, resources, and other essential project information. This overview is integral for maintaining a clear vision of the project's trajectory and ensuring that all team members are aligned with the project's objectives.

One of the standout features of ASANA is its customizability. Users can tailor projects and workflows according to their specific needs and save them as templates for future use. This customization extends to the platform's rules-based automation, which significantly reduces manual efforts and error rates, consequently enhancing efficiency.

Market Position and Popularity: ASANA has established itself as a leading software in the realm of product and project management. Its popularity stems from its ability to connect company-wide goals to the necessary work across different teams and functions. ASANA's role in increasing employee productivity and company efficiency has been recognized and documented, making it a go-to choice for many businesses seeking a robust project management solution.

Moreover, ASANA's appeal extends beyond traditional office environments. It is equally suitable for remote teams, university users included, offering features that support both onsite and remote work setups. This flexibility has been crucial, especially in the evolving work dynamics post-2020, where remote work has become more prevalent.

3. History and Development of ASANA

Founding and Initial Development: ASANA's journey began in 2008, founded by Dustin Moskovitz and Justin Rosenstein. The inception of ASANA was rooted in the founders' experience at Facebook, where they developed a productivity tool named Tasks. Leaving Facebook, they embarked on creating ASANA, which officially launched out of beta in November 2011 and commercially in April 2012. The foundation of ASANA was built on the principle of enhancing team productivity and efficiency through better task management and collaboration tools.

Growth and Expansion: The following years marked significant milestones for ASANA. In 2014, it launched its native iOS app, followed by the Android app in 2015, catering to the growing need for mobile accessibility in project management. The year 2016 saw ASANA raising $50 million in Series C financing, led by Sam Altman of Y Combinator. This funding was pivotal in scaling the platform's capabilities and reach.

In 2017, ASANA integrated with Gmail and launched its app in French and German, demonstrating its commitment to global expansion and user accessibility. By January 2018, ASANA had over 35,000 paying customers, including notable names like eBay, Uber, and IBM. This period also saw the company raise $75 million in Series D funding, further solidifying its financial and market position.

Public Listing and Recent Developments: The year 2020 was a landmark for ASANA as it went public on the New York Stock Exchange via a direct public offering. In August 2021, ASANA dual-listed on the Long-Term Stock Exchange, indicating its sustained growth and stability in the market.

As of December 2021, ASANA's customer base expanded to 114,000 with two million paid seats globally. A significant number of these customers, 739 to be exact, were spending over $50,000 annually, showcasing the platform's appeal to large-scale enterprises.

In 2022, ASANA continued to innovate and expand its capabilities. It released the annual Anatomy of Work Index, a comprehensive report surveying over 10,000 knowledge workers to understand trends in the modern workplace. Furthermore, it announced a partnership with Align Technology, introducing Asana Smiles for Align, a customizable workflow for Invisalign trained doctors in the U.S. By September 2022, the number of customers had increased to 131,000, with a significant 41% increase in customers spending over $5,000 annually.

4. Advantages of ASANA

Advanced Tools and Regular Updates: ASANA's commitment to innovation is evident in its continuous enhancement of existing features and introduction of new tools. Regular updates ensure that the platform remains on the cutting edge, offering users the latest in project management technology.

Workflow Automation: One of the most significant advantages of ASANA is its ability to automate repetitive tasks. Users can set up to 50 rules per project to automate processes, which simplifies workflows, reduces errors, and saves time. This automation empowers teams to focus more on problem-solving and less on administrative tasks.

Dynamic Reporting: ASANA excels in providing real-time reporting and insights. With features like dashboards, charts, and graphs, users can visualize high-level data and zoom in for detailed analyses. These interactive reports allow teams to delve into project details with ease, enhancing the decision-making process.

Work Request Management: The platform's Forms feature enables users to standardize their work intake processes. This feature is particularly useful for managing a variety of work requests, keeping everything centralized, organized, and trackable.

Integrations: ASANA's strength also lies in its integration capabilities. With over 100 integration options, including major platforms like Microsoft Teams, Office 365, and Google products, ASANA fits seamlessly into various digital ecosystems. This vast range of integrations streamlines workflows by connecting different tools and services.

Customization: Custom fields in ASANA allow for significant flexibility, letting teams track essential information and maintain visibility of work progress. This customization ensures that stakeholders have a complete understanding of ongoing tasks and projects, tailored to their specific needs.

Free Plan for Small Teams: ASANA's free plan is a notable advantage for startups and small businesses. It supports teams of up to 15 members and includes essential features like unlimited tasks, projects, messages, and file storage (up to 100MB per file). This plan offers small teams a robust work management solution without financial commitment.

5. Disadvantages of ASANA

Learning Curve: One of the significant challenges new users face with ASANA is its learning curve. The platform's array of features and options, while beneficial, can be overwhelming, especially for non-technical users. This complexity necessitates training and onboarding, which could lead to additional time and costs for organizations implementing ASANA.

Scope and Scale Mismatch: ASANA's advanced features, tailored for comprehensive project management, might not align well with the needs of small teams or projects with limited scope. For such teams, the platform might offer more functionality than necessary, leading to underutilization of its capabilities.

Single Assignee Limitation: A notable limitation in ASANA's task management is the assignment of tasks to only one person. This approach, aimed at clarity of responsibility, can become a bottleneck if the assigned individual becomes unavailable. Teams then require workarounds to maintain workflow continuity.

Absence of Built-In Time Tracking: While ASANA is effective in tracking projects and tasks, it lacks a built-in time tracking feature. This gap can be problematic for projects that involve billing clients or require team members to track time against budgets. Users need to integrate third-party time tracking apps to compensate for this shortfall.

Limited Exporting Options: ASANA allows data export only in CSV and JSON formats. Direct exporting to commonly used formats like Excel or PDF is not available, which might be inconvenient for users needing to present or analyze data outside the platform. While third-party apps can facilitate this, it adds an extra step in the data handling process.

6. Case Study - Outreach Using ASANA

Background and Challenges: Outreach, a sales engagement platform, faced challenges with its internal workflows as it scaled. With different teams using a variety of tools ranging from work management platforms to spreadsheets, there was a lack of consistency and efficiency. This situation led to difficulties in scoping projects, meeting deadlines, and aligning on common goals. Moreover, the IT department was struggling with the proliferation of tools and the need to manage security risks and permissions.

Implementation of ASANA: In their quest for optimization, Outreach chose ASANA for its ease of use, security, and adaptability. The decision to implement ASANA was driven by its simplicity and ability to cater to a wide range of use cases, making it an ideal choice for the company-wide application, except for the Engineering team, which continued using their existing project management tool. This selection allowed for better cross-team collaboration and information sharing.

Results and Improvements: The adoption of ASANA led to significant improvements in Outreach's operations:

- **Improved Security:** With ASANA, Outreach strengthened its security with access controls and simplified user management, crucial for a company handling sensitive sales data.
- **Accelerated Processes:** ASANA's automation features eliminated manual steps in employee onboarding and other routine processes, leading to faster and more efficient workflows.
- **Greater Accountability:** ASANA created a heightened sense of accountability, even in a remote environment, which was particularly beneficial during the shift to remote work in 2020.
- **Flexibility and Scalability:** The IT team gained flexibility in managing licenses and could integrate ASANA with other tools like Okta for secure identity management.
- **Enhanced Collaboration:** Various teams within Outreach, including Marketing, Sales Operations, and HR, leveraged ASANA to manage their workflows more effectively. This ranged from running marketing campaigns to onboarding new hires through automated processes.
- **Company-wide Impact:** The widespread use of ASANA within Outreach led to increased work visibility, reduced back-and-forth communication, and better management of security risks.

This case study provides insight into how ASANA can be leveraged to address specific business challenges and enhance overall organizational efficiency.

7. Comparative Analysis: ASANA vs. Microsoft Planner

Overview and Core Features: ASANA and Microsoft Planner are both prominent project management tools, each offering a suite of features tailored to task and project management. ASANA enables the creation of subtasks, setting deadlines, assigning tasks, and creating multiple workspaces for projects. Microsoft Planner, part of the Microsoft Office 365 ecosystem, offers task groups, swim lanes, deadlines, task assignments, and notes.

Native Features: ASANA boasts native time tracking and workflow automation, allowing users to track time spent on tasks and automate routine actions. Planner, however, lacks a native time-tracking feature and built-in workflow automation, relying on third-party integrations for these functionalities.

Pricing: ASANA's pricing is considered flexible, offering a free basic plan and several premium options. In contrast, Planner is part of various Office 365 subscription plans, making it a cost-effective option for those already using the Office 365 ecosystem.

Integrations: ASANA stands out with its integration capabilities, offering more than 350 third-party integrations, including Salesforce, Dropbox, and Power BI. Planner, while integrating well within the Microsoft ecosystem, is limited in terms of third-party integrations compared to ASANA.

Collaboration and Usability: Both tools provide avenues for team collaboration. ASANA offers features like task comments, project conversations, and team pages, whereas Planner’s collaboration capabilities are more aligned with its integration with Microsoft Teams. However, Planner may be less intuitive for users not familiar with the Microsoft ecosystem.

Pros and Cons: ASANA’s strengths lie in its thorough automation, delegation capabilities, and customization options. However, its plethora of features can be overwhelming for new users, and its premium tiers may be expensive for small teams. On the other hand, Planner's key advantages include great team collaboration features and easy setup, but it falls short in terms of third-party integrations and customization options compared to ASANA.

8. ASANA vs. Trello

Core Features: ASANA offers task dependencies as a built-in feature, while Trello requires integration for this. Both platforms provide templates and workflow automation. ASANA has a more robust native reporting and analytics feature compared to Trello, which offers basic functionality and requires third-party integration for full range reporting.

Project Planning: Trello focuses on Kanban-style planning, whereas ASANA allows teams to create new projects and organize tasks and subtasks into sections, offering multiple views like List, Board, Calendar, and Timeline for project planning.

Integrations: Both platforms offer a wide range of third-party integrations, enhancing their adaptability to different workflows.

Pros and Cons: Trello is noted for its simplicity, impressive mobile app, and robust automation features, but it has limited reporting tools and may not be ideal for handling multiple or complex projects.

ASANA is loaded with features and offers extensive integrations, but its advanced security tools are only available in the Enterprise plan, and its mobile app experience could be improved.

9. ASANA vs. Monday.com

Approach to Task Management: ASANA emphasizes a structured approach to organizing tasks and is designed for teams seeking a simplified experience. Monday.com offers a more flexible and customizable platform suitable for teams with complex projects and workflows .

Pricing Comparison: ASANA and Monday.com both offer free plans, but with different features and user support. ASANA's Premium plan is slightly more expensive than Monday.com's Basic plan, with each offering different features. Both platforms have Business and Enterprise plans, with varied features and price points.

Functionality: ASANA provides Kanban boards with a clean interface and supports custom fields for task organization. Monday.com offers more comprehensive customization options for its Kanban boards. ASANA's Timeline view serves as a simplified Gantt chart, whereas Monday.com offers more robust Gantt chart functionality. Monday.com includes native time tracking in its Pro plan, unlike ASANA which relies on third-party integrations.

Pros and Cons: ASANA is praised for its intuitive user interface and strong task management, but its Gantt chart functionality is limited, and premium features are confined to higher-tier plans. Monday.com is highly customizable and offers powerful automations, but some essential features are only available in higher-tier plans, and its pricing can be relatively expensive for smaller teams.

In summary, while ASANA offers a structured and feature-rich environment, Trello stands out for its simplicity and ease of use, and Monday.com excels in customization and flexibility. Each platform has its unique strengths and limitations, making the choice dependent on specific project requirements and team preferences.

10. ASANA's Impact on Managing Student Projects

Organizational Efficiency: ASANA can significantly improve the organization of coursework and extracurricular activities. It serves as a central hub for storing important information, notes, and tasks, ensuring better collaboration and continuity as members join or leave.

Workspace Creation and Usage: Students can create specific workspaces for their organizations or clubs within ASANA. These workspaces can house various projects, ranging from bookkeeping to event planning, providing a structured approach to manage different aspects of student organizations.

Member Involvement and Communication: ASANA facilitates greater member participation. Students can be invited to contribute to existing projects and tasks and are encouraged to initiate their own. The platform aids in maintaining ongoing communication, reducing the need for frequent meetings or extensive email exchanges.

Meeting Management: Running meetings through ASANA can optimize meeting times and productivity. By setting up projects for meeting agendas and organizing them in priority order, ASANA ensures that meetings are focused and efficient, allowing more time for impactful discussions and activities.

11. Use in University Courses and Workshops

Collaborative Learning Environment: ASANA's structure enables faculty and students to collaborate effectively on various projects and tasks. By creating teams within the university's ASANA organization, educators can foster a more interactive and engaged learning environment.

Data Visibility and Privacy: The platform's structure allows for control over who can see and access data, essential for maintaining privacy and compliance with academic standards.

Resource and Seat Management: In a university setting, managing the number of users (or seats) and ensuring that all necessary members have access to ASANA is crucial. The platform's flexibility in team and user management can align well with the dynamic nature of academic institutions.

Scalability and Customization: Universities can scale their use of ASANA based on needs, choosing from various plans including Premium, Business, and Enterprise. This flexibility is crucial for adapting to the diverse requirements of different courses and workshops.

Educational Discount and Compliance: ASANA offers a 50% discount for eligible academic institutions. Additionally, it supports compliance with the Family Educational Rights and Privacy Act (FERPA), ensuring the security of personal data, which is crucial for educational institutions.

In summary, the use of ASANA in a university setting can enhance the management of student projects, courses, and workshops by improving organization, collaboration, and communication. Its adaptability, scalability, and compliance with educational standards make it a viable tool for academic environments.

12. ASANA's capabilities for e-learning and online teaching in academic environment

Templates for Educational Processes: ASANA offers ready-to-use templates specifically designed for education. These templates can assist in planning student events, creating curriculums, and streamlining logistics. This feature allows educators to focus more on teaching and less on organizing information.

Knowledge Management: A knowledge management template in ASANA helps ensure that all team members, including students and faculty, prioritize and organize information consistently. This can be particularly useful in managing course materials, assignments, and collaborative projects.

Centralized Information Hub: With over 260 app integrations, ASANA can centralize information from various tools in one place. This integration is invaluable for keeping track of conversations, classroom materials, and action items, ensuring that all educational content is easily accessible and organized.

Integration with Communication Tools: ASANA integrates seamlessly with popular communication tools like Microsoft Teams, Google Drive, Gmail, Outlook, and Slack. These integrations allow for turning emails and conversations into actionable, trackable tasks directly within ASANA, thereby streamlining communication and collaboration in an educational setting.

Automating Repetitive Tasks The integration with Zapier allows for the automation of repetitive tasks without the need for coding. This feature can significantly reduce the administrative load on educators and students, allowing them to focus more on the educational content.

Enhancing Engagement with Multimedia: ASANA's capability to embed Vimeo videos directly into the platform can enhance engagement and collaboration. This feature is particularly beneficial for online workshops and courses, where multimedia content plays a crucial role in the learning experience.

In summary, ASANA's range of tools and integrations offers a robust solution for managing e-learning and online teaching in university settings. By facilitating knowledge management, centralizing information, integrating with essential communication tools, automating tasks, and enhancing multimedia engagement, ASANA can significantly improve the efficiency and effectiveness of educational processes.

13. Conclusion.

In conclusion, ASANA's implementation in university settings for project management, e-learning, and online teaching presents numerous benefits:

Enhanced Organizational Efficiency: ASANA streamlines the management of student projects, coursework, and extracurricular activities, fostering better collaboration and efficiency.

Improved Meeting and Classroom Management: The platform's features allow for more focused and productive meetings and classes, with efficient agenda management and task tracking.

Integration and Automation: ASANA's extensive integrations and automation capabilities centralize information, streamline communication, and reduce administrative burdens, enhancing the overall educational experience.

Support for E-learning and Online Teaching: With specialized templates, multimedia integration, and tools for knowledge management, ASANA supports diverse educational needs, making it a valuable tool for universities adapting to evolving teaching methods and digital learning environments.

Overall, ASANA's adaptability, user-friendly interface, and robust feature set make it a compelling choice for universities seeking to improve project management and educational delivery methods.

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REVOLUTIONIZING ARCHITECTURE: THE INTEGRATION OF 3D PRINTING TECHNOLOGY, VR EXPERIENCES, AIA AND VIDEO GAMES IN ARCHITECTURE

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Abstract

In an ever-changing society, so open to new technological developments, the field of architecture cannot be left aside. That is why the integration of technological innovation holds significant importance within the realm of architecture, empowering architects to devise designs with increased efficiency, sustainability, and creativity, all while meeting the dynamic demands of society. Embracing these advancements not only enriches the field of architecture but also plays a pivotal role in crafting environments that are safer, more sustainable, and visually compelling. With the help of artificial intelligence and supported by the developments in 3D printing or virtual reality, the future of architecture can be seen as more futuristic and in tune with the demands of a society that requires generative design, sophisticated technological solutions to special problems, such as construction in areas where constructions had not been seen before or using special materials that previous architecture could not have envisaged. This article explores the synergistic integration of cutting-edge technologies, namely 3D printing, Virtual Reality (VR) experiences, Artificial Intelligence in Architecture (AIA), and elements inspired by video games, within the realm of architecture. The convergence of these technologies offers a transformative approach to architectural design, visualization, and user engagement. 3D printing facilitates rapid prototyping and the creation of intricate structures, while VR experiences provide immersive, realistic simulations of architectural spaces. AIA contributes to data-driven design decisions, optimizing structures for functionality and sustainability. Additionally, borrowing concepts from video games introduces interactive elements and gamified experiences in architectural design, enhancing user engagement and understanding. This interdisciplinary integration holds promise for revolutionizing architectural processes, fostering innovation, and redefining the boundaries of creativity within the built environment. However, it necessitates a careful consideration of ethical concerns, including responsible AI use and the potential impact on the human-centric aspects of architectural design.

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1. Introduction

Architecture, as both an art form and a scientific discipline, has historically been a reflection of human progress and innovation. However, with the advent of 3D printing technology, the architectural landscape is undergoing a transformative revolution that promises to reshape how we conceive, design, and construct buildings. This article delves deep into the profound impact of 3D printing on the architectural industry, exploring its myriad benefits, persistent challenges, and the limitless possibilities it offers.

The field of architecture has always been at the forefront of technological advancements. From the transition to computer-aided design (CAD) to the integration of sustainable materials, architects continually embrace innovation to design better, more functional, and aesthetically pleasing structures. In recent years, Virtual Reality (VR) has emerged as a transformative tool for architects, offering a new dimension of design and collaboration. In this article, we will explore the importance of VR experience in architecture and how it is revolutionizing the industry.

The importance of AI in architecture cannot be overstated. AI is reshaping the profession by optimizing design, fostering creativity, improving building performance, enhancing project management, and creating personalized user experiences. As architects continue to harness the power of AI, we can expect to see more sustainable, efficient, and user-centric buildings that not only meet current needs but also adapt to the ever-evolving demands of the future. Architectural intelligence is paving the way for a brighter and more innovative built environment.

Video games have evolved from simple pixelated graphics to breathtakingly immersive virtual worlds. One of the key elements contributing to this transformation is architecture. The significance of architecture in video games goes beyond just visual aesthetics; it plays a pivotal role in shaping gameplay, storytelling, and overall player experience. In this article, we delve into the multifaceted role that architecture plays in the world of video games.

3D printing, scientifically known as additive manufacturing, is a process that constructs objects layer by layer from a digital model. Its origins can be traced back to the 1980s when it was predominantly used for rapid prototyping in industries like automotive and aerospace. Over the decades, this technology has evolved, becoming increasingly

accessible and versatile. In the realm of architecture, it has transitioned from an innovative concept to a full-fledged transformative force.

2. 3D Printing and Architecture

The initial applications of 3D printing in architecture focused on the creation of intricate scale models and prototypes of architectural designs. Architects swiftly recognized the technology's potential to enhance the design process by facilitating rapid iteration and experimentation. This newfound flexibility not only accelerated the early stages of design but also fostered greater precision and creativity.

As 3D printing technology advanced, it transcended the realm of scale models, empowering architects to fabricate full-scale architectural components. This development marked a pivotal moment in architectural history, opening up new horizons for innovation in construction. Architects and engineers found themselves equipped to explore complex geometry, intricate patterns, and bespoke shapes that were previously unattainable using traditional construction methods.

Perhaps one of the most profound advantages of 3D printing in architecture is the unprecedented design freedom it bestows. Conventional construction often relies on standardized building materials and techniques, which can impose limitations on architectural design. With 3D printing, architects can break free from these constraints and embark on a journey into a realm of endless possibilities.

Now, architects can conceive complex and organic forms, ornate facades, and avant-garde structures that defy convention. The ability to design for both aesthetics and functionality simultaneously has led to the creation of breathtaking and highly functional architectural masterpieces.

In the contemporary architectural landscape, sustainability stands as a central concern, and 3D printing aligns seamlessly with this ethos. It significantly reduces material waste by utilizing only the necessary amount of material required for a specific architectural component. Moreover, 3D printing can incorporate recycled materials, thereby contributing to the principles of a circular economy.

Furthermore, the lightweight yet structurally robust structures produced by 3D printing can lead to enhanced energy efficiency in buildings. Designs that optimize natural lighting, ventilation, and insulation have the potential to significantly reduce energy consumption and the environmental impact of construction.

Architectural projects often involve multiple iterations of designs, a process that can be laborious and expensive with traditional construction methods. 3D printing streamlines this procedure by enabling architects to rapidly create and modify prototypes. This rapid

prototyping capability expedites the design phase, ensuring that architects can refine their concepts with unprecedented efficiency.

Moreover, the use of 3D-printed scale models provides a tangible and highly detailed representation of the final design, facilitating effective communication with clients and stakeholders. This leads to more informed decisions and a more collaborative design process.

Notwithstanding the immense promise associated with the integration of 3D printing and architecture, several challenges remain:

1. Cost: Acquiring high-quality 3D printers and materials can be financially prohibitive, potentially hindering widespread adoption.
2. Scalability: The endeavor to scale up 3D printing for large construction projects is still in its nascent stage and necessitates overcoming logistical complexities.
3. Material Limitations: While the array of 3D printing materials is expanding, limitations persist concerning durability, weather resistance, and sustainability.
4. Regulatory and Code Compliance: Many building codes and regulations have yet to comprehensively accommodate the innovative construction methods enabled by 3D printing.

The future of 3D printing in architecture is exceptionally promising. As technology continues its relentless march forward, we can anticipate even more sustainable, ingenious, and cost-effective solutions for architectural design and construction. The convergence of 3D printing with other emerging technologies such as artificial intelligence and generative design algorithms is poised to usher in unprecedented architectural achievements.

The assimilation of 3D printing technology into architecture represents a profound paradigm shift in how we envision, design, and construct edifices. It empowers architects to explore uncharted realms of design freedom, embrace sustainability as a guiding principle, and streamline the construction process. While challenges persist, the future of 3D printing in architecture beckons with boundless potential. As this technology continues to evolve, architects have an exhilarating canvas upon which to shape the future of our built environment. The era of 3D-printed architecture has dawned, and it promises to be nothing short of extraordinary.

3. The Importance of Virtual Reality in Architecture

One of the primary benefits of VR in architecture is its ability to enhance design visualization. Traditional 2D blueprints and 3D models can only provide a limited understanding of a building's spatial dynamics. However, VR allows architects to create

immersive, three-dimensional environments where clients and stakeholders can experience the design firsthand.

With VR, architects can design in a virtual space and navigate it as if they were walking through a physical structure. This level of immersion enables them to identify design flaws, test lighting conditions, and optimize spatial layouts with unprecedented precision. Clients can also explore their future spaces in detail, making it easier for them to provide feedback and make informed decisions.

Architecture projects often involve collaboration among various stakeholders, including architects, engineers, contractors, and clients. VR facilitates more efficient collaboration by enabling remote participants to meet in a shared virtual environment. This eliminates geographical constraints and allows stakeholders from different locations to work together seamlessly.

Furthermore, VR collaboration tools enable real-time changes and annotations within the virtual environment. Architects and clients can discuss design alterations, materials, and finishes while visually experiencing the impact. This streamlines decision-making processes, reduces misunderstandings, and ultimately accelerates project timelines.

Incorporating VR into the architectural workflow can result in significant cost and time savings. By identifying and resolving design issues in the virtual realm, architects can avoid costly modifications during construction. This reduces the likelihood of project delays and overruns, which are common in the industry.

Additionally, VR can aid in the pre-visualization of construction processes. Contractors can use VR to simulate construction sequences, ensuring that the project can be executed efficiently. This not only saves time but also minimizes resource wastage.

Architects strive to create spaces that align with their clients' visions and needs. VR provides an unparalleled opportunity for architects to involve clients in the design process actively. When clients can explore their future spaces in VR, they gain a deeper understanding of the design intent and can offer more informed feedback.

This increased engagement leads to higher client satisfaction as they feel more connected to the project. Satisfied clients are more likely to recommend architects and return for future collaborations, contributing to the architect's reputation and business success.

As technology continues to advance, the importance of VR in architecture will only grow. VR is evolving to include augmented reality (AR), which allows architects to overlay digital designs onto physical environments in real-time. This capability will further streamline the design and construction processes and enhance on-site decision-making.

In conclusion, VR experience in architecture is not just a technological trend but a transformative tool that enhances design visualization, streamlines collaboration, saves time and money, and increases client engagement and satisfaction. As architects continue

to embrace this technology, it is poised to redefine the future of architecture, creating more innovative and sustainable structures that meet the needs of our ever-changing world.

In today's fast-paced world, technology is revolutionizing almost every industry, and architecture is no exception. The integration of Artificial Intelligence (AI) into the field of architecture is ushering in a new era of design, efficiency, and sustainability. In this article, we will explore the importance of AI in architecture and how it is reshaping the way architects conceive, plan, and build structures.

AI empowers architects to optimize their designs like never before. Through algorithms and machine learning, AI can analyze vast datasets of architectural blueprints, historical designs, and environmental factors to identify patterns and make design suggestions. This data-driven approach enables architects to create more efficient, functional, and aesthetically pleasing structures.

For example, AI can analyze climate data to recommend passive cooling strategies, suggest material choices based on sustainability criteria, or optimize space utilization for maximum efficiency. This results in designs that are not only visually appealing but also environmentally friendly and cost-effective.

4. Artificial Intelligence (AI) and Architectural Projects

Generative design, a subset of AI, is transforming how architects generate ideas and concepts. By inputting parameters such as project goals, site conditions, and materials, generative design algorithms can rapidly generate numerous design options. Architects can then evaluate and refine these options based on their preferences and project requirements.

Generative design encourages creativity by exploring design possibilities that may not have been considered otherwise. It allows architects to quickly iterate and fine-tune their designs, leading to innovative and optimized solutions.

AI plays a crucial role in assessing the performance of buildings. Through sensors and IoT (Internet of Things) devices, AI can monitor and analyze real-time data related to energy consumption, temperature, humidity, and occupant behavior. Architects can use this information to refine building designs and systems for enhanced sustainability and occupant comfort.

AI-driven simulations also enable architects to predict how a building will perform under different conditions. This aids in designing structures that are energy-efficient and resilient, contributing to a more sustainable built environment.

AI-driven project management tools are streamlining the construction process. AI can predict project timelines, identify potential bottlenecks, and allocate resources efficiently. This results in reduced project delays and cost overruns, which are common in the construction industry.

Moreover, AI-powered software can assist architects in automating repetitive tasks, such as generating construction documents or conducting site surveys. This frees up architects to focus on more creative and strategic aspects of their projects.

In addition to its impact on the design and construction phases, AI can enhance the user experience within buildings. Smart buildings equipped with AI-driven systems can adapt to occupants' preferences for lighting, temperature, and security. This personalization enhances occupant comfort and productivity, making buildings more enjoyable and efficient spaces to inhabit.

Artificial Intelligence (AI) has undoubtedly brought about transformative changes in the field of architecture, offering new tools and capabilities to architects. However, it is crucial to acknowledge that while AI has the potential to revolutionize architecture for the better, it also comes with its own set of challenges and negative effects. In this article, we will explore some of the downsides and potential bad effects of AI in architecture.

One of the most significant concerns surrounding AI in architecture is the potential for job displacement. As AI technologies, including generative design and automated drafting, become more advanced, there is a risk that certain tasks traditionally performed by architects and drafters could be automated. This could lead to a reduced demand for human architects, especially in routine design and documentation tasks.

While AI can assist architects in generating design options and optimizing designs, there is a risk of overreliance on AI-driven solutions. Architects might rely too heavily on AI-generated designs, potentially stifling their creativity and the diversity of architectural styles. Aesthetic decisions made solely based on algorithms may result in a homogenized architectural landscape.

The use of AI in architecture often involves collecting and analyzing vast amounts of data, including sensitive project details and client information. This raises concerns about data privacy and security. Architects must ensure that the data they collect and store is adequately protected from cyber threats and breaches, which can have serious consequences for both the profession and clients.

AI systems are only as good as the data they are trained on, and bias in data can lead to biased AI outcomes. In architecture, this could manifest as biases in design decisions, favoring certain demographics or preferences over others. Architects and AI developers must be vigilant in addressing potential biases in AI systems to ensure fair and equitable design outcomes.

AI-powered tools can facilitate remote collaboration and communication in architecture. While this can be advantageous, it may also lead to reduced face-to-face interaction among architects, clients, and project stakeholders. The human element in architecture, including the ability to understand and interpret non-verbal cues, can be diminished in a purely digital environment.

Overreliance on AI and technology in architecture can lead to a vulnerability in the profession. Architects who rely heavily on AI tools may face challenges when technology fails or when they encounter situations that require creative problem-solving outside the capabilities of AI systems.

While AI has the potential to bring numerous benefits to architecture, it is essential to recognize and address the potential negative effects and challenges it poses. Architects must strike a balance between leveraging AI's capabilities and preserving the profession's creativity, ethics, and human interaction. By being aware of these challenges and actively working to mitigate them, architects can harness the power of AI while safeguarding the integrity and future of the field.

5. Architecture and Video Games

Video games have evolved from simple pixelated graphics to breathtakingly immersive virtual worlds. One of the key elements contributing to this transformation is architecture. The significance of architecture in video games goes beyond just visual aesthetics; it plays a pivotal role in shaping gameplay, storytelling, and overall player experience. In this article, we delve into the multifaceted role that architecture plays in the world of video games.

Architecture in video games serves as the backdrop for the entire gaming experience. It sets the tone, mood, and atmosphere, creating a captivating visual landscape that draws players into the game's world. Whether it's the grandiose castles in fantasy RPGs or the post-apocalyptic ruins in survival horror games, the architecture adds a layer of realism and immersion that enhances the gaming experience.

The design of game levels often revolves around architectural elements. The layout of buildings, rooms, and structures can influence the flow of gameplay. For example, narrow corridors can create tension and suspense, while open spaces allow for strategic maneuvering. Well-designed architecture can provide players with both challenges and opportunities, making gameplay more engaging and dynamic.

In many video games, architecture is an integral part of world-building and storytelling. The architecture of a game world can reveal its history, culture, and the lore of the in-game universe. For instance, a decrepit, abandoned asylum can tell a haunting tale of a dark past, while a futuristic cityscape can hint at a technologically advanced civilization. Players often find themselves exploring these architectural wonders to uncover hidden secrets and unravel the narrative.

The significance of architecture in video games extends to player immersion. Well-crafted architecture helps players suspend disbelief and fully immerse themselves in the game's world. When players can interact with and explore intricately designed environments, they become more emotionally invested in the game's narrative and objectives.

Some video games incorporate architectural puzzles and challenges as part of their gameplay mechanics. Players must use their problem-solving skills to navigate complex structures, unlock doors, or decode hidden messages within architectural elements. These challenges not only add depth to the gameplay but also encourage critical thinking and creativity.

Certain video games are known for their attention to historical accuracy and cultural representation through architecture. Games like Assassin's Creed series transport players to different time periods and locations, showcasing the architectural wonders of ancient Egypt, Renaissance Italy, or Revolutionary America. This allows players to not only enjoy the gameplay but also learn about history and culture through interactive experiences.

6. Conclusions

The development of 3D printing technologies holds immense significance for the field of architecture, revolutionizing traditional design and construction methods. This innovative technology empowers architects to translate their creative visions into tangible, intricate structures with unprecedented precision. 3D printing allows for the rapid prototyping of architectural models, enabling architects to test and refine their designs efficiently. Moreover, the flexibility and versatility of 3D printing materials permit the construction of complex geometries that were previously challenging or impossible to achieve through conventional means. This not only expands the realm of architectural possibilities but also enhances the sustainability of construction by minimizing material wastage. Additionally, 3D printing facilitates cost-effective, on-site production of customized building components, contributing to a more streamlined and resource-efficient construction process. As technology continues to advance, it is poised to fundamentally transform the way architects conceive, design, and bring their ideas to life, ushering in a new era of innovation and efficiency in the field of architecture.

The evolution of Virtual Reality (VR) technologies is of paramount importance to the field of architecture, offering architects and designers a transformative toolset for conceptualization, visualization, and communication. VR allows architects to immerse themselves and their clients in realistic, three-dimensional representations of architectural designs, providing an unparalleled sense of scale and spatial understanding. This immersive experience not only facilitates more informed design decisions but also enhances collaboration among stakeholders by enabling them to explore and interact with the virtual environment in real-time. Furthermore, VR serves as a powerful presentation and communication tool, allowing architects to convey their ideas more comprehensively to clients, builders, and other project collaborators. By simulating the actual experience of being within a space, VR aids in identifying design flaws and optimizing functionality before the construction phase, ultimately leading to more efficient and successful architectural outcomes. As VR technologies continue to advance, they hold the promise of

redefining the design and evaluation processes in architecture, ushering in a new era of creativity, efficiency, and client engagement.

The development of Artificial Intelligence (AI) technologies has become increasingly vital to architecture, offering architects powerful tools for data analysis, design optimization, and decision-making. AI enables architects to process vast amounts of data related to environmental conditions, materials, and user preferences, allowing for more informed and efficient design choices. Machine learning algorithms can analyze historical data to predict future trends in urban planning and design, assisting architects in creating sustainable and resilient structures. Additionally, AI-driven generative design tools can explore numerous design possibilities, helping architects discover innovative solutions and optimize designs for various criteria.

However, the overuse of AI in architecture also poses potential threats. One concern is the risk of dehumanizing the design process, as excessive reliance on algorithms might diminish the role of human intuition and creativity. Moreover, ethical considerations arise, such as the responsible use of AI in decision-making, potential biases in algorithms, and the impact on employment within the architectural profession. Striking a balance between leveraging AI for its benefits while mitigating its risks is crucial to ensuring that AI technologies enhance rather than overshadow the human-centric aspects of architecture. It is essential for architects and policymakers to address these challenges and establish ethical guidelines to harness the full potential of AI in a responsible and sustainable manner.

Architecture is an indispensable element of video games, shaping everything from visuals and gameplay to storytelling and player engagement. It serves as the canvas on which the virtual worlds are painted, adding layers of depth and complexity to the gaming experience. As technology continues to advance, we can expect even more intricate and awe-inspiring architectural designs in video games, further blurring the line between reality and the virtual realm.

Technological innovation is essential in the architectural field because it empowers architects to design more efficiently, sustainably, and creatively while addressing the evolving needs of society. Embracing these innovations not only enhances the practice of architecture but also contributes to the creation of safer, more sustainable, and aesthetically captivating built environments.

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EXPLORING LANGUAGE LEARNING IN MULTIPLAYER ONLINE GAMES AT UNIVERSITY LEVEL

Gyongyver MĂDUȚA[1]

Abstract

This qualitative study explores the efficacy of utilizing multiplayer online games for language learning among university students. Focused on participants' experiences, the research delves into the realm of language acquisition through gaming, seeking valuable insights into the potential advantages and challenges of this innovative approach. By immersing university students in language learning activities within a selected multiplayer online game, the study aims to understand the nuanced impact of gamification on language proficiency and communication skills. The investigation employs a combination of pre- and post-participation surveys, semi-structured interviews, and in-game observations to gather comprehensive data. The objective is to uncover the dynamic interplay between gaming and language learning, shedding light on the multifaceted aspects of this educational paradigm. This research contributes to the growing discourse on gamified language education, offering a nuanced understanding of how multiplayer online games can be effectively integrated into university-level language learning programs.

Keywords: gamified language learning, multiplayer online games, educational gamification, experiential learning, online learning environments.

JEL Classification: I21, I23, C83, C88

1. Introduction

The field of gamified language learning has seen a noticeable upsurge in interest in recent years, fueled by a combination of educational theories, technological advancements, and an increasing awareness of the advantages of immersive and interesting learning environments. This phenomenon is a reflection of a paradigm shift in pedagogical approaches, as researchers and educators are investigating the possibility of incorporating game elements into curricula for language learning. This interest is a result of multiple important factors.

First off, the way that students interact with educational content has been profoundly impacted by the pervasive influence of digital technologies in modern society. The familiarity and appeal of digital games are leveraged in gamified language learning [1] to

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create a dynamic and interactive learning environment. This method promotes a more interesting and interactive learning environment by catering to the tastes of a generation that is used to interactive and visually stimulating content.

Second, by including game components, the motivational issues that are frequently linked to conventional language learning techniques are addressed. By introducing components like progression, competition, and rewards, gamification taps into internal motivators that encourage sustained interest and active participation. At the university level, where students may have a variety of extracurricular activities and increased academic demands, this motivational factor is especially important.

Even with the growing interest in gamified language learning, there is still a significant research vacuum, particularly when it comes to university-level multiplayer online games. There is a substantial knowledge gap about the effectiveness of multiplayer online games designed for university settings because the majority of studies that have been done so far have concentrated on either classroom-based methods or individual gamified applications.

There are several reasons for the research gap. First off, there hasn't been much empirical research done in this field yet because multiplayer online games are still relatively new as a teaching tool. Comprehensive studies into the efficacy of these games in higher education have lagged due to the rapid advancement of technology, which frequently surpasses the pace of scholarly investigation.

Additionally, standardizing research methodologies is challenging due to the diverse landscape of multiplayer online games. Different games may possess distinct features, mechanics, and dynamics that impact the learning process in different ways. This complexity adds to the research gap by requiring a more nuanced and customized approach to examining the effects of multiplayer online games on language learning.

Moreover, the integration of novel approaches like multiplayer online games may be hampered by the conventional language courses at universities and the institutional emphasis on traditional teaching techniques. Without strong empirical proof of the innovative technologies' educational benefits, faculty members and administrators might be hesitant to embrace them, which would prevent widespread adoption and research.

Filling this research void will help us better understand the possible advantages and difficulties of using multiplayer online games for language learning at the university level. To design and implement well-structured studies that consider the unique dynamics of multiplayer online games and their alignment with the pedagogical goals of higher education institutions, educators, game developers, and researchers must collaborate across disciplinary boundaries. By closing this gap, teachers will be better equipped to decide which cutting-edge and captivating methods to add to language learning curricula, which will ultimately improve university students' educational experiences.

There are many potential benefits to integrating multiplayer online games into university language instruction, but two stand out in particular: higher engagement and contextualized language use.

Students are captivated by gamified language learning because it changes the conventional paradigm of education into one that is immersive and interactive. By utilizing the innate allure of gaming, multiplayer online games offer a vibrant and captivating medium that draws in and keeps students interested. Games' interactive features encourage participation, which makes learning a language naturally enjoyable. This increased involvement promotes consistent and voluntary participation, which is essential for long-term language acquisition, as well as a positive attitude toward learning.

One of the standout advantages of multiplayer online games is the creation of authentic and contextualized language use scenarios. Unlike traditional language learning methods that often present language in isolated contexts, games provide a dynamic environment where language use is embedded within the context of the game world. This contextualization is particularly beneficial for university students as it mirrors real-life language applications they might encounter in their academic and professional endeavors. Whether negotiating quests, collaborating with in-game characters, or communicating with fellow players, students are exposed to language in meaningful contexts, reinforcing vocabulary, syntax, and idiomatic expressions in a way that resonates with the complexities of real-world language use.

Multiplayer online games tap into intrinsic motivational factors, aligning with the natural curiosity and desire for challenge that many students possess. The autonomy granted within the gaming environment allows students to explore, experiment, and make decisions, contributing to a sense of ownership over their learning journey. This intrinsic motivation, coupled with the customizable nature of many games, empowers students to take charge of their language learning experience, fostering a self-directed approach that extends beyond the confines of the traditional classroom setting.

University students often thrive in collaborative and social learning environments [2]. Multiplayer online games provide a platform for meaningful social interactions, encouraging communication and collaboration among players. The multiplayer aspect facilitates language use in communicative contexts, promoting verbal and written exchanges with peers. Collaborative quests, group projects, and interactive in-game events offer opportunities for students to negotiate meaning, solve problems together, and engage in authentic language interactions, enhancing both linguistic and interpersonal skills.

In essence, the integration of multiplayer online games into language learning at the university level represents a paradigm shift towards more engaging, contextualized, and student-centric approaches. The potential advantages extend beyond conventional language learning methodologies, offering a pathway to reinvigorate language education and address the diverse needs and preferences of today's university students.

2. Theoretical background

Several educational theories support the integration of gaming into language education, emphasizing the potential benefits of gamified approaches for language acquisition and cognitive development.

2.1 Constructivism

Constructivist theories posit that learners actively construct knowledge through experiences and interactions with their environment [3]. Games, especially those designed for language learning, align with the principles of constructivism by providing learners with hands-on, experiential opportunities. In gaming environments, students engage in problem-solving, decision-making, and exploration, constructing linguistic knowledge within the context of meaningful tasks. The immersive and interactive nature of games promotes a learner-centric approach, allowing individuals to build their understanding of language rules, vocabulary, and cultural nuances through active participation.

2.2 Flow Theory

Flow theory, introduced by psychologist Mihaly Csikszentmihalyi, suggests that individuals experience optimal learning and enjoyment when they are in a state of "flow" — a state of deep concentration and complete engagement. Well-designed language learning games have the potential to induce flow by presenting challenges that match the learner's skill level, providing immediate feedback, and maintaining a balance between difficulty and competence. In a flow state, learners are more likely to be absorbed in the language learning process, leading to increased motivation and enhanced retention of language skills.

2.3 Sociocultural Theory

Sociocultural theories, such as the work of Lev Vygotsky, emphasize the importance of social interaction and cultural context in the learning process [4]. Multiplayer online games inherently incorporate social elements, allowing learners to engage in collaborative activities, share knowledge, and negotiate meaning within a virtual community. This sociocultural aspect of gaming aligns with the idea that language learning is a social practice, and the interactive nature of games facilitates the development of communication skills in authentic contexts. The collaborative and communicative features of multiplayer games provide a platform for students to co-construct knowledge and language skills through social interaction.

2.4 Cognitive Load Theory

Cognitive Load Theory, proposed by John Sweller [5], suggests that learning is most effective when the cognitive load is managed appropriately. Well-designed language learning games can optimize cognitive load by presenting information in a gradual and scaffolded manner, allowing learners to progress from simple to more complex language tasks. The interactive and iterative nature of games provides a supportive learning environment, reducing extraneous cognitive load and promoting effective encoding of linguistic elements.

2.5 Motivation Theory

Motivation theories, including Self-Determination Theory, highlight the importance of intrinsic motivation for sustained learning engagement. Gamified language learning environments leverage elements such as rewards, challenges, and progress tracking, tapping into intrinsic motivators [6]. The autonomy and agency granted to learners within gaming environments contribute to a sense of ownership over the learning process, fostering sustained interest and commitment to language acquisition.

Incorporating these theories into the design of language learning games enhances the alignment of gaming experiences with educational objectives. By leveraging principles from constructivism, flow theory, sociocultural theory, cognitive load theory, and motivation theory, educators and game developers can create immersive, engaging, and effective language learning experiences that cater to the diverse needs and preferences of learners.

3. Methodology

The research questions of the current study are framed within the larger context of examining how successful it is to integrate multiplayer online games into university-level language instruction. Getting a thorough understanding of the experiences, difficulties, and results related to this novel strategy is the main objective. Each research question has its contextual placement listed below:

- Perceived Benefits of Using Multiplayer Online Games: The first research question seeks to explore the subjective experiences of students engaged in language learning through multiplayer online games. By focusing on perceived benefits [7], the study aims to uncover the positive aspects that participants attribute to this gamified approach. The context lies in understanding the unique advantages, such as increased motivation, engagement, and enjoyment, that students associate with using multiplayer online games for language acquisition.

- Challenges Encountered in Learning a Language Through Gaming: This research question delves into the potential hurdles and difficulties that students may face when utilizing multiplayer online games as a medium for language learning [8]. By addressing challenges, the study aims to identify barriers that might impede the effectiveness of this approach. The context involves exploring aspects like technical obstacles, communication barriers within the gaming environment, or any resistance from traditional educational norms that students encounter during their language learning journey through gaming.
- Contribution of Multiplayer Online Games to Language Proficiency and Communication Skills: The third research question is positioned to examine the tangible outcomes of using multiplayer online games for language learning, particularly focusing on language proficiency and communication skills. Here, the context revolves around understanding how engaging in gaming activities influences participants' language competencies. This involves assessing the impact on vocabulary acquisition, grammar proficiency, and the development of effective communication skills within the gaming context.

Overall, these research questions collectively contribute to a comprehensive exploration of the gamified language learning experience at the university level. By investigating perceived benefits, challenges, and contributions to language proficiency and communication skills, the study aims to inform educators, researchers, and game developers about the nuanced dynamics of integrating multiplayer online games into language education programs. The context is shaped by a desire to uncover not only the positive aspects but also the potential obstacles and tangible learning outcomes associated with this innovative pedagogical approach.

3.1. Participants and data collection

Participants were recruited from a diverse pool of university students enrolled in language courses. The aim was to achieve a sample size of 20 participants to ensure a rich understanding of their experiences.

During the procedure, participants engaged in language learning activities within a selected multiplayer online game for a specified period. These activities included collaborative quests, communication with in-game characters, and interactions with other players.

Data collection comprised pre- and post-participation surveys to assess language proficiency. Semi-structured interviews were conducted to explore participants' experiences, perceptions, and challenges. Additionally, in-game observations were undertaken to capture real-time language use and interactions.

Thematic analysis was employed for interview data, while quantitative analysis was utilized for survey results. Recurring themes, patterns, and correlations were identified to draw meaningful conclusions about the impact of multiplayer online games on language learning.

Researchers observed and recorded in-game interactions, noting the frequency and nature of language use. Screenshots or video clips were collected to illustrate specific instances of language learning within the game.

Post-participation surveys were administered to assess changes in language proficiency and gather qualitative feedback on participants' experiences. Questions included perceived challenges, favorite in-game activities, and overall satisfaction with Language.

One-on-one interviews were conducted with a subset of participants to delve deeper into their experiences. The exploration covered participants' motivations, perceived learning gains, and challenges faced during the gaming-based language learning process.

3.2. Procedure

Participants were recruited from university students enrolled in intermediate-level language courses (English) at a diverse urban university, ensuring a mix of genders, majors, and gaming experiences.

In preparation, participants were introduced to the concept of a custom-designed multiplayer online game for language learning. A brief tutorial on the game mechanics, controls, and language learning objectives was provided. Additionally, a pre-participation survey was distributed to assess participants' current language proficiency and their attitudes toward language learning and gaming.

Collaborative Quests: Participants formed teams and embarked on quests that required communication in English. Quests involved solving language puzzles, interacting with in-game characters in English, and completing challenges that reinforced vocabulary and grammar.

Communication with NPCs (Non-Player Characters): Participants were encouraged to engage in conversations with NPCs, simulating real-life language use scenarios. NPCs responded dynamically, offering opportunities for participants to practice different aspects of language, from casual conversations to more formal interactions.

Player-Player Interactions: In-game forums or chat rooms were facilitated where players could communicate with each other in English. Multiplayer events, such as language exchange sessions or collaborative projects, were organized, fostering a sense of community and shared learning.

Interview transcripts were analyzed for recurring themes related to perceived benefits, challenges, and overall experiences. Patterns in participants' language proficiency development through in-game activities were identified.

Survey data was analyzed using statistical tools to measure changes in language proficiency. Survey responses were correlated with in-game activities to identify specific aspects of the game that contributed to language learning outcomes.

This detailed procedure using the multiplayer online game provided a structured and immersive environment for language learning. Collaborative quests, NPC interactions, and player-player engagement were combined to create a comprehensive language learning experience.

4. Results

Quantitative analysis of pre- and post-participation surveys revealed a statistically significant improvement in participants' English language proficiency.

On average, participants demonstrated a 15% increase in their ability to comprehend and communicate in English.

90% of participants reported a positive attitude toward using a multiplayer online game as a language learning tool. Many highlighted the gamified approach as a motivating factor, emphasizing that the immersive and interactive nature of the game contributed to a more enjoyable learning experience.

Thematic analysis of interviews revealed that collaborative quests within the game provided authentic contexts for language use. Participants expressed satisfaction with the relevance of in-game scenarios, such as negotiating with in-game characters, solving language-based puzzles, and participating in group activities that mimicked real-life language use.

Some participants noted challenges in player-player interactions, particularly in coordinating activities and maintaining focus on language learning objectives. This highlighted the need for well-structured communication channels within the game to optimize language learning opportunities during multiplayer interactions.

Participants reported an increased sense of confidence in using English in various contexts, both within and outside the game. The dynamic nature of in-game interactions, such as negotiating with NPCs and engaging in multiplayer events, contributed to participants feeling more comfortable expressing themselves in English.

Participants identified specific in-game activities that they found most beneficial, such as language exchange sessions and collaborative projects. The social and collaborative aspects of these activities were highlighted as key contributors to language learning enjoyment and success.

The positive results of the study suggest that the multiplayer online game effectively contributes to language learning at the university level. The gamified approach, particularly

through authentic language use in quests, fosters an immersive and enjoyable learning experience. However, challenges in player-player interactions indicate the importance of refining communication features within the game.

The findings support the integration of multiplayer online games into university language curricula, providing an alternative and engaging method for language learning. Game developers and educators should collaborate to refine multiplayer features, ensuring optimal language learning opportunities and addressing challenges faced during player interactions.

Participants, primarily IT students, demonstrated a substantial improvement in their technical English vocabulary.

In-depth coding quests and IT-related challenges within multiplayer online games contributed to a specialized language proficiency gain, with a 20% increase in accurately using technical terms. Thematic analysis of interviews revealed that participants experienced improved problem-solving communication skills.

Collaborative coding projects and troubleshooting scenarios facilitated effective communication of complex IT concepts, enhancing participants' ability to articulate solutions and strategies in English.

Participants reported a seamless integration of language and coding skills, emphasizing the relevance of language learning within the context of their IT studies. The ability to discuss coding issues, collaborate on projects, and explain technical concepts in English became a natural extension of their everyday IT interactions. Participants expressed a heightened sense of readiness for professional communication in an English-dominated IT environment. Engaging in in-game scenarios that simulated workplace communication, such as virtual team meetings and client interactions, contributed to a more confident and articulate communication style.

Some participants highlighted challenges in coordinating coding activities within a team, particularly when navigating diverse language proficiency levels. This emphasized the need for targeted language learning features within the game to address specific IT communication challenges in collaborative coding environments.

The majority of participants favored in-game activities that closely mirrored real-world IT scenarios. Simulations of debugging sessions, project management discussions, and code reviews were identified as highly valuable for language learning, aligning with the practical demands of their IT studies.

5. Conclusions

The current study demonstrates the potential of multiplayer online games as effective tools for language learning at the university level. The positive impact on language proficiency,

perceived enjoyment, and increased confidence suggests a promising avenue for further exploration and implementation in language education.

According to the study, an online multiplayer language game helps IT students meet their language learning objectives. For this particular group of people, the game's emphasis on technical vocabulary, problem-solving communication, and the fusion of language and coding skills shows that it has the potential to be an invaluable addition to conventional language learning techniques.

IT students find that playing multiplayer online games is a useful and entertaining way to improve their English language skills. The game is positioned as a useful tool for improving language proficiency within the particular context of IT studies because of its emphasis on technical vocabulary, problem-solving communication, and real-world IT scenarios. In order to address issues with team dynamics, game developers should think about including features that cater to the different language proficiency levels of IT student populations. The results also point to the possibility of including multiplayer online games in IT program English language curricula to specifically support technical communication.

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INTERFACE AND PRESENTATION ON ROMANIAN TOURISM WEBSITES

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Abstract

The interest in this paper is to analyze the Romanian tourism websites of three famous travel agencies from the point of view of the user interface and the website presentation. We do not enter the technical area of functionality and actual programming, which would require ample and applied, domain-specific information for a pertinent insight, sticking, instead, to what can be detached from the interaction of the regular visitor, who is not knowledgeable in programming or design as a specialist, and from his/her basic navigation experience practically. To this purpose, we have chosen to draw a comparison between the websites of the Romanian tourism agencies Christian Tour, Happy Tour and Eximtur, which are analyzed from the perspective announced above, and as they appear in the autumn of 2023, more exactly the end of the month of October, so not around any special holidays, events or sales opportunities in our country. The purpose of the analysis is to indicate the way the websites present appealing elements for the user from an emotional perspective (in Donald Norman's terms), and to rank them from this angle, as well as from the point of view of user optimization at a first glance.

Keywords: web design, tourism websites, Romanian travel agencies, emotionality, user optimization

JEL Classification: H5, Z10

1. Introduction

In a world of an overflow of information, most of which can be accessed using the Internet, and implicitly websites, what people seek while resorting to this manner of getting informed is, mostly, to save time, which means that the importance of not only having the information available, but also of having it organized in the best way possible to make the experience of a search both efficient and pleasurable becomes overriding. This paper means to explore the extent to which websites of Romanian tourism agencies fulfil some basic principles of interface and presentation composition, to check if, in this field of tourism and in our country, there is enough interest to offer a qualitative navigation experience to the user. In a world struck by the pandemic in recent years, the quality and appeal of the website of a company performing in the field of travel and tourism becomes crucial in manifold senses,

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as business, sales and profit depend on it more than ever when the odds have been against this field altogether, and its re-launching needs to take fresh forms in every aspect, including online marketing and commerce.

To this purpose, three tourism agencies have been chosen on the criterion of representing the top positions in the classification of companies of this domain – according to Traveler: Christian Tour for the greatest earnings, Happy Tour for being the most popular in the eyes of the young generation, and Eximtur for enormous demand when it comes to Romanian sand-and-beach holidays [1]. The outlook in the analysis resorts to the layperson's opinion – which represents the regular user's and the non-specialists in web design. More precisely, we first think about the websites' likeability and the sense of navigation ease that they inspire. We look at the visitor's experience to see its degree of optimization from a less technical point of view, relying on intuitive insights. Last but not least, we point out the emotional aspect that favors a positive navigation experience and ultimately the visitor's behavior as a potential buyer of the products and services advertised on the websites.

2. First impressions of the homepages

This section means to compare the homepage of the websites upon a first glance. At a first look, Christian Tour's homepage is the roomiest, less choked with details, which renders a general feel of relaxation and organization of the available space. As opposed to this, the Eximtur homepage is much more cramped, leaving the Happy Tour one in the middle in this respect. However, this effect says nothing about the content, it is more about the atmosphere of the page as one enters it. Let us see the content of the homepages of these three websites in more detail.

2.1 Christian Tour

The horizontal menu at the top of the page, with a detailed selection in the drop-down classes, contains the categories "Destinations", "Holidays", "Package Tours", "Winter Holidays", "Accommodation", "Romania", "Early Booking", "Exotic", "Adventure", "Family", "City Break", and "Senior Voyage", most of which reappear in the vertical menu that follows in a separate white rectangle, on the left, which shows the following headings: relaxation holidays, individual holidays, vacations in Romania, package tours and pilgrimages, Senior Voyage, exotic holidays, plane tickets, accommodation, city breaks, autumn and separately winter holidays, sand-and-beach Early Booking ones, cruises, coach rentals and catalogues [2]. A second vertical column in the middle part of the white rectangular area is a form allowing visitors to select the destination, the desired means of transport and the period of the travel along with the number of rooms for a specified number of people, assuming the visitor is restricted by timeline and has a specific destination in mind, rather than having a preference for a particular type of holiday, or searching for something less exact, merely prospecting the market offers. The third column in this menu

invites the visitor to check the offers for a fairytale winter 2023-2024, the text appearing above a picture of some relevant items sending us to think of winter and travel.

Following on the page, there is a carousel that reiterates some of the headings enumerated in the menu above in the first column, adding photographs, and others, among which specific destinations, such as: Marocco (with a photo of a young woman in traditional garments); advertising the magical Lapland as the home of Santa Claus (accompanied by a photo in which a little girl sits on Santa's lap); a Cappadocia package tour titled the "40 laws of love" with a stylized air balloon; adventure and exotic travel (the photo of which shows some people riding in a safari and photographing zebras); Jordan with a photo of, most likely, Petra [3]. There is an announcement, involving TBI bank, related to financial issues and facilities as to how one may pay for the holidays more easily. The types of holidays in succession in the carousel include details such as a specified price, meal arrangements and some key stopovers or sights in the respective package.

Below the carousel, there is a Calendar button which sends the visitor on a page that enumerates the holidays one can go on by month of the year. Here, the usual categories under every month are listed by means of transport – plane, coach, cruises, but also the broad kind of holiday, i.e. relaxation or package tour, preceded by the transportation or the adjective "exotic" [4].

Back on the homepage, there follow some blocks with images and the types of holidays mentioned in the first menu, with the added categories "Groups" and "Business Travel" [5]. These are alternated, by groups, with, first, a horizontal menu entitled "Offers for holidays in Romania", displaying the possibility to select a city, and, secondly, in the same horizontal layout, "Offers for city-breaks" listing cities all over the world in an alphabetical order [6].

Under all these, we have three boxes of different, vibrant colors announcing "Christian Tour Values" (neon dark blue), "Payment in Instalments" (in purple) and "Terms and Conditions for signing up and paying for the products" (in green) [7]. On the next line, we have some logos accompanied below by concepts such as "Trust", "Safety", "Continuity" and the mention of the 26 years that the company has lasted on the market and, last but not least, a blog [8]. This third part of the page towards the bottom is meant to reassure and inspire trustworthiness and the seriousness of the business, giving additional details in the area of exotic holidays which seem to explore spaces that may appear estranged or might inspire uncomfortableness to the Romanian tourist given their more pronouncedly different nature and culture. This reassurance concern from the part of the tour operator shows the intention to take care of the potential customers' emotional and psychological comfort. After this, a newsletter button appears, which is strategically placed at the end with the sense that the visitor might acquiesce to subscribe, being convinced by all that (s)he has seen on the website.

On the Blog, on four columns, there are photos of such destinations as we have mentioned – Jordan, Cappadocia, Thailand, and African Serengeti – all introduced with a suggestive and at the same time intriguing and appealing description – Jordan as "pacifistic",

Cappadocia as "cool", Thailand as the country of smiles, and Serengeti as a "dazzling wilderness" – to catch the visitor's attention [9]. Then, there is some text, followed in each case by the "Read more" button which sends the viewer to a new page filled with details related to the respective place.

2.2 Happy Tour

The upper part of the homepage in the case of the Happy Tour website portrays two horizontal menus: one aligned right, which begins with "Disneyland Paris", next to which there are the following destinations-countries listed: "Romania", "Bulgaria", "Turkey", "Greece", the Disneyland entry opening on a whole new different page, whereas the others provide a dropdown selection of options, containing mainly areas or cities, but sometimes sights (for instance, in Bulgaria, St. Constantin and Elena) [10]. The other horizontal menu, aligned left and right below this one, has as headings "Holidays by plane", "Hotels", "Plane tickets" and "Package Tours", each displaying its own pertinent menu below, once the visitor clicks on an option, where (s)he is then able to complete personalized data and subsequently search for this tailored input [11].

The carousel that follows shows a range of holidays: "It's time for a holiday in Dubai"; "Exotic holidays"; "Lapland 2023"; "Disneyland Hotel Is Re-opening"; "Pay for your holiday in Romania with vacation vouchers"; "Offer to your loved ones a present in the form of beautiful memories"; "Time for Cruises" [12]. Every entry has a button with "See the offers", which opens a new page for details.

Below the carousel, Happy Tour chooses to use a fragment of text which presents the travel agency as a partner with the help of whom one can acquire memorable moments. In this centered text, there are bold words – types of holidays, i.e. "special offers" and "exotic" – and destinations – the ones in the first horizontal menu, Dubai from the carousel, and Egypt [13].

Blocks with images – "Lapland 2023", "Exotic holidays" and "Dubai 2023" – appear below the title "Happy Tour Recommends" [14]. Then, other blocks are under "Holiday by plane in Egypt" with resorts and areas in the country, then some specific accommodations under "Discover Romania", cities under "Plane tickets", more (sometimes of the same) cities under "Hotels in the world", and four countries under "Package tours by plane" [15].

On the Happy Tour homepage, the Blog appears in the grey area at the bottom, in a vertical menu on the left. On the right, the newsletter subscription is in the form of a white rectangular button on which it says, in red capital letters, "Subscribe".

2.3 Eximtur

Eximtur begins with a left vertical menu entitled "Holidays" with four categories, "Holidays in Romania", "Holidays Abroad", "External Accommodation", "Plane Tickets"

[16]. Upon hovering over the category name, we get vast choices opening up to the right, which represent an overview of the whole amount of offers.

Then, there is a horizontal form entitled "Where do you want to travel?", providing options to be filled in a personalized manner once the desired option is chosen from the set called "Categories" [17].

The rest of the page is organized into "Eximtur holidays", "Charters", "Hotels in the country and abroad", "External accommodation" and "Plane tickets", portraying below each category rectangular photos with destinations that can be clicked on [18]. Also, every set of photos and destinations ends with a button on the right – "See more" – which announces that there are others that can be viewed in the set.

The Eximtur homepage ends with a thick horizontal blue bar, inquiring whether the tourist has found what (s)he was looking for: "Haven't found the desired offer of period? Contact us" [19]. The "Contact us" is a white rectangular button on this blue field. At the very end of the page, there are the newsletter and blog buttons, coming in similar shape and on dark blue, and, respectively, light blue backgrounds.

3. Analysis

The very first item that appears on the homepage of both Happy Tour and Eximtur websites is a search field with "What are you looking for today?", which is missing from the Christian Tour homepage. On Happy Tour it is smaller and placed on the right, whereas on Eximtur it is centered and bigger. We could say that using it appears to give the visitor much more search freedom. However, since the menus on all website homepages are extremely comprehensive, and information is repeated countless times, this search field seems redundant and unnecessary. Therefore, a good organization of the services and products on the page is much more important than the existence of this field. Christian Tour does not have one, and the homepage is not missing out on anything for this reason (quite the opposite, actually).

In the case of the Christian Tour website, the choice of photographs in the carousel is welcome, as it places the types of holidays in a context, sometimes creating a story around them or merely revealing a bit about the destination characteristics or activities. An intelligent manner of drawing our attention to the headings in the use of the photographs is that they are not of a single type but mixing cartoon-like ones with panoramic drone-like images, and some that appear to be created precisely as a visual input for that holiday. The blend achieved is multi-layered. On the one hand, it combines layers of identity, emotion and statuses that appeal to different aspects of one's personality: playfulness and the inner child in the sketchy ones, nostalgia in the portrayal of a child and the myth of Santa (also addressing the parent, to stir in him/her the desire to do something for his/her little one(s)), mysteriousness, sensuousness and even sexuality with the picture of the beautiful exotic young woman and fit-bodied skin-showing young man and woman (in the early 2024-

summer bookings). Hence, more roles in the same human being are triggered, as well as diverse age categories and stages of maturity, in the idea that the visitor will definitely identify with at least one. The varied styles in the rendering of the images themselves cover a wide variety of preferences for simply the kind of picture one may like – more elaborate and lifelike, simplistic, more colorful, and detailed, suggestive of something and/or hinting at certain ideas or concepts, static or dynamic, panoramic or close-ups, some for which some preparation has been done in advance or merely looking like snapshots etc. These variations cover more moods as well, leaving one under the impression that a wide range of tastes can be and is in fact met by the products and services advertised on the websites, rendering the sense of completeness, richness, and potential satisfaction of more needs.

Above, where we have presented the carousel, we have said that the pictures are accompanied by bits of text that give us a glimpse of the actual characteristics of the offers. We could say here that the information chosen for these sneak-peak text boxes that come with the images is appropriate, in terms of relevance and quantity, managing to arouse one's curiosity without being burdensome or verging on something too complex to digest or take in. It has the right amount of conciseness, being at the same time descriptive enough to help one form a brief minimal impression or become intrigued.

In comparison with the Christian Tour carousel, the Happy Tour website uses only classical-type photos, and the information that accompanies them is only the title presented above the picture in each case. This renders a feeling that the carousel is more unitary or harmonious, to which the use of only a title with no other details for the offers contributes. The advantage is that it looks more spacious and perhaps classy, helping the visitor focus on the big picture and, since the information is absolutely minimal, actually be able to remember the options. The "less is more" approach is more elegant and provides a smoother feel to the navigation experience. Hence, aesthetics may have to gain from the decision to build the carousel in this way, with minimalist information and photographs that look the same. Nevertheless, finding out anything at all about the actual offers takes more time in this way, as it presupposes accessing another page. To a visitor who is in a hurry, this may be annoying, as opening a new page constantly may seem inefficient, and (s)he may give up consulting the offers altogether or become tired much sooner, before having the opportunity to check them and like something. Overall, interest stands more chances of being piqued and retained with the carousel on the Christian Tour site.

On the Happy Tour carousel, there is a spelling mistake in one of the entries – in Romanian, in original, "Vremea crozierelor" instead of, most likely, "Vremea croazierelor" [20]. Unfortunately, this is a gross mistake when it comes to website design, as an inattention of this kind seriously affects the good image of the business and impairs professionalism, so it is an absolute no, something to be definitely avoided at all costs. Even though everyone may realize and understand that it is of course an error, sloppiness in the making of the website echoes over the whole business organization and its activity, not just the site presentation itself.

The Happy Tour website uses, as we have seen, a text to address the visitors, with some words written in bold letters. This strategy to attract attention to them is, however, both redundant, unnecessary, as they all exist in the menus above, already providing the visitor with the means to find out more about them, and downright futile, as these terms do not incorporate links to send one to further information on them. From this latter point of view, they are even deceptive, as the person navigating the website would expect them to send somewhere, determining her/him to hover with the mouse over them, and when in fact they do not, this is both confusing and irritating. Hence, the only rationale behind the existence of the bit of text is that the creators of the website may have thought that the power of direct address is appealing – but have not considered the downturns of the manner in which they have achieved it. Moreover, the last line, which prompts us to travel "#happy"(/ily) with the agency – written in red, to draw even more attention in an attempt to symbolize power – sends to an Instagram page that does not exist, which is yet another blunder that only manages to create the opposite effect, of disappointment and displeasure, rather than the enthusiasm initially intended.

The three options under the recommendations made by Happy Tour are completely redundant with the offers found in the menus above (which the content creators must have realized, as they have the smallest size among the photos permeating the second half of the page). Their only plus is that they show some more pictures, which are indeed aesthetically pleasing. Also, as a plus, we notice the effort to use a different style for the respective categories, so as to help the user visually separate more easily the categories while scrolling down on the page. The three photos of Egypt destinations are much bigger than the recommendations and noticeably so in comparison with those of accommodations in Romania, the latter having a red band at the bottom with price ranges, which makes them even more visibly different. Those in the next, "Plane tickets" section, are wider and less high and so on, every time a detail being changed to mark the separate group of photos. The differences are sufficient to create visual separation quickly, and at the same time not great enough to engender a feeling of disproportionateness, incongruity or lack of cohesion.

Unlike on the Happy Tour homepage, on Eximtur all the categories containing pictures with destinations provide photographs of the same size and type. It is evident that Eximtur has chosen uniformity as a strategy in this compilation. The photographs are indeed high-resolution, and their evenness renders the impression of harmony, given their superior quality and vibrant colors. The ability to fast identify the category that they belong to with only a quick look from the viewer is lost, but the effect of consistency gives the page its elegance. The use of the same fonts contributes to this feeling as well. Another gain from this strategy would be that the visitor does not feel tired or baffled navigating the page. The similarities of the fonts, photos and sharp, even, aligned edges inspire neatness and order. These features also make the visual and mental assimilation of information regarding the layout smoother, as it helps prediction and is according to the expectations that the user subconsciously forms. If we think about the huge photo taking up the first part of the homepage, with the young woman relaxing in the long chair, we can conclude that Eximtur

aims through their website at the chief value of relaxation, avoiding stress associated with the baffling of expectations even in their design.

The Christian Tour homepage is the only one than ends with a consistent Blog section that is actually present on the page instead of represented by a button. As we have seen above, there are plenty of useful tips and even comprehensive advice as to what the tourist should expect in the exotic destinations introduced here and how to deal with the newness of these aspects from which one is more estranged, as they are significantly different from what is valid in one's home culture, and therefore potentially tricky to handle. This approach shows concern for the wellbeing of the tourist, appears as an intention to go the extra mile, where the sellers of tourist products put themselves in the shoes of their prospective customers, wanting to be of help as much as they want to sell and be profitable. This attitude wins popularity points, being a good marketing strategy. It mirrors an intention of reassurance, which scores high in the consciousness of the client, assuring a type of psychological comfortableness that determines more openness towards embracing the otherness of the portrayed destinations, putting one in the mindset of considering purchase more intently than if this extra element had not been present in this manner. The invitation to subscribe for the newsletter comes in the noticeable, unmissable big orange horizontal bar below, which invites one to accept a subscription for the newsletter which comes accompanied by a promise of better, "special offers" as an outcome spelled out directly. Then, the prospect of being bothered by regular advertising e-mails is overtly presented as having a definite advantage, which means that an emphasis is placed on the gain that the visitor would acquire.

In comparison with Christian Tour, the Eximtur homepage ends with the blue horizontal bar described above. The inquiry whether the visitor has found the desired product is formulated in the negative form, being a negative-interrogative sentence. This is a poor approach, as in Romanian the sentence begins with the word "No", inducing negativity without perhaps realizing it. Eximtur has the least emphasized introduction of the Blog, which is an entry among many in that vertical menu at the bottom of the page. It is not highlighted enough, coming after the entry "Careers" (which a lot of visitors may be confused about, as per its content and relevance). This lack of visibility is probably not recommendable when it comes to advice and testimonials – the information that can be typically found on a blog – especially given the temporal-historical slice that we are living these post-pandemic, ongoing-war chunk of history, when others' opinions and communication in general are elements that have been functioning as a lifeline on many occasions and have a huge bearing on consumer behavior. Also, as far as the newsletter is concerned, the sense is that Eximtur requires the subscription instead of offering it as an advantage. The button announcing it is too visible and bright, leaving the impression that the travel agency is too desperate or at least highly keen on obtaining it from the visitors.

We notice, on all websites, that the information is arranged in such a way that the same categories reoccur, differently arranged, taking into account various possible criteria of

selection. This is often a case of "needless duplication" in the navigation elements, accompanied, moreover, by "multiple competing navigation schemes" which race each other "for users' attention" [21]. The recurrence and re-arrangement of the same information or headings in various ways may be a strategy to falsely render the notion of a greater amount of products and packages than the one really available, suggesting indirectly to the user that the business is expansive and the supply vast, hence that the travel agency is successful. Also, this kind of layout will actually lead the user to the same products, no matter which path is chosen, much as in a network in which "all roads lead to Rome". On Happy Tour, the categories under the recommendations made by the agency are completely redundant with some of those in the carousel above.

All the websites seem to display categories in an extremely subjective manner, apparently in no particular order or coherent logic within a set. About these categories, we could say that they are a bit confusing, often not mutually exclusive and not fitted according to the same classification criterion: "arbitrary, overlapping, nonexhaustive, and subjective", resembling Jorge Luis Borges' funny (and supposedly imagined) animal classification Chinese encyclopedia, whose categories include "Suckling pigs", "Mermaids", "Fabulous" and "Tremble as if they were mad" [22]. On Christian Tour, the categories enumerated above under the "Calendar" button illustrate this.

We notice a tendency on Christian Tour and Happy Tour websites to introduce an element of magic and infantilism with the presence of Santa Claus, snowmen (on the former) and Mickey and Minnie Mouse (on the latter). Both of these websites try to bring out and address the inner child and evoke all the connotations surrounding (nostalgia for) this character: the need for feeding her/his needs and fulfilling his/her wishes as an adult – perhaps due to a compensatory mechanism of the adult soothing his/her childhood version as a care provider later on in life, and thus acquiring a sense of accomplishment and success; the sense of security back in one's childhood, when life was much simpler while one was simply cared for and decisions were made for the child's benefit in his/her stead; the sense of being carefree again etc. Addressing the inner child is a strategy of putting one in a good mood and thus making the visitor more open to suggestions. If the visitors have children of their own, then the tactic above, of addressing the inner child, combines with the trigger of the role of the good parent, offering his/her child a nice holiday and thus a joyful experience, basically making the child happy and thus reassuring oneself as a fit/good parent. Eximtur focuses on a different need, namely the adult's need for relaxation, the wide huge photo in the opening of the homepage being evidence of that – the young woman relaxing on a long chair, with her back at us (signifying that she has left all her problems behind, and a devil-may-care attitude), facing the beach and sea water, with her hands at the back of her head to suggest a comfortable position. The infantile, childhood-related magic and fantasy elements are missing from the Eximtur homepage, but they are replaced by the cult of one's wellbeing.

Taking into account the above, we could draw some conclusions on which type of design is favored on the websites under analysis, among the three mentioned by Donald Norman in his study *Emotional Design*. He describes the existence of three aspects of design: the "visceral", in which "appearance" and beauty is primordial; the "behavioral", which prioritizes "effectiveness of use"; and the "reflective" [23], which is about a "personal component", "meanings" and the object being a "symbol" or "reminder" of identity, "an expression of one's self" [24]. Norman warns against the faulty conceptualization of a dichotomy between emotion and knowledge, feeling and mind, saying that "Emotions are inseparable from and a necessary part of cognition." [25]

From the criticism brought to some aspects in the organization of the homepages under scrutiny, it is obvious that the behavioral aspect of design is not primordial, as attention was not on a particularly rational and disciplined layout. It was rather about the seeking of emotional and visceral components to be displayed in the design. This is achieved with the use of triggers for the inner child, magic, elements from the childhood universe, and the value assigned to relaxation by mature adults (on Eximtur). Photographs and colors, raising nostalgia or a positive state are deemed more important than text. Emotions are useful because they enable choice [26]. Among the things that give rise to "positive affect", we find "'attractive' people" [27] (portrayed on the Christian Tour homepage), which, along with "arousal" prompt individuals to act more, and more in the line of what they immediately desire without thinking of the consequences, so driven by "Mr. Hyde" [28] rather than the superego, less conservative, and prone to impulse buying to satisfy the pleasure of self-indulging in a holiday.

4. Opinion poll

The opinion poll was performed on a focus group of twenty second-year computer science students. The rationale behind it was to overlap intuitive user hunches and layperson's opinions of the websites with the perspectives of future specialists, who already have some minimal technical knowledge on matters such as user optimization and front-end work, but not enough to fully put an imprint on their choices.

The participants in the poll had to answer two questions, comparing the three homepages:

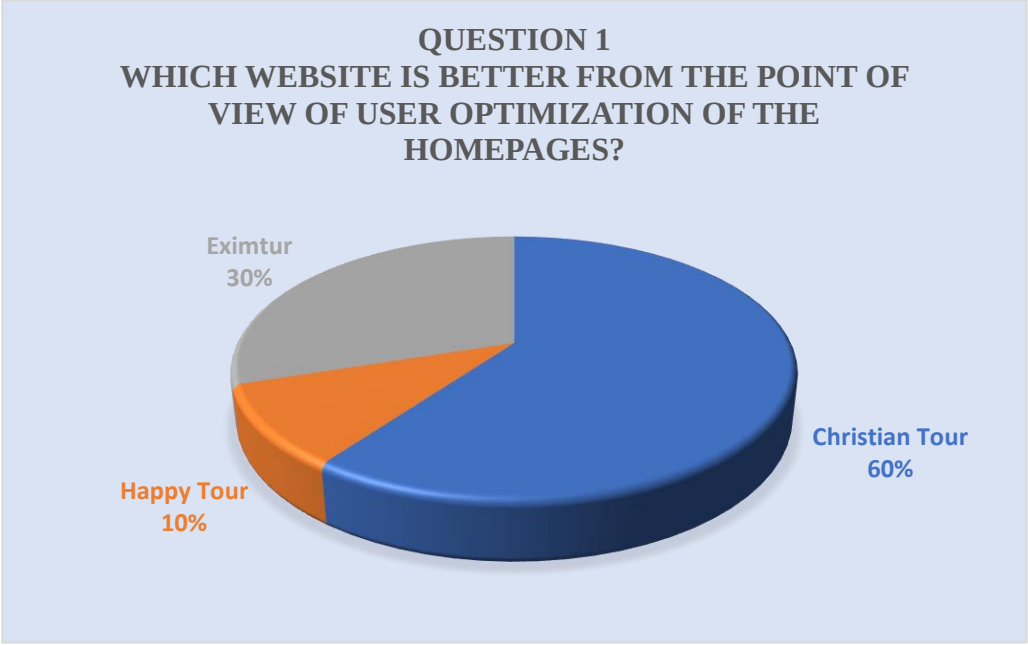
1) Which website is better from the point of view of user optimization of the homepages? State two reasons why.

2) Which homepage is aesthetically more pleasing? Give (an) argument(s).

We have to make here the comment that even though the second question seems purely subjective, if it is answered by the future specialist – so someone who looks at it with a more informed eye than the regular, unknowledgeable visitor – there will be at least some unconscious professional influence on the input, as the judgment will be made having at the back of the mind some knowledge as to what is recommendable when it comes to harmony and aesthetics in the drawing up of website pages. Thus, their opinion is not the

totally "innocent" one of the naked eye – so to say – but includes the outlook of the specialist-to-be, which we consider beneficial here, as the purpose is to establish what is aesthetically right while having at least some idea of computer science sanctions.

The results are summed up in the following two charts.



We notice that in the case of the first question, there is wide agreement as to the fact that the Christian Tour website homepage is more optimized for the viewer. The opinion poll result reflects what we have intuitively provided as arguments for this perspective. Almost two thirds of the respondents agree on its superiority. Among the reasons provided by the students, the most prominent were it is well-organized, the types of holidays are clearly on display in tabs, so that the experience is pre-sorted; the search tool is visually well laid-out; better-chosen criteria for trip ideas in the second part of the page; one gets more information about offers at a first look. Professionally, the web technology used to create it is superior to that employed for the other sites, more modern, and the search menu works faster.

For the second question, there is a tight battle for supremacy between Christian Tour and Eximtur, with the latter winning over. The main reason is, apparently, the huge photo placed in the opening of the homepage, characterized as inspiring, exotic, and therefore drawing in the viewer. The fact that the homepages of the other websites use forms instead of this tool is apparently seen as a disadvantage when it comes to aesthetics. This dreamy element has thus made the difference in a positive sense. This is more forcefully valid and relevant given the particularity of the products and services sold on it, which address leisure, i.e. the dreamy element is necessary when the business is to sell precisely an escape from daily reality and hassle. It is possible, then, for this element not to have made the positive contrast had the object of activity been a different one. Paradoxically perhaps, the Christian Tour has gotten more comments or arguments in the "Why?" section of this second question, these being of the type: better color palette, with lighter colors that do not disturb the eye, rounded corners for the tabs or buttons, small fluid animations, which are supposed to enhance the pleasant feel given by the website. In contrast, the Eximtur page has received fewer pro arguments, the most recurrent being that it inspires relaxation, mainly through its background photo. This goes to show that relaxation trumps all the other enjoyable details, which goes along the contention made above related to the emotional component of one's own psychological wellbeing and comfort being paramount, surpassing even the satisfactory fulfilment of social roles. Could an explanation be that the pandemic times have ultimately after all made us more egocentric or even selfish? Also, that people feel more stressed and need to escape from it? The respondents who chose Happy Tour brought in support of their claim the idea of a smaller agglomeration of details, finding the other pages a bit overwhelming from this perspective (a motivation invoked by those who chose Eximtur as well), also feeling that the combination of red and white is less predictable than white and shades of blue and somehow more engaging for this reason.

5. Conclusions

All websites resort to emotional elements. Be they nostalgia, the right to relaxation, the need for security or for successfully fulfilling certain roles, what they have in common is the element of emotionality. From the research, we may conclude that the feeling

component is considered a valuable trigger, deemed to be favoring purchase behavior. This is, as we have mentioned, the apanage of the specificity of the business of leisure which makes it relevant in context.

All websites have redundant elements, Happy Tour taking precedence in this respect in the negative sense. However, redundancy can also be a conscious choice, to send the potential customer to the same products and services over and over as a marketing strategy. The objective in this case would be to achieve smart redundancy, i.e. make it so that the customer should not immediately notice it or so that it is not annoying.

Even though Christian Tour uses a more modern and organized interface, with the most complex psychology behind it, visibly better optimized for the user, Eximtur nevertheless wins the points when it comes to likeability, although they are very close up in the visitors' preferences. What follows from this is that one's own relaxation component and suggestion seems to take primacy over the other elements.

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THE IMPORTANCE OF DIGITAL MARKETING FOR HIGHER EDUCATION IN IMPROVING THE EDUCATIONAL VALUE CHAIN

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Abstract

In the fast-changing digital landscape of higher education, the adoption of digital marketing strategies has become essential for higher education institutions aiming at global relevance and effective student engagement. The article dives into the transformative impact of digital marketing on higher education, focusing on six key aspects. Firstly, we explore the global reach and accessibility facilitated by digital channels, using strategies such as social media advertising and relevant digital content. Secondly, personalized communication takes center stage, emphasizing targeted email campaigns, social media posts, and customized landing pages. The power of content marketing and storytelling is examined as the third aspect, utilizing mediums like blog posts, videos, and well-planned social media campaigns. Social media engagement, the fourth dimension, is analyzed across platforms like Instagram, Twitter, and LinkedIn, offering insights into effective strategies. The fifth dimension explores the role of Search Engine Optimization (SEO) in enhancing online visibility and engagement. Finally, the article highlights data-driven decision-making as higher education institutions leverage metrics such as website traffic analysis, social media analytics, and conversion rate monitoring. Through these comprehensive strategies, higher education institutions can successfully navigate the fast-changing digital landscape, connecting with a global audience and fostering engagement. Digital marketing holds the capability to significantly enhance various aspects of the educational value chain, facilitating successful outreach, engagement, and support for students. The article also underlines the role of the synergistic relationship generated by the CMO – CIO partnership that gives a particular form to the digital transformation vision of the Higher Education institution, the movement from vision to reality on the path to digital maturity being impacted by a digital marketing considering CX improvement and the 7Ds.

Keywords: Digital Marketing, Higher Education, Educational Value Chain, CMO – CIO partnership, CX

JEL Classification: D83, I23, L86, M31, O31, O33

1. Introduction

[1] Romanian-American University

Ten years ago, Edelman (2013) brought to our attention his expectation for marketing expansion based on its giving role (providing relevant insights, creating valuable connections, and delivering performance excellence), highlighting, for instance, the impressive insights (derived from data) about customers ensured by marketing with the help of Big Data and analytics, as well as Chief Marketing Officers' need (in order to drive both personalization, and new experiences) to more and more guide information technology (IT) regarding priorities in new technologies' investment. At the beginning of the next year, Ariker and Perrey (2014) underlined the need of Chief Marketing Officers and Chief Information Officers (they are natural partners) to have a successful partnership (based on clearly defined goals and empathy, as well as a shared vocabulary and complete transparency) so as to turn Big Data (precisely understood) into big profits.

Just some months later, Jauchius (2014) described the role of Customer Information Management (CIM) built as a result of the closed working relationship between the Chief Marketing Officer (CMO) and Chief Information Officer (CIO), considering that: the central part of the technology and marketing overlap is the building of CIM database, and that the greater part of digital is within marketing; the CMO – CIO partnership is driven by marketing need to produce this move in digital technology and digital knowledge in accordance with customer-driven requirements' solving. While approaching the challenge of digital maturity, Purcarea and Negricea (2014) showed how in today omnichannel world digital customer engagement became a top strategic priority, customers expecting seamless integration of digital and analog channels, and seamless organizational internal integration (within the context of a more company's interactivity with more empowered customers) should be the end goal, answering accordingly to the new requirements of the supply chain management.

Horrigan (a, 2016; b, 2016; c, 2016), who gave attention to digital readiness, underlined that for using next-generation technologies it is necessary to see the different levels of both preparedness (of both people and institutions), and of new technologies' usage as these technologies diffuse in society. With regard to *the spectrum of digital readiness for e-learning* (digitally ready, cautious clickers, the reluctant, traditional learners, and the unprepared), he made reference to the comparison of key measures of digital readiness (use, trust and skills) across the above-mentioned groups. And on the basis of research conducted by the nonpartisan fact tank Pew Research Center (Washington, D.C.), he concluded that *greater digital readiness translates into higher level of use of technology in learning*.

Negricea and Purcarea (2017) highlighted how digital customer experience (DCX) is evolving step by step, digital marketers being increasingly aware of both the role of CX as the top digital transformation priority, and of the rising consumers' technology hyper adoption powered by emotion. They showed marketers' struggling to create more cohesive cross-channel customer engagement, by offering relevant content and messaging within the evolving customer journey. At the same time, they made reference to significant research

findings about recommendations regarding both where to focus resources to successfully implement digital transformation, and the need to better understand that CX improvement (CX and brand working together) is a very important benefit of digital transformation.

There is no doubt about the importance of better understanding the level of digital readiness, taking into account the real need to integrate new technologies into universities operational frameworks and advance on the path to digital transformation (Iswahyudi, Hindarto, and Indrajit, 2023). It was also recently reconfirmed that as an intermediary between an organization's resources and digital transformation is the readiness for this digital transformation, an organization needs to reconfigure its resources in order to achieve the appropriate level of this transformation (Chwiłkowska-Kubala et al., 2023).

According to a Forbes Councils Member (Tippets, 2023), a CMO – CIO partnership that shapes a digital transformation vision, brainstorms potential risks, challenges and consequences, and builds a flexible digital road map is opening the way to successfully valorize the power of digital transformation by guiding the business on the basis of their clear communication, and mutual understanding of goals and objectives, as well as regular results reviews and measures of their collaboratively initiatives (identifying improvements' areas and adjusting strategies accordingly). Starting in their collaboratively working from expertise and insights' sharing, goals and objectives' identifying and ideas' exploring, the CMOs (who understand the implications of both customer data on sales, and CX) and CIOs (who understand data sources' collection, capturing and unifying, while protecting personally identifiable information) will make possible their needs' efficiently and cost-effectively meeting, leveraging their data predictive value.

In the opinion of Dr. Charles Brandon (2023), in order to achieve both a successful and sustainable digital transformation it is necessary to address some key factors (such as: clear strategy and vision, strong leadership commitment, customer-centric focus, agile and adaptive culture, effective change management, data-driven decision-making, cross-functional collaboration, continuous learning and skill development, measurable goals and key performance indicators, technology alignment, flexibility and adaptability, continuous improvement, cybersecurity and risk management, vendor and partner management, user-centric design, cost management, legal and regulatory compliance) that differentiate successful digital transformation initiatives from failed efforts. Going on the right path presupposes to integrate the new technologies (like automation, cloud computing, big data analytics, the Internet of Things, blockchain, AI and generative AI) and create a holistic organizational ecosystem (in which front, mid, and back-office operations are coherently connected). With regard to the importance of a sustainable digital transformation it is also worth mentioning that – as highlighted by a Director of the Center for Universal Education at The Brookings Institution (Washington, D.C.), Rebecca Winthrop (2023), while commenting on the last United Nations General Assembly (UNGA) meetings in New York – to the list of forces the Sustainable Development Goals (SDGs, adopted in 2015 by the

United Nations) the generative AI has been added recently. And that within the context in which the well-known and much debated Chat GPT3 was released in November 2022 after the Transforming Education Summit (TES) during UNGA 2022.

On the other hand, Trend Hunter AI, recognized as the world's largest and most popular trend community (Jeremy Gutsche launched TrendHunter.com in 2005), highlighted in September 2023 three trend themes in AI Education: generative AI in education, sophisticated AI detectors (AI detection platforms like GPT Zero), and AI-assisted writing in education (like Turnitin). Trend Hunter also underlined three industry implications: language learning (introduction of Duolingo Max), writing and editing (the disruption generated by the sophisticated AI detectors), and academic integrity.

According to Grammarly for Education (a, n.d.; b, n.d.), to succeed in the workplace students need to test and learn the proper strategies provided by higher education institutions so as to be able to respond and innovate while facing the new technologies like Generative AI, Learning Management Systems, Internet of Things, Student Learning Analytics, Virtual Reality and Augmented Reality. As technology use is thrown learning with great force into the future, it has become an urgent strategic priority to accelerate the adoption of educational technology in higher education. As shown, for instance, by McKinsey Global Institute (2022), both current employees and candidates have to be evaluated first for their potential and capacity to learn (not only for their knowledge and skills).

The obvious transformative impact of digital marketing on higher education

The *American Marketing Association* highlights in the article "Analyzing Effective Higher Education Marketing Strategies" the shift from traditional to digital marketing strategies, fueled by technological advancements, which has significantly impacted the effectiveness of marketing efforts. Unlike traditional one-way communications, digital marketing offers a two-way interaction, allowing organizations, including higher education institutions, to engage with their audience more effectively. The emergence of various digital marketing strategies provides higher education institutions with diverse tools to connect with potential students, enhance communication, and promote their brand. This highlights the evolving landscape of marketing in the digital era and the opportunities it presents for higher education institutions.

Deloitte suggests in its article entitled "Higher Education meets digital technology" the fact that one of the main factors behind the ongoing transformation in education is the necessity to provide personalized experiences for students throughout their entire academic journey, both within and outside the institution. Students have heightened expectations, desiring customized communication, tailored learning experiences, and support services that cater to their individual needs. The use of digital tools and platforms is highlighted as a key

strategy for higher education institutions to deliver personalized experiences, leading to increased student engagement and retention.

A recent article from *Digital Marketing Institute* entitled "The What, Why & How of Social Media for Higher Education", underscores the multifaceted nature of social media platforms and their strategic use in digital marketing for higher education institutions, emphasizing the importance of diverse content, engagement, and strategic partnerships.

The article "Digital marketing as a route to reaching international students" from *Times Higher Education*, highlights, among others, that the recruitment of international students is becoming more competitive, making universities to adopt effective digital marketing strategies to stand out, while there is a need to understand the fact that unique preferences of different demographics is crucial and tailoring marketing content based on the preferences of the target demographic is essential.

The ongoing expansion of the digital landscape presents an extensive and untapped opportunity for reaching wider audiences. For universities seeking to connect with potential students, engage with current ones, and establish a strong online presence, digital marketing has become fundamental. It empowers higher education institutions to transcend geographical limitations. Using social media platforms, search engine optimization (SEO), and online advertising, institutions can showcase their programs, faculty, and campus life to a global audience. This extended reach not only attracts a diverse student body but also contributes to the creation of a multicultural and inclusive learning environment.

There is an obvious transformative impact of digital marketing on higher education, the following key aspects being relevant in this sense.

2. Global and accessible

Digital marketing serves as a catalyst for higher education institutions to pass geographical boundaries. With a simple click, universities can establish connections with prospective students from every corner of the globe. Utilizing social media platforms, search engine optimization (SEO), and online advertising, institutions can present their programs, faculty, and campus life to a worldwide audience (see table 1 below). This expanded reach not only attracts a diverse student body but also contributes to the establishment of a multicultural and inclusive learning environment.

Social Media Advertising	Targeted ads on platforms such as Facebook and Instagram to reach specific audiences globally.
Virtual Campus Tours	Utilization of virtual reality or 360-degree videos for immersive online campus experiences.

Multilingual Digital Content	Creation of digital content in multiple languages to cater to global audience.

Table 1. Expanded reach with the help of digital marketing

3. Tailored communication

A significant advantage of digital marketing represents its ability to personalize communication for specific audiences. By leveraging targeted advertising and data analytics, higher education institutions can craft personalized messages tailored to the interests, demographics, and behaviors of potential students (see table 2 below). This personalized approach enhances engagement and fosters a meaningful connection between the institution and its audience.

Email Marketing Campaigns	Sending personalized emails based on a student's interests.
Targeted Social Media Posts	Crafting social media content that speaks directly to the interests and aspirations of different audience segments.
Custom Landing Pages	Developing landing pages for specific programs or events to provide customized digital content.

Table 2. Crafting personalized messages

4. Content marketing and storytelling

In the very competitive field of higher education, storytelling plays an important role. Digital marketing offers higher education institutions a platform for engaging in content marketing, allowing them to share narratives that resonate with their audiences. Whether through blog posts, videos, or social media campaigns, institutions can showcase their unique identity, values, and successes, cultivating a sense of community and loyalty among students and alumni (see table 3 below).

Blog Posts	Regular blog posts featuring student success stories, faculty interviews, and campus events.
Video Content	Creating engaging videos, including virtual campus tours, interviews, as well as documentary-style digital content.

Social Media Campaigns	Launching social media campaigns that tell a relevant story across various platforms, generating interest and engagement.

Table 3. Content marketing and storytelling

It is worth mentioning within this framework that according to a 2022 Aira survey of marketers worldwide (Voss, 2023), the majority of respondents (58.9%) confirmed that they optimized existing content (for search or to outshine competitors' copy, for instance) by using AI tools. The article's author added that is worth paying attention to how can be enhanced content (repurposing content, personalizing it, creating high-ranking content, testing content) by using ChatGPT and other generative AI tools (like Anyword, Jasper, Copy.ai, Frase, and Quillbot).

5. Engagement through social media

Social media platforms have evolved into powerful digital tools for higher education institutions to connect with their audiences. From Instagram and Facebook to LinkedIn and Twitter, higher education institutions can use these platforms to share updates, spotlight achievements, and engage with both current and prospective students (see table 4 below). Social media also provides a space for students to connect with each other, fostering a strong sense of community.

Instagram	Regular posting of visually appealing digital content.
Twitter	Active participation in trending educational topics and real-time engagement with students and alumni.
LinkedIn	Professional engagement, sharing faculty achievements, research breakthroughs, and industry partnerships.
TikTok	Good for short video content

Table 4. Engagement through social media

It is worth mentioning that progress could be seen in many areas including in video effects making. For example, as shown recently by Sato (2023), without downloading another app TikTok users can use a new mobile editing feature and create video effects right in it, confirming the expansion of TikTok culture (where AR effects are a big part of it). It is also well-known that TikTok filters (always central to it) are increasingly becoming more realistic, while users can add interactivity in filters and work off (in the TikTok mobile app) of filter templates, having the possibility to use in their effects more than 2,000 assets. On

the other hand, it is good to know that the performance (in revenues) obtained by ByteDance, the TikTok parent (Konstantinovic, 2023), challenged the social media throne of Meta.

6. The importance of Search Engine Optimization (SEO)

In a world where many prospective students initiate their interaction with a university through online searches, SEO takes center stage. Higher education institutions must ensure that their websites prominently appear in search engine results (see table 5 below). By optimizing content for relevant keywords, universities can enhance their visibility and attract more relevant leads.

Keyword Optimization	Identifying relevant terms potential students are likely to search for and incorporating them into website content.
High-Quality Relevant Content	Producing content that answers questions, provides value, and relevant to the target audience.
Backlink Building	Developing a network of high-quality backlinks from well-known sources to enhance the website's credibility.

Table 5. The importance of Search Engine Optimization (SEO)

It is useful to note here how important is for higher education institutions what is happening in the field of search regarding the evolution of new tailored experiences. As shown by a Google expert (Edwards, 2023), there is a continuous evolution and improvement alongside the web and in general in our world in which at no time will be search (that is connecting human curiosity and wisdom placed on web) a solved problem. And Google already introduced new improvements (while also exploring another new way regarding web content) to help searchers: find the relevant and reliable information when following a topic; valorize Google app and mobile web by exploring diverse perspectives on Search; learn from others' experiences on the web (based on a new experiment introduced in Search Labs). And as SEO is always changing it is also important to better understand the role of user-generated content (UGC, a game-changer in digital content) in SEO as a key activation, by incorporating UGC into the SEO strategy (Liddell, 2023), so as to obtain significant benefits (such as: enhanced search engine rankings, increased user engagement, content variety, long-tail keywords, authenticity and trust, community building, social signals, user-generated backlinks, lower content creation costs, feedback and insights, diverse perspectives and opinions brought to organization content).

7. Data-driven decision making

Digital marketing offers a vast amount of relevant data that institutions can leverage for informed decision-making. Analyzing website traffic, social media engagement, and online campaign performance provides valuable insights regarding the audience preferences (see Table 6 below). This data-driven approach allows universities to refine their strategies, allocate resources more effectively, and measure the return on investment (ROI) for various digital marketing initiatives.

Website Traffic Analysis	Understanding which pages attract the most traffic helps in optimizing content.
Social Media Analytics	Tracking engagement metrics, such as likes, shares, and comments, to measure the success of social media efforts.
Conversion Rate Monitoring	Analyzing how many visitors take desired actions provides insights into campaign effectiveness.

Table 6. Improving data-driven decision making with the help of digital marketing

Understanding the deep linkage between universities' challenge to align their program offerings with the dynamic demands of the labor market, and the role of the digital marketing in enhancing the educational value chain

According to *The Skills Revolution and the Future of Learning and Earning* Report from the *World Government Summit 2023* in collaboration with *McKinsey & Company*, higher education is undergoing a transition towards a skills-centric approach. Institutions are augmenting the practical application of skills in their curricula, placing a significant focus on fostering communities and networks. This shift prompts a reassessment of certain credentials, giving rise to a novel micro credentialing system in higher education designed to equip students more flexibly for the professional pathway.

To ensure a workforce equipped with skills aligned to the evolving workplace landscape, employers are encouraged to prioritize hiring based on skills rather than solely relying on experience and qualifications. Adopting a 'talent incubator' mindset becomes pivotal, supporting employees as they assume varied roles.

The same report highlights the concerted efforts of educational institutions and businesses to adapt and integrate evolving skill requirements into their frameworks underscore the global commitment to preparing learners for the dynamic demands of the future workforce. The emphasis on higher-level cognitive and social-emotional skills, as demonstrated by initiatives like the OECD Learning Compass 2030 and UNICEF Global Framework,

reflects a forward-thinking approach aimed at fostering resilience and adaptability in individuals.

According to the report, higher education institutions play a very important role in shaping individuals for the future job market. Despite the evolving emphasis on continuous learning, degrees remain highly valued by both individuals and employers, with the assurance of a better life. The global higher education market is projected to grow substantially, highlighting the ongoing importance of higher education institutions in the educational value chain.

The imperative for higher education institutions is to align program offerings with the dynamic demands of the labor market. This involves investing in guidance and support systems for students to identify career pathways matching their talents and interests. Strengthening relationships with employers is also very important to ensure that programs are industry-aligned.

Below, table 7 highlights the key stages of the educational value chain while providing clearer descriptions for each stage.

Pre-Enrollment	Outreach, marketing, and recruitment efforts to raise awareness and attract prospective students.
Admissions	Application processes, assessments, and enrollment procedures for new students
Curriculum Design	Development and planning of academic programs, courses, and learning objectives
Teaching Methods	Implementation of pedagogical approaches and assessment methods
Student Engagement	Activities and initiatives fostering student participation, interaction, and collaboration
Assessment & Feedback	Activities and initiatives fostering student participation, interaction, and collaboration
Credentialing	Granting degrees, diplomas, certificates or other credentials upon successful program completion.

Career Services	Assistance and resources to support students in transitioning from education to the labor market

Table 7. Key stages of the educational value chain

Addressing to the changing nature of work within the context of digital transformations post COVID-19 crisis, Bousrih, Elhaj and Hassan (2022) underlined significant aspects, such as: the labor market indicators are influenced by digitalization which changes essentially the nature of work; being competitive in the labor market is involving mastering digital skills, between these skills and higher salaries being a clear correlation. They also showed that to generate economic growth the most important key factors are technology, labor, and capital (according to macroeconomic theories), and that the labor market is impacted by the new technologies.

Thirteen years ago, two researchers (Pathak and Pathak, 2010) from one of Australia's leading universities, Queensland University of Technology (QUT), Brisbane, addressed the topic of the process of making a new arrangement of the higher education value chain, starting from the need of creating competitive advantages of cost and differentiation (demanded by the changing dynamics of higher education sector), and considering Michael Porter's concept of value chain launched in 1985 and conceived as having five primary (inbound logistics, operations, outbound logistics, marketing and sale, services) and four support services (human resource, technology, firm infrastructure, procurement) in the value chain proposed by Porter. On the basis of identified trends in the literature they gave a brief statement of the main points of the new age value drivers in higher education (student enrolments, research grants and publications, teaching and learning training, research training and development services, technology: it enabling students, student's evaluation of teaching, *visibility through active brand building and differentiation, and alumni as brand ambassadors*), showing that *the new emerging power centers in the reconfigured value chain of the higher education sector are the support services* (value being commensurate with the emerging performance benchmarks, and the key thrust areas being revaluated). Beyond the increasing significance of support services within the emerging value chain in higher education discussed by these Australian researchers, they also underlined not only the emerging trend of teaching and learning, but also the role of technology (as an enabler and creator of both cost advantage and enhanced efficiency) and the formalization (rules, regulations, policies and procedures governing the specific activities) of marketing & sales services. They brought to our attention the coexistence of all three formats (with their own unique business model) of higher education (brick, brick & click, and click).

According to European Union (2017), there is a contrast between value chain (understood as a way of obtaining a competitive advantage and fulfill customer requirements) and

supply chain (seen as a business transformation tool both minimizing costs and maximizing customer satisfaction by providing – *formulated in terms of the marketing mix* – the right product at the right time at the right place and the right price). Within this framework, it was highlighted significant aspects, as follows: the prominence of the digital value chain (as term), value chains being made by the digital transformations (key to competitiveness if used effectively) more digital, while business processes become digitized; considerable opportunities to create value for customers are being offered by the value chains on the basis of digital technologies' mastery; a key technological trends' convergence facilitate digital innovation in all sectors (products, processes, services, business models).

As the reputed father of modern marketing, Professor Philip Kotler (2012), reminded us, the art of brand building means marketing. And we have seen above how visibility through active brand building and differentiation, and alumni as brand ambassadors, is one of the main points of the new age value drivers in higher education. And within the above-mentioned prominence of the digital value chain, it is imperative to pay attention to the way of leveraging digital marketing.

As demonstrated by the reputed digital strategist Dr. Dave Chaffey (2023): "In practice, digital marketing focuses on managing different forms of online company presence, such as company websites, mobile apps and social media company pages, integrated with different online communications techniques… These include search engine marketing, content marketing, social media marketing, online advertising, email marketing and partnership arrangements with other websites… digital marketing is sometimes considered to have a broader scope than online marketing since it refers to digital media such as web, e-mail and wireless media, but also includes management of digital customer data and electronic customer relationship management systems (E-CRM systems)." It is well-known that Chaffey (2022) identified the so-called 7Ds of digital marketing (including key digital marketing concepts and techniques): Digital goals, Digital audiences, Digital devices, Digital platforms, Digital media, Digital data and Digital technology.

According to an author from the digital marketing agency Search Influence (Scott, 2023) – who revealed research findings regarding the top 10 results in Google for marketing strategies in higher education institutions – the most frequently cited strategies were as follows: SEO, Social Media Marketing, Email Marketing, Video Content, Personalization, Pay-Per-Click (PPC () and Digital Advertising, Content Marketing, Branding, Chatbots and Conversational Marketing, Data-Driven Strategies. He also revealed his perspectives after analyzing the articles, resulting significant aspects such as: despite the fact we are already in the new normal, there is still a continued focus on the COVID-19 pandemic; there is a focus on the rise of Instagram, and Generation Z are starting product experiences on TikTok; before students even know they are looking they will continue to be exposed to universities' schools and programs, where the continuous importance of social; it is important to be focused on real-time and alumni engagement; it is also important for universities to have a

central oversight (to avoid dismantling their own messaging and budgets), considering the decentralized nature of a higher education marketing strategy that is costing very much; there is a real need to pay more attention to analysis, tracking, and reporting,

Allow us to add that, without doubt, digital marketing has the potential to profoundly elevate multiple phases of the educational value chain, enabling effective outreach, engagement, and support for students. Below are several steps through which digital marketing can enhance the educational value chain.

Pre-Enrollment	Targeted Social Media Advertising, Content Marketing (Blogs, Videos)
Admissions	Webinars and Virtual Tours, Online Application Promotion
Curriculum Design	Data Analytics for Program Improvement, Online Surveys and Feedback
Teaching Methods	Social Media Engagement for Community Building, E-Learning Platforms
Student Engagement	Email Campaigns, Social Media Engagement for Community Interaction
Assessment & Feedback	Online Assessment Tools, Data Analysis for Personalized Feedback
Credentialing	Virtual Graduation Celebrations, Digital Certificates/Diplomas
Career Services	Digital Alumni Networks, Online Job Platforms

Table 8. How digital marketing can enhance the educational value chain

According to an article entitled "Learn how and why schools and colleges use digital marketing" from *WSA The Communications Agency*, a strategic and well-executed digital marketing strategy represents an imperative for educational institutions to thrive in a competitive, technology-driven world, where digital marketing platforms facilitate open dialogue and interaction, encouraging feedback and suggestions for improvement, fostering a sense of community and inclusivity.

Conclusion

Digital marketing plays a pivotal role in Higher Education by enhancing the educational value chain. Its strategic implementation not only expands institutional reach but also fosters engagement, facilitates personalized communication, and ultimately contributes to a more dynamic and inclusive learning environment. Embracing digital marketing practices is essential for higher education institutions seeking to adapt, thrive, and effectively meet the evolving needs of modern and digital education. It will be interesting to follow the synergistic relationship generated by the CMO – CIO partnership that gives a particular form to the digital transformation vision of the Higher Education institution, the movement from vision to reality on the path to digital maturity (according to the agile digital road map built by the CMO – CIO partnership) being also impacted by a digital marketing considering the above-mentioned 7Ds.

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ADOPTING DECISIONS IN THE CORPORATE BANKING SECTOR: A CASE STUDY ON ROMANIA

Mihai RUSCANU[1]

Abstract

This paper examines the relationship between corporate loan growth and banking risk and how this relationship is used to adopt decisions in the corporate banking sector, using a panel dataset of 5 banks functioning in Romania over the period 2007-2021. Main findings include the following. The rise of corporate loan growth and the increasing size of the banks decrease the ratio of non-performing loans and therefore the associated risk. Usually, larger banks may have a higher reliance on debt financing instead on equity. The profitability of banks rises when the number of corporate loans is growing and falls as expected when costs increase, when a greater proportion of assets is allowed for allocated for loans and may be influenced negatively by the size of the bank. These insights have a pivotal role, leading to strategic choices to foster growth and resilience in the dynamic landscape of Romania's corporate banking area.

Keywords: corporate banking, decisions, Romania, corporate loan growth

JEL Classification: G20, G30, G32

1. Introduction

In the banking area, the needs for individuals and companies differ from one another and therefore, banks adapted their products and services portfolios to meet the requirements of the clients. Big companies need more complex banking solutions than individuals and much higher amounts of loans. This is the reason why many banks developed corporate banking areas.

Corporate banking comprehends the total banking products and services provided to large companies, usually publicly traded ones with high profit and turnover. Some examples are corporate loans, treasury and cash management services, trade finance, private equity financing. Loans enable corporations to grow even more, enabling new job opportunities for people and contributing therefore to the growth of the economy.

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To better understand the corporate banking area and its impact on a bank, a short comparison with retail banking area is necessary, carefully outlined by [1]. Firstly, corporate clients need very large loans to fund their investments. The revenue is higher because of the higher interest amount paid. Secondly, while services for retail clients are mainly standardized, the ones for corporates need to be custom tailored to their present and future needs. This helps strengthen the long-term relationship. Lastly, the different banking fees are higher for corporate clients, increasing the revenue for the bank. Because of bigger loans with higher interest and fees, together with a good long-term relationship, corporate banking turns out to be more profitable than retail banking.

Nowadays banks from all over the world offer a large variety of products and services for corporates. These range from corporate loans, trade finance, cash management to risk management solutions and capital market services. In Romania, the most common and the most important ones are corporate loans, trade finance and cash management.

Given that loans are one of the main sources of income for a bank, the changes in the amounts of loans do affect the banking risk. Some authors have studied the impact of bank loan growth on the banking risk in different countries.

Given the fact that corporate banking is of higher importance for banks because of the better financial benefits it brings, the impact of corporate loans on banking risk is of great interest. Their growth will be a crucial indicator in understanding banking financial situation, risk and how to adopt decisions to foster growth and stability. This relatively newly examined aspect will potentially help contribute to future research in the corporate banking area.

The purpose of this study is to show the impact that corporate loan growth has on banking risk in Romania and how this impact can be analyzed to make informed decisions at the management level. Key financial indicators of banks will be examined with the relationships between them and corporate loan growth together with other control variables, which will be carefully explained, considering their potential implication in shaping the decision process.

2. Literature Review

[2] conducted a study to investigate the relationships between loan growth and bank risk, profitability, and solvency. They showed that an increase in loan growth can lead to an increase in the risk faced by banks and that between profitability and bank risk is a statistically significant relationship. Rapid expansion of lending is the cause of an increase in non-performing loans and reduces the return. Even though loan growth may seem beneficial, resulting in an increase in earnings from interest and therefore to a sustainable and continuous process of financial development, if the growth is does eventually become

assertive, the corresponding rise in the banking risk will be situated on the same ascending trend.

[3] reveal in their scientific study how general loan growth impacts banking risk. According to their main findings, loan growth negatively affects non-performing loans and the ratio of equity to total assets, while positively influencing return on assets. The idea that loan growth generates notable profits for banks is supported also by [2]. Also, they provide an essential implication for banks, stating that when banks decide to create a strategy to increase loan growth, they will need to carefully weigh the balance between profitability and risk.

In a scientific study, [4] examined a sample of Islamic banks from 29 countries to find out how loan growth and capitalization influenced credit risk. The research concluded with the discovery that elevated loan growth in Islamic banks leads to an escalation in credit risk, with the effects observed one year in advance. In addition, banks with higher capital have a higher tendency to take on bigger risk.

[5] showed no correlation between loan growth and profitability but revealed a positive relationship between loan growth and non-performing loans, stronger during financial crises.

[6] undertook an investigation to see the impact of non-performing loans on the lending activities of banks. As [2] revealed, a fast expansion in lending causes an increase in non-performing loans. To enlarge this finding, [6] found out that the presence of NPL exerts a detrimental influence on lending operations of banks, as higher rates of NPL are linked to reduced growth in performing loans. Therefore, the idea outlined by [3] that banks should be careful regarding the pace of lending rhythm is of great importance taking into consideration the potentially downward trend performing loans may be situated on.

[7] conducted research to prove the existence of a positive relationship between non-performing loans and loan growth in Europe, using a dataset of 200 banks for the period 2014-2019. It was observed that the limited expansion in lending during the designated period indicates the presence of a mechanism where non-performing loans diminish bank profits, elevate funding expenses, and undermine capital. The magnitude of the impact outlined in the study suggests that removing all NPLs from the sample would lead to doubling the growth rate of bank loans. Further, the effect of NPLs is stronger when its level is lower. NPLs not only affect a bank's financial situation directly regarding the lack of future interest incomes, but also escalate the costs of obtaining funds that make lending less profitable. A crucial aspect proven in the study is that the lending growth rate is particularly more responsive and sensitive to NPLs within the corporate loan portfolio.

3. Methodology

[3] used the following research model:

$$NPL_{it} = \alpha + \beta_1 LG_{it} + \beta_2 LTA_{it} + \beta_3 CI_{it} + \beta_4 SIZE_{it} + \varepsilon_{it} \quad (1)$$

$$ETA_{it} = \alpha + \beta_1 LG_{it} + \beta_2 LTA_{it} + \beta_3 CI_{it} + \beta_4 SIZE_{it} + \varepsilon_{it} \quad (2)$$

$$ROA_{it} = \alpha + \beta_1 LG_{it} + \beta_2 LTA_{it} + \beta_3 CI_{it} + \beta_4 SIZE_{it} + \varepsilon_{it} \quad (3)$$

To adapt it to the corporate banking area, CLG, corporate loan growth, will be used instead of LG, loan growth. In the case of Equation 3, ROAA, return on average assets, will be used instead of ROA, return on assets, to provide a more precise representation because by considering the average assets, it reduces the impact of fluctuations in asset value. The final model used for regressions is the following:

$$NPL_{it} = \alpha + \beta_1 CLG_{it} + \beta_2 LTA_{it} + \beta_3 CI_{it} + \beta_4 SIZE_{it} + \varepsilon_{it} \quad (1)$$

$$ETA_{it} = \alpha + \beta_1 CLG_{it} + \beta_2 LTA_{it} + \beta_3 CI_{it} + \beta_4 SIZE_{it} + \varepsilon_{it} \quad (2)$$

$$ROAA_{it} = \alpha + \beta_1 CLG_{it} + \beta_2 LTA_{it} + \beta_3 CI_{it} + \beta_4 SIZE_{it} + \varepsilon_{it} \quad (3)$$

This model will be used to assess how Corporate Loan Growth affects key financial indicators of banks' performance, non-performing loans, equity-to-assets ratio and return on average assets ratio. Also, the potential influence that the control variables have on these relationships will be thoroughly examined. It will be outlined how these performance indicators can be used to shape the decision-making process to improve risk management, optimize performance and foster financial stability.

Fundamental analysis models such as Ordinary Least Squares (Pooled OLS) Fixed Effects Model (FEM) and Random Effects Model (REM) will be employed. The Redundant Fixed Effects – Likelihood Ratio will be used to choose between Pooled OLS and FEM. After that, the Hausman test will help choose between FEM and REM. In case both tests fail, Pooled OLS method will be used. Serial correlation tests are relevant for macro panels, +20-30 years, not being a concern for micro panels, such as in this situation, the period being 15 years.

Variable Names	Definition
Independent Variables	
CLG	Corporate Loan Growth
Dependent Variables	
NPL	Non-performing Loans

ETA	Equity to Total Assets
ROAA	Return On Average Assets
Control Variables	
LTA	Loans To Total Assets
CI	Cost to Income
SIZE	Total Assets

Table 1: Variables Definition

Corporate Loan Growth indicates how much a bank's corporate loan amount increased compared to the previous year. A positive loan growth indicator shows an expansion in the economy. Banks are responsible for this expansion by providing funds to corporates for investments. However, excessive lending creates risks, taking into consideration the possibility of the corporate borrower to be unable to pay back the loan.

Loans become non-performing when the borrower encounters financial difficulties, as cash flow problems or declining profitability and therefore cannot meet the repayment obligations. The time that must pass for a loan to be considered non-performing is usually 90, but it can be also 180.

Return on Average Assets is a metric used by banks and by companies to assess their profitability in relation to the total assets. It is obtained by dividing the net income by the average assets. A higher ROAA denotes higher profitability.

The Equity-To-Assets ratio measures the amount of equity a bank has in relation to its total assets. It is obtained by dividing net worth by the total assets. It shows the percentage of bank's assets that are financed by its equity. A higher ratio indicates a larger part of assets are financed by equity, which generally implies a stronger financial position and reduced risk.

Loans to total assets ratio measures the composition of a bank's asset portfolio, showing how many assets are reserved for loans. The Cost to Income ratio shows a bank's costs as a proportion of its income. It is calculated by dividing the operating costs of the bank to its operating income. CI is used to estimate the bank's efficiency and a lower CI ratio indicates better performance for the banks. The size of a bank is represented by its total assets. As banks grow, they expand their activities by providing new or better products and services for clients.

The data for the 5 Banks functioning in Romania was collected for a period of 15 years to provide an overview of the corporate lending growth and banking risk locally. The reason

for choosing only 5 banks is the method of gathering the data. Regarding the Corporate Loan Growth and Non-performing loans, data was unavailable in various databases, and it had to be manually collected by going through the banks' annual reports. The variables LTA, ETA, SIZE, CI, ROAA were collected from the Orbis database. The period is 15 years due to the time availability of the data.

4. Results

Variable	Observations	Mean	Standard Deviation	Minimum	Maximum
NPL (ratio)	75	10,17	7,09	1,61	29,20
CLG (ratio)	75	12,32	16,11	-17,46	80,00
ETA (ratio)	75	10,62	1,51	7,68	15,38
ROAA (ratio)	75	1,47	1,22	-4,35	5,87
LTA (ratio)	75	57,68	6,69	39,18	70,48
CI (ratio)	75	52,16	8,15	30,60	77,77
SIZE (bn RON)	75	48,09	23,22	12,82	132,49

Table 2: Descriptive statistics

Table 2 contains a summary of the statistics for the variables used in the regressions. It shows the mean, the standard deviation, the minimum and the maximum value for each indicator. The dataset had a total of 75 observations. The mean of the NPL is 10,17 and the maximum value is 29,20. The standard deviation of CLG is 16,11, while the minimum is -17,46 and the maximum is 80,00. The average ratio of ETA is 10,62 with a standard deviation is 1,51. ROAA has the largest value 5,87 and the smallest is -4,35. LTA is averaging around 57,68, jumping from a bottom value of 39,18 to a peak value of 70,48. CI

has a standard deviation of 8,15 and a mean value of 52,16. The mid-range value of the SIZE reached 48,09 billion RON with the greatest value being 132,49 billion RON and the smallest value being 12,82 billion RON.

After the data was collected, to compute the regressions, EViews statistical tool was used. In this section, all regressions will have their results outlined and discussed. The graphs showing the trendlines for the NPL, ETA, ROAA and CLG were computed in Excel.

4.1. NPL as Dependent Variable

$$NPL_{it} = \alpha + \beta_1 CLG_{it} + \beta_2 LTA_{it} + \beta_3 CI_{it} + \beta_4 SIZE_{it} + \varepsilon_{it} \quad (1)$$

Dependent Variable: NPL	OLS	FEM	REM
CLG	-0.163506***	-0.161071**	-0.163506***
	(0.050594)	(0.050958)	(0.047047)
LTA	0.137597	0.020200	0.137597
	(0.148528)	(0.176269)	(0.138118)
CI	0.033964	-0.066776	0.033964
	(0.105874)	(0.121965)	(0.098453)
SIZE	-0.060085	-0.180924***	-0.060085
	(0.040944)	(0.052535)	(0.038074)
CONSTANT	5.365280	23.17081	5.365280
	(12.94402)	(15.99940)	(12.03674)
Observations	75	75	75
Redundant Fixed Effects -Likelihood Ratio		0.0084	
Hausman Test			0.0048

The value within the parenthesis represents the standard error. ***p < 0.01, **p < 0.05, *p < 0.1.			

Table 3: Regression Results for NPL

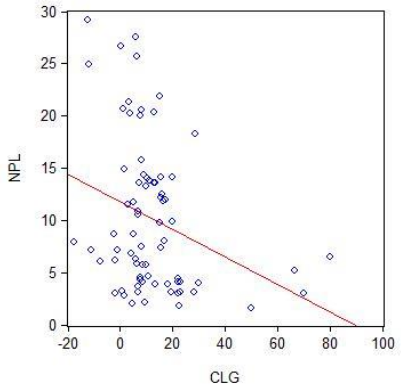

Figure 1. Relationship between CLG and NPL

The Redundant Fixed Effects -Likelihood Ratio indicates a value lower than 0.05 for the FEM model, therefore FEM is significant. To choose between FEM and REM Hausman test was used. The value is also lower than 0.05 so FEM is the right model. FEM will be used for the regression in which NPL is the dependent variable.

Corporate loans growth coefficient has a value of -0.161071 which denotes negative relationship. Hence, for an increase in corporate loan growth, NPL will be on a downward trend. The standard error is relatively small, 0.050958. P-value is lower than 0.05 meaning that the coefficient is statistically significant. Given that enterprises have a lower chance of encountering loan repayment problems, due to their financial size and the high number of transactions, an increase in CLG should be expected to decrease the overall ratio of NPL. Even though previous studies used general LG, the result is in accordance with [3].

LTA has a positive relationship and CI has a negative relationship with the dependent variable, but neither has a probability lower than 0.05. For that reason, the coefficient is not meaningful to interpret, having the relationship occurs probably because of random chance.

SIZE has a negative relationship with NPL and is statistically significant at both levels of significance, coefficient is -0.180924 and p-value < 0.01. When SIZE increases, NPL ratio decreases.

Larger banks, measured by their amount of total assets, have a smaller proportion of non-performing loans compared to smaller banks. A few reasons may be that larger banks have more diversified loan portfolios to reduce risk or that they may have much more resources to monitor and manage their loans. Other reason may be that larger banks, due to their loan capabilities, are able to have a bigger corporate loan portfolio.

4.2. Results for ETA as a dependent variable

$$ETA_{it} = \alpha + \beta_1 CLG_{it} + \beta_2 LTA_{it} + \beta_3 CI_{it} + \beta_4 SIZE_{it} + \varepsilon_{it} \quad (2)$$

Dependent Variable: ETA	OLS	FEM	REM
CLG	-0.011710	-0.004320	-0.011710
	(0.011292)	(0.010112)	(0.009336)
LTA	-0.069166*	-0.127078***	-0.069166**
	(0.033150)	(0.034979)	(0.027408)
CI	-0.034319	-0.034870	-0.034319*
	(0.023630)	(0.024203)	(0.019537)
SIZE	-0.013434	-0.022434*	-0.013434*
	(0.009138)	(0.010425)	(0.007555)
CONSTANT	17.18745***	20.89835***	17.18745***
	(2.888954)	(3.174948)	(2.388590)
Observations	75	75	75
Redundant Fixed Effects -Likelihood Ratio		0.0000	
Hausman Test			0.0000
The value within the parenthesis represents the standard error. ***p < 0.01, **p < 0.05, *p < 0.1.			

Table 4: Regression Results for ETA

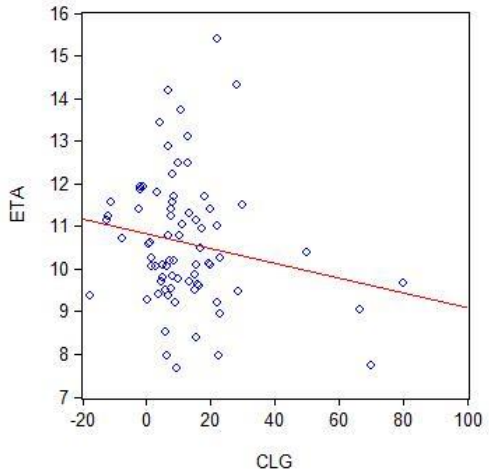

Figure 2. Relationship between CLG and ETA

Like in the previous regression, The Redundant Fixed Effects - Likelihood Ratio value is lower 0.05 for the FEM model, making it significant. The Hausman Test value is also lower than 0.05 so FEM is the right model.

The coefficient for Corporate Loan Growth (CLG) in the regression model is -0.004320, illustrating a negative connection. When CLG increases, Equity to Total Assets (ETA) decreases. But the p-value is not lower the 0.05, being higher than 0.1. This means that the result is not statistically significant. The evidence in the data is proven to not be sufficient to support the presence of a significant relationship. The possibility of a connection between ETA and LG may be proven in future research. A short explanation is provided below in the case of the existence of this correlation.

Banks may rely more on debt financing rather than equity. It can be a good strategy for expansion and investment opportunities, but it increases the exposure to financial risk. A higher debt-to-equity ratio can create vulnerability to negative changes in the economy. One possible explanation may be that given the amount of a corporate loan and the desired pace associated with CLG, existing equity may not be sufficient to fund all the loans. In this scenario, debt financing is an easier solution, but not necessarily better.

LTA has a negative bond with ETA, coefficient value is -0.127078, and is statistically significant at both levels of significance, p-value is lower than 0.5 and 0.1. When LTA

increases, ETA decreases. If a larger amount of assets is allocated towards loans, a smaller amount is allocated to equity. A decreasing ETA may indicate a higher reliance on debt, which may raise risk.

CI has a negative connection but is not significant. SIZE also has a negative relationship but is marginally significant. The p-value may be detected as higher than 0.05. Given that its value is closer to significance, it is worth interpreting. Therefore, when SIZE increases, ETA decreases. This bond suggests that larger banks tend to have a lower equity to assets ratio. The conclusion that banks have greater reliance on debt financing rather than equity financing is trustworthy especially when discussing leading banks.

4.3. Results for ROAA as a dependent Variable

$$ROAA_{it} = \alpha + \beta_1 CLG_{it} + \beta_2 LTA_{it} + \beta_3 CI_{it} + \beta_4 SIZE_{it} + \varepsilon_{it} \quad (3)$$

Dependent Variable: ROAA	OLS	FEM	REM
CLG	0.024245***	0.025566***	0.024245***
	(0.008631)	(0.009101)	(0.008403)
LTA	-0.057479**	-0.043724	-0.057479**
	(0.025339)	(0.031481)	(0.024668)
CI	-0.050670***	-0.055996**	-0.050670***
	(0.018062)	(0.021783)	(0.017583)
SIZE	-0.011846*	-0.004875	-0.011846*
	(0.006985)	(0.009383)	(0.006800)
CONSTANT	7.666071***	6.798807**	7.666071***
	(2.208219)	(2.857465)	(2.149740)
Observations	75	75	75
Redundant Fixed Effects -Likelihood Ratio		0.1101	
Hausman Test			0.0968

The value within the parenthesis represents the standard error. ***p < 0.01, **p < 0.05, *p < 0.1.			

Table 5: Regression Results for ROAA

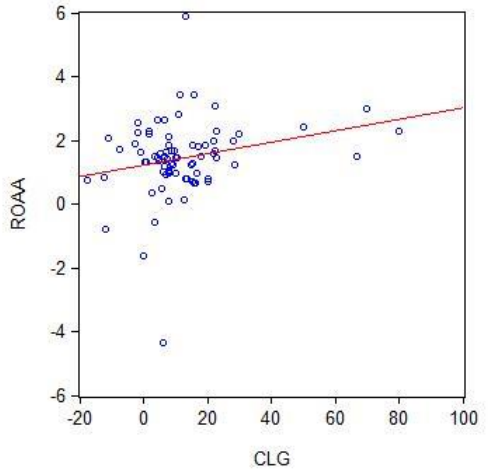

Figure 3. Relationship between CLG and ROAA

The Fixed Effect Test's value is higher than 0.5. In this case, the fixed effects are redundant, and the FEM is not appropriate. The Hausman Test value is also higher than 0.05. In conclusion, the REM model is the most appropriate to use when ROAA is the dependent variable.

CLG has a positive connection with ROAA (0.024245) and is statistically significant at both levels of significance (p-value lower than 0.05). When CLG increases, ROAA increases. The profitability of the bank is therefore on an upward trend. The increase in CLG indicates that the bank is effectively extending credit to corporate clients, which automatically leads to higher incomes from interest rates. A higher demand for financing may also be observed.

LTA has a negative relationship (-0.057479) and is significant. This finding exposes the fact that when LTA increases, ROAA decreases. The ability to generate funds from assets is diminishing as the amount of assets allocated to loans grows. A few reasons may be lower interest rates or bigger loans loss provisions. A lower LTA ratio may indicate that banks are prioritizing a conservative lending approach where risk management is crucial. Lower

interest rate may also result from the fierce market competition, forcing banks reduce interest earnings to continuously attract new corporate customers and remain competitive.

CI also has a negative bond. Coefficient value is -0.050670 and p-value lower the 0.1, being significant at both levels. A rise in CI leads to a fall in ROAA. This result is expected, as operating costs increase, profitability is reducing. Costs may come from various sources and their rise if subject to a lot of internal and external factors. [8] outlines some of the possible sources, from taxes and employee wages to utility expenses and sales and marketing expenses.

SIZE is also taking part in a negative connection with ROAA but is marginally significant. P-value lower than 0.1. This, as pointed out previously, may be because of the limited size of the sample. A truly significant relationship is possible to appear in future research. Therefore, interpreting this variable is of interest. As SIZE increases, ROAA decreases. Larger banks confront themselves with lower profitability. This may be due to a few key reasons. Firstly, the complexity of their operations can include higher operating costs and regulatory requirements. Secondly, leading banks may encounter greater competition and pronounced market saturation, thus reducing earnings.

5. Implications for Decision-Making in Corporate Banking

Understanding the dynamics of the corporate banking sector is essential for proper and informed decisions, planning and risk management. The relationships presented earlier are of great importance for practitioners, policymakers, and financial institutions by providing valuable insights.

One of the main findings of this study is the negative relationship between corporate loan growth and non-performing loans. This indicates that a focus on expanding the corporate loan portfolio can contribute significantly to risk mitigation. Therefore, banks can take advantage and optimize the loan portfolio to expand to institution size and increase the profits, with strategies that foster growth and enhance asset quality, lowering NPL so that they enhance the overall stability and resilience of the institution. Possible actions decision-makers might adopt using this insight are consisting of an increase in the marketing activities to attract new corporate customers, a more streamlined loan approval process and new expansion strategies to capitalize on economies of scale. The negative relationship between SIZE and NPL emphasizes the importance of scale. Decision-makers can leverage the advantages of size to minimize risk, possibly through diversified lending practices and enhanced risk monitoring capabilities.

The negative bond between loan-to-assets ratio and equity-to-assets ratio signifies that a higher allocation of assets to loans is associated with a decrease in equity. This underscores the trade-off between risk and return, suggesting that a conservative lending approach,

where assets are not heavily concentrated in loans, may contribute to a more resilient equity position. Possible actions would be assessing the optimal balance between debt and equity financing, considering the bank's size and implementing measures to diversify the asset portfolio and mitigate the potential risks associated with a high concentration of loans.

The positive relationship between corporate loan growth and Return on Average Assets provides a valuable insight. Actively extending credit to corporate clients positively impacts Return on Average Assets. Strategic initiatives can be aligned with CLG, potentially capitalizing on increased demand for financing and higher interest rate incomes. Possible actions to be taken are to promote corporate loans while closely monitoring the impact on operational costs and to consider implementing cost-cutting measures.

However, the negative relationship between SIZE and ROAA provides another perspective. Decision-makers should assess operational efficiency, considering factors such as regulatory requirements and market competition, because as operational costs rise, profitability diminishes.

Additionally, by using the evolution trends of the NPL, ETA and ROAA, CLG as seen in Figure 4, Figure 5, Figure 6 and Figure 7, decision-makers gain valuable insights. The downward trend in NPL indicates effective risk management strategies. To enhance these, decision-makers could refine credit-assessment procedures or lending criteria. The upward trend in ETA suggests that there is a strengthening of the equity position, suggesting lower risk and greater financial stability. The constant trend of ROAA can be interpreted as a sign of operational efficiency and consistent financial performance. The downward trend in CLG indicates a possible need for reassessment of the lending strategies. Solutions such as new market segments or better loan products could change the trajectory of the trend.

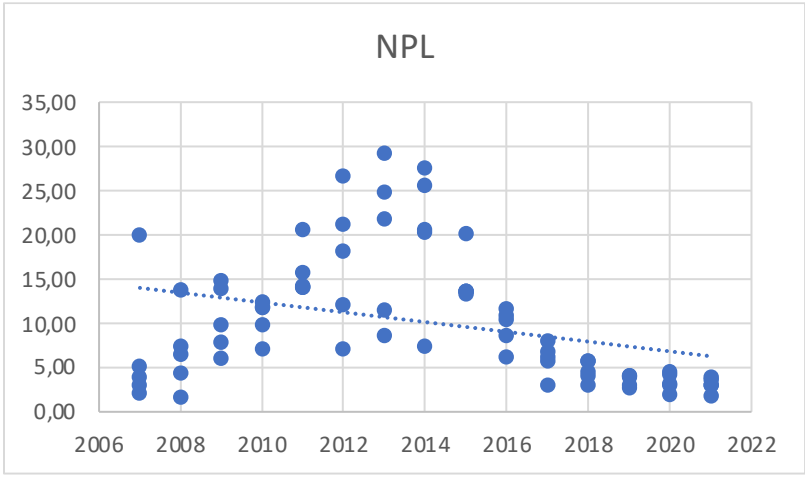

Figure 4. NPL Trendline

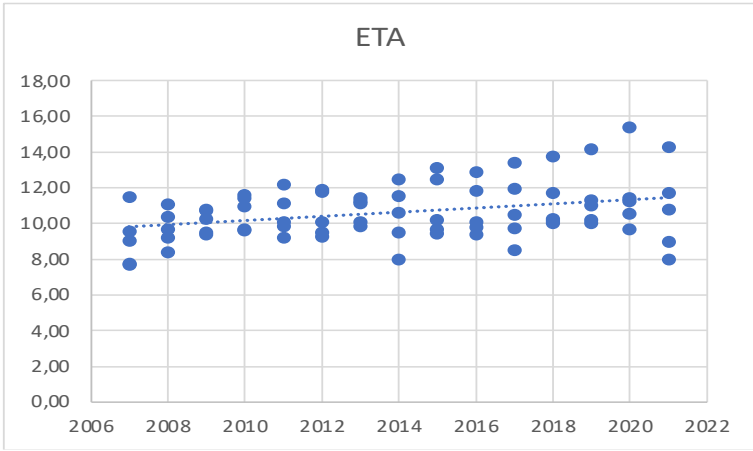

Figure 5. ETA Trendline

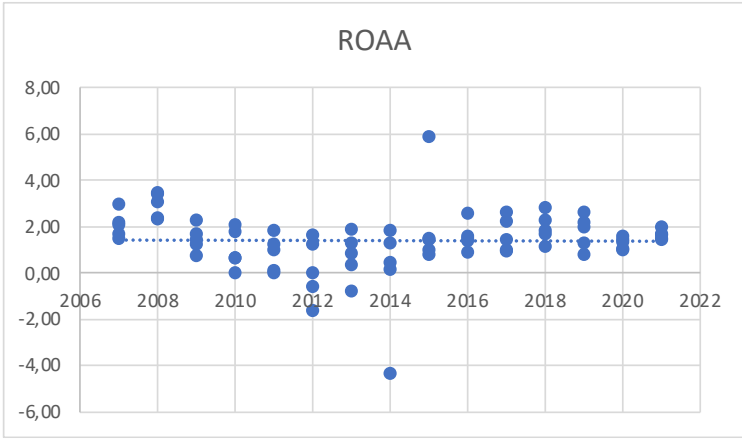

Figure 6. ROAA Trendline

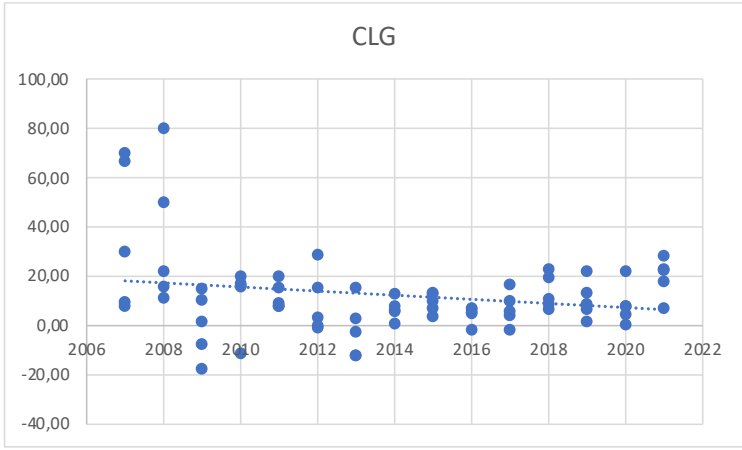

Figure 7. CLG Trendline

6. Conclusions

This study presented the how decisions are adopted in the corporate banking sector in Romania. Based on a panel dataset of 5 banks over the period 2007-2021, multiple regressions were computed to examine the kind of relationships that exist between corporate loan growth, together with control variables such as loans-to-assets ratio, cost-to-income ratio, the size of the bank measured in total assets, and key banking financial indicators such as non-performing loans, equity-to-total assets ratio and return on average assets.

The main findings show that NPL decreases as CLG and SIZE increase. ETA decreases when SIZE and LTA increases. ROAA increases when CLG increases and decreases when LTA and CI and SIZE increase. Therefore, it can be concluded that corporate loan growth plays an important positive role in influencing crucial banking indicators, improving profitability, and reducing risk and uncertainty related to non-performing loans. These findings are of great importance for decision-makers. They should prioritize strategies that foster CLG and operational scaling to reduce NPL and improve stability. Also, asset allocation is crucial to maintain a resilient equity position.

This study can theoretically improve research in terms of the importance of corporate loans in banks everyday activity and how they are used to adopt decisions, those being the most common banking corporate service. A broader view of their impact on risk mitigation, profitability enhancement and decision role could be observed and studied on research involving a larger scale, extending beyond borders of Romania, to Europe or worldwide. Further, conducting a longitudinal study over an extended period can provide deeper insights on the dynamic behavior of the relationship between corporate loan growth and banking risk and how decisions are adopted in the corporate banking area.

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NON-FINANCIAL REPORTING - A CRUCIAL COMPONENT IN ASSESING THE GLOBAL PERFORMANCE OF THE ECONOMIC SUSTAINABILITY OF THE ENTITY

Marilena ZUCA[1]

Abstract

In the modern business environment, non-financial reporting—such as sustainability and corporate social responsibility reports—is becoming a more significant trend. The term "non-financial reporting" describes how economic organizations fulfil their obligations to the environment, to employees, to diversity and inclusion, to human rights, to governance concerns, and to prevent bribery and corruption. Significant effects of non-financial reporting are felt by a variety of stakeholders, including customers, workers, investors, and the general public. The results of the research clearly showed the high levels of interest, perception, and expectations of these parties with respect to the accuracy and reliability of non-financial information, as well as the necessity of finding new methods to improve the accountability and transparency of economic entities in this area.

Keywords: non-financial reporting, performance, sustainability, transparency, corporate social responsibility, sustainability accounting, non-financial statement

JEL Classification: M41

1. Introduction. Non-financial information: conceptual approaches, history.

An economic entity's decision-making process is based on financial accounting data. Its job is to give users - both internal and external - competitive advantages so they can arrive at and support the best decisions. Hence, for accounting to serve its intended function, the data it produces must be of high quality, meaning it must possess certain qualities that guarantee its applicability to everyone with an interest in the entity's financial operations.

Since the early 1990s, the interest and concerns of shareholders/associates, investors, and customers have gradually increased regarding the disclosure of non-financial information (NFI), and stakeholders now view this information as essential to evaluating the company's long-term viability and success.

Non-financial information refers to additional disclosures made by companies that are usually voluntary. However, the increasing adoption of voluntary disclosures is seen by specialists as a transformation of conventional accounting focused on ways to extend

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current practices and/or develop new forms of reporting and financial accounting highlighting.

The purpose of this accounting transformation is to detect and report information that is useful "*for identifying sustainability risks and increasing investor and consumer confidence" [1].*

Since there is no standard name for non-financial information in this context, reports that disclose non-financial information have been identified using a variety of terminology in specialized literature. Examples of these terms include sustainability reporting, environmental reporting, and reporting integrity.

Furthermore, prominent organizations like the Sustainability Accounting Standards Board (SASB), Task Force on Climate-related Financial Disclosure (TFCD), International Integrated Reporting Council (IIRC), Global Reporting Initiative (GRI), and International Integrated Reporting Council (IIRC) have demonstrated a growing interest in the disclosure of non-financial information in both voluntary and required corporate reports in recent years. As a result, these organizations have created standards and guidelines that are typically used to write non-financial reports and determine their content.

Directive 2014/95/EU, which requires member states to make non-financial statements for entities of great public interest, was created by the European Union in response to its emphasis on the need for greater transparency from businesses regarding their financial and non-financial performance. The directive refers to non-financial information and provides examples of it but does not provide a definition in this sense.

However, at the level of the European Union Commission it has been stated that "non-financial information (NFI) is generally environmental, social and governance (ESG) information", thus identifying what is relevant in this type of reporting[2].

As a result, the use of non-financial reporting terms has increased; yet, their definitions are still not widely agreed upon. This renders these terms up to the users' discretion, and the ideas and comprehension of non-financial reporting are limited to the corporation and its stakeholders.

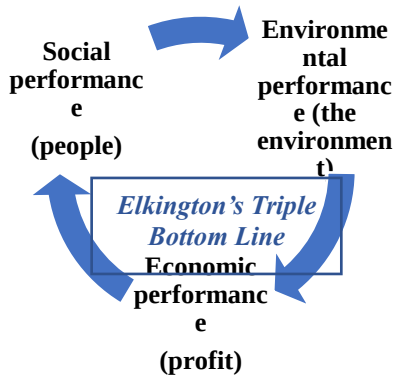
Companies may be able to comprehend and disclose a variety of non-financial information more accurately and transparently if there were an accepted standard for them. This is especially important when it comes to the requirement for the reporting of non-financial data because of the negative economic effects on businesses that could result from regulatory infringement and harm their reputation. A lack of shared understanding, opacity, and confusion over non-financial information could result from low comparability of reporting. These problems may lead to discrepancies in expectations, such as those among stakeholders, legal obligations, and the actual reporting of non-financial data.

The following ideas about non-financial information have found relevance in the specialized literature because it was determined that, in the context of the EU directive, it is necessary to comprehend the term "*non-financial information*" and to develop a thorough and widely accepted definition*:*

- Non-financial data pertains to corporate social responsibility and encompasses the company's actions, policies, and influence on environmental and social matters [2];
- Non-financial data pertains to the performance of businesses. This term refers to the disclosure of a business's total performance, taking into account all of its outcomes rather than just the social and environmental sectors [3];
- Non-financial information pertains to the production of value and is regarded as data that is not included in the financial accounts. The most important thing to consider in this instance is whether the information is disclosed inside or outside of the financial statements [4];
- Non-financial information is regarded as non-accounting information since it is external to financial information and unrelated to financial and economic statistics [5];
- Information about governance, the environment, society, and sustainability in general is regarded as non-financial information [6].

In summary, the definition of non-financial information is naturally linked to information of an economic-social character and is influenced by the particulars of the national and cultural contexts of each economic organization. Any data that the company reports which is not related to its finances is considered non-financial data. In other words, non-financial reporting is a form of simple, transparent reporting in which economic entities formally disclose certain information that is not related to their finances, including human rights information, thus helping organizations to measure, to understand and communicate impact, as well as set goals and manage change more effectively.

The "Elkington's Triple Bottom Line" model, a reporting structure developed by John Elkington [7], is a pertinent model for non-financial data. Its triple bottom line represents a company's social, economic, and environmental performance, or its people, profit, and the earth.

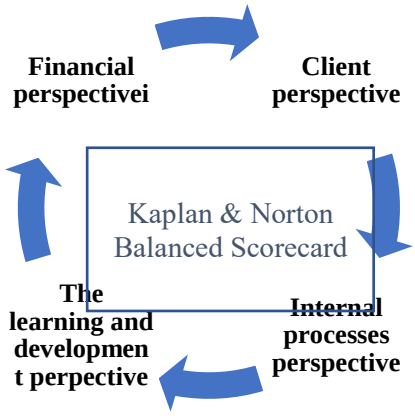


Source: adaptation after Elkington, John, (1998). Cannibals with forks: the triple bottom line of 21st century business. Gabriola Island, BC; Stony Creek, CT: New Society Publishers

Even though the model incorporates a financial reporting component, the framework implies that there are other non-financial methods for evaluating a company's success. The framework's underlying theory was that conventional methods of evaluating a company's performance and success were out of date and that all three elements had to be considered in order to accurately calculate the overall cost of the enterprise's operations:

1. The people aspect describes the company's social performance and evaluates its level of social responsibility. Unfortunately, it is challenging to choose which characteristics to measure and report with reliability, making the human aspect more difficult to quantify.
2. The profit aspect refers to the financial situation of the company. This is the traditional way of measuring business performance.
3. Sustainability/Planetary Aspect: describes the business's environmental performance and assesses how environmentally conscious or irresponsible it is. (For instance, the company's yearly CO2 emissions indicator can be used to calculate the planet factor.)

Another non-financial data model considered relevant is the Kaplan & Norton Balanced Scorecard which is another way to measure business performance by combining financial and non-financial data [8]. This is both efficient and successful since it allows us to observe both the financial and non-financial parts of the firm and determine whether it is currently reaching its goals. The dashboard presents a balanced summary of the company's performance from four distinct angles: the financial, customer, internal business process, and learning and development viewpoints. This approach highlights how important it is to maintain a balance between financial and non-financial data when assessing the performance of a firm, as centering all of the goals and tactics around a single facet of the enterprise may have an adverse effect on its performance.



Source: adaptation after Kaplan R., Norton D., (1996). The Balanced Scorecard: Translating Strategy into Action. Harvard Business Review Press

2. Literature review

Sustainability and non-financial information are now major concerns for investors, regulators, consumers, and shareholders. Investors, shareholders, banks, and regulators expect more standardization from companies to drive accountability and include non-financial factors in reports, regulations, and agreements. Capital market participants are paying more attention to the reporting of non-financial information. This endeavor has been intensified by the Covid-19 issue, diversity and inclusion, and an increasing worldwide attention on climate change.

One obstacle that many businesses face is the challenge of adjusting standard reporting to the complexity of non-financial data. Non-financial information finds it difficult to become credible in the eyes of stakeholders, whereas financial reporting is by its by nature quantitative, verifiable, and trustworthy [9].

By measuring, tracking, and reporting their sustainability performance, businesses can assist in improving society, the economy, and the prospects for sustainability. Because there is no mandated legislation in this area, firms are free to write their statements whatever they see fit when it comes to reporting. Nonetheless, several initiatives—national, European, and international—have created standardized techniques to assist businesses in creating their sustainability reports, which are required by the European Directive 2014/95/EU to be acknowledged by the businesses that utilize them [10].

The Global Reporting Initiative (GRI) guidelines are the primary determinant of the quality of sustainability reports, since they are the most extensively utilized benchmark for businesses worldwide due to its dependability [11] and the fact that it offers opportunities to compare data about the effects that businesses have on the economy, the environment, and society globally [12].

Directive 2014/95/EU, often known as the Non-Financial Reporting Directive or NFRD, establishes a unified regulatory framework for non-financial information for the member states of the European Union. This directive serves as the foundation for the legislative framework for sustainability reporting practices in Europe. That directive applies to large public interest companies with over 500 employees on average during the financial year, both single companies and consolidated groups of companies. Companies falling within the scope of the directive must also have a total balance sheet exceeding EUR 20 million and/or a turnover exceeding EUR 40 million, as applicable, on a consolidated basis. By 2021, around 11,600 companies in Europe were within its scope [13].

Directive 2013/34/EU on the declaration of non-financial information and on diversity by specific enterprises and large groupings of companies is amended by Directive 2014/95/EU of the European Parliament and of the Council on October 22, 2014. Directive 2013/34/EU introduces two new paragraphs, 19a and 29a, which for the first-time force certain businesses to provide information about how they conduct business and handle social and environmental concerns. This amended directive is applicable to all EU members, who are required to take the legislative and administrative measures required to comply with it.

In order to alleviate the administrative burden of reporting on businesses and enhance the quality and dependability of non-financial reporting, a reform process of Directive 2014/95/EU was started in January 2020. In order to get feedback and opinions from different stakeholders regarding the revision of the directive's provisions, a wide public consultation was also held from February to June 2020. As a result of this consultation, the European Commission proposed on April 21, 2021, to amend the NFRD by introducing the Corporate Sustainability Reporting Directive (CSRD) [13]. The EU claims that by providing a uniform standard, it will lower the costs associated with reporting for businesses and enhance how stakeholders and investors evaluate and use the data that is presented.

In terms of goods and services, employment possibilities, human rights, health, the environment, innovation, education, training, and development, as well as working conditions, all these factors have a big impact on life in the EU and beyond. In addition, EU residents anticipate that businesses will be conscious of their positive and negative effects on the environment and society and will take steps to prevent, manage, and mitigate any negative effects, particularly those resulting from their international supply chains.

This duty is called *corporate social responsibility (CSR) or responsible business conduct (RBC*). Financing economic activities that support environmental, social, and governance-related goals is crucial for promoting sustainable growth, funding the ecological transition, and unlocking the necessary investments to achieve, among other things, the EU goal of climate neutrality by 2050, all within the framework of the 2019 European Ecological Pact. The EU is now well on its way towards improving corporate transparency and accountability for social and environmental issues thanks to the enactment of Directive 2014/95/EU on the disclosure of non-financial information and diversity, also known as the "Non-Financial Reporting Directive" or NFRD. The Directive is a crucial instrument for furthering the corporate social responsibility agenda of the European Union (CSR).

The Commission declared on December 11, 2019, in its Communication on the European Green Deal [14] that it will be reviewing the NFRD as part of its plan to solidify the groundwork for sustainable investment. Many inadequacies in the NFRD's implementation were discovered during a public consultation that was held between February and June 2020. These inadequacies included the lack of comparability, reliability, and relevance of the non-financial information that was provided.

The Commission determined that a new approach to financing sustainable growth was required, acknowledging the private sector's critical role in funding the green transition and the requirement for long-term signals to steer capital and financial flows towards green investments and away from stranded assets. The NFRD will be revised as one of the many initiatives that will be the focus of the new strategy. As highlighted by the European Commission, it is important that companies and financial institutions also improve their disclosure of non-financial information so that investors are fully informed about the sustainability of their investments.

Users of non-financial information, primarily investors and civil society organizations, are now demanding more and better from companies about their social and environmental

information, performance, and environmental impact. This is despite the fact that the adoption of the NFRD in 2014 was a significant step towards greater transparency and business accountability on social and environmental issues.

3. Research methodology

This study examines the non-financial reporting system using rules created by the European Union, and it falls under the broader research field of financial reporting. The study is trying to establish itself within the positivist movement and be connected to interpretive, critical, and comparative aspects of the research object. Most of the study is quantitative.

The method, which is deductive in nature, begins with accepted ideas and theories, evaluates arguments for and against the topic under consideration, and pushes for the achievement of the highest level of non-financial reporting integration. By enhancing the specialized literature and providing a clear overview of the current situation, the quantitative research ensured that information was organised and explained**.** It also helped to establish a clear perspective on non-financial reporting as a crucial component for evaluating the sustainability of the economic entity's global performance.

The study of specialized literature focused on the three types of information sources identified by Saunders [15]. Primary sources include first drafts of work in their raw form, which may be reports, manuscripts in progress for publication, or other early-stage studies. Secondary sources have a much wider scope, they are usually accessible to the public and subject to review by it and include books, publications, scientific journals. Bibliographies, encyclopedias, and dictionaries are examples of synthesis publications, which are considered tertiary sources and are studied in order to complete other resource categories. An essential component of the research process, the deepening and revision of the specialized literature allowed the achievement of a comprehensive perspective on the investigated issue, both from the point of view of the state of knowledge and the research trend in the field, as well as of the main questions that require further answers or revealing some aspects, still insufficiently explored. The European Parliament and Council of the EU's legislation, as well as reports from standard-setters and other organizations like the Task Force on Climate-related Financial Disclosure, the Sustainability Accounting Standards Board, the Global Reporting Initiative, and the International Integrated Reporting Council (IIRC), were given special consideration. (TFCD).

4. Non-financial reporting: a major step towards integrated reporting

Non-financial information is often defined as environmental, social and corporate governance (ESG/ESG) information, referring to the three central components in measuring a company's sustainability and social impact. This information and non-financial reporting are a form of transparency reporting where companies formally disclose

certain information that is not related to their finances, including human rights information. The multidimensional idea of the Corporate Sustainability Report (CSR) and the European stakeholder approach of corporate governance, which emphasizes the significance of understanding the firm as an entity in connection to its environment, are the origins of the practice of non-financial reporting. Freeman's theory states that in addition to the company's shareholders, other stakeholders must be taken into account, including its workers, clients, suppliers, local communities, governments, and society as a whole. With the emergence of this approach, the first response of many companies was to expand the communication of their achievements in terms of social responsibility. The information communicated by the companies themselves are the first indicators that can be received by the public to check whether the decisions taken respect the announced commitments as well as their own interests [16].

As a result, accountability is typically integrated with reporting and focuses on the stakeholders of the business. This indicates that investors and society at large are thoughtful about the future generations.

Although non-financial information reporting has been done in bits and pieces since the 1980s, it has truly taken off in the last 20 years. This is mostly because everyone is aware of the ecological catastrophe and wants sustainable growth, but it's also because of the financial crisis of 2008 and the numerous corporate governance scandals involving big businesses over the past 20 years, such as the Enron scandal and the Parmalat financial scam.

In this context, the need to report non-financial information gradually emerged. This was done by companies initially on a voluntary basis, with the aim of alleviating some of the skepticisms of users of financial reports and restoring the confidence of stakeholders by expressing a desire to behave responsibly [17]. As a result, the release of non-financial reports started out randomly and was restricted to a small number of subjects that the corporations themselves thought would be interesting. Later, a copycat effect and subtle influence from interested parties helped this approach be renewed and accepted. It progressively became more systematic, and these reports are now typical: each year, they are published by 93% of the 250 biggest firms in the world.

The rules were created with the goal of providing companies with a defined methodology as well as making the released statistics easy to interpret, reputable, and comparable for their users. Reporting guidelines are provided either by private non-governmental organizations (and thus voluntary adoption by businesses) or, in some countries, by governments based on imposed criteria.

Adopting sustainability reporting has had a positive impact on company performance and value, according to industry experts, with the Organization for Economic Cooperation and Development (OECD) itself suggesting that companies that show sustainable performance on MSG/ESG criteria and communicate effectively about them appear to enjoy better financial performance [18].

The topic of non-financial reporting has become a recurring theme in recent years, and the

practice has been increasingly professionalized. However, the framework surrounding such reporting is constantly evolving and companies are increasingly challenged by the form, content, and process of their reporting. While this need generates numerous opportunities for businesses, investors, consumers, and all stakeholders, it also introduces several obstacles. Indeed, for sustainability statements to be relevant and meaningful, the information presented must be verifiable and comparable, as well as practical and reliable.

5. Reporting on sustainability

Sustainable development and non-financial data show two unique methods of investigation. The first line is a philosophical debate concerning responsibility, if and how it contributes to sustainable development, and what efforts must be taken to achieve it. This strategy is based on a completely new accounting system meant to encourage a long-term strategy. The second line is the management perspective associated with various terms and tools for sustainability. This could be seen as an extension or modification of conventional financial costing or management accounting [19].

The emergence of sustainable accounting as a new field of study in accounting enables a thorough revaluation of the relative importance of social, environmental, and economic advantages and risks as well as how they interact with corporate accounting systems. during several time periods from 1971 to 1980, 1981 to 1990, 1991 to 1995, and up to the present. These periods distinguish empirical studies, normative statements, philosophical discussions, curricula, literature, and regulatory frameworks [20]. During the years 1991–1995, environmental accounting virtually completely dominated the social accounting field. Along with the creation of a framework to direct the use of environmental auditing and, specifically, the creation of environmental management systems, there have also been a number of expansions from environmental disclosures to environmental audits. The regulatory environment governing social and environmental accounting disclosures was weak, and social and environmental issues and non-financial quantification were not included in conceptual frameworks for accounting. While progress has varied among nations, it has been swift when compared to the field of social accounting disclosures.

The concept of sustainability and the role of management accounting in promoting sustainable development has grown in popularity. More ideas and major statistical work, as well as a growing body of measures on sustainable development accounting, are being made in many international and national contexts by re-examining the foundations of accounting in light of sustainable development concerns [21].

International policy bodies such as the United Nations and the OECD have sponsored work addressing sustainability accounting [22], with environmental accounting being the most advanced form of sustainability accounting and increasingly processed in academia since the work of Robert Hugh Gray in the early 1990s and through the publication of the Sustainability Accounting Guidelines at the 2002 World Summit on Sustainable

Development [23]. Sustainability components of accounting and reporting are now highly significant, useful, and realistic thanks to creative experimentation with new reporting by organizations with extensive accounting experience.

Over the last two decades, sustainability accounting has gained prominence. Many organizations use innovative financial disclosure methods and approaches to give information about their main activities and the influence they have on the environment and the social environment. As a result, stakeholders, suppliers, and government agencies demand a deeper understanding of how businesses manage their resources in order to fulfil their goals of sustainable development.

According to common definitions, there are three key dimensions of sustainability, each dimension focusing on different sub-dimensions [24]:

- Environmental factors: energy, water, greenhouse gases, emissions, hazardous and non-hazardous waste, recycling, packaging.
- Social: community investment, working conditions, human rights and fair trade, public policy, diversity, safety, anti-corruption.
- Economic: accountability, transparency, corporate governance, stakeholder value, economic performance, financial performance.

The Organization for Economic Cooperation and Development (OECD) and the United Nations Commission on Sustainable Development (UNCSD) are two key players in developing a policy framework that better integrates the three dimensions of sustainability by decoupling economic growth from environmental pressures. On the one hand, UNCSD focuses solely on the environmental dimension of sustainability reporting in accounting, whereas the OECD (Organization for Economic Cooperation and Development) focuses solely on two frameworks, the analytical and accounting frameworks.

The OECD offers two different approaches to the accounting framework for sustainability accounting: measuring environmental-economic-social inter-relationships and welfare-based approaches. Measuring environmental-economic-social inter-relationships requires a clear understanding of the relationships that exist between the natural environment and the economy. Physical flow accounts are useful for showing the characteristics of production and consumption activities. Some of these accounts focus on the physical exchange between the economic system and the natural environment. Welfare-based approaches to sustainability are concerned with the conservation of the stock of wealth [25].

Sustainability is defined as the preservation of a country's capital base and can thus be quantified. These financial accounts, which are measured over an accounting period of time, also incorporate a number of environmental changes. Another motivation, according to specialists Möller and Schaltegger, is to assist in decision-making [26]. They claim that making decisions based just on financial data is, at most, shallow and that, in some commercial domains, financial data cannot be used to reliably evaluate organizational learning, customer satisfaction, and product quality.

The majority of experts in the sector suggest combining non-financial and financial data to enable well-informed decision-making. This conclusion results from the necessity of a long-term vision for sustainability, which is expressed in strategic planning. Companies that emphasize sustainability practices have higher financial performance, as measured by profit before tax, return on assets and cash flow from operations, as well as higher compared to their peers.

Furthermore, it is suggested by Adams [27] and Frost [28] that better business performance may follow from greater government participation. Also, it is anticipated that the growing need for non-financial information by investors and shareholders will lead to higher transparency through the implementation of uniform standards for reporting. Even if sustainability and financial performance are positively correlated, transparency still needs to increase to satisfy investors and shareholders.

6. The impact of Directives 2013/34/EU and 2014/95/EU on Romanian accounting legislation

In the second half of 2016, certain large companies and groups replaced in Romania annual, consolidated financial statements and related reports of certain types of companies, as well as non-financial information and diversity information, under *Directive 2014/95/EU* of the European Parliament and the Council of Europe, which was adopted in October 2014 and amends Directive 2013/34/EU regarding the presentation of financial statements. Directive 2014/95/EU modifies Directive 2013/34/EU by introducing the requirement for certain types of organizations to report non-financial performance and how they carry out their own policies for guaranteeing diversity at the top management levels. According to the rules of the legislation, this Directive applies to large firms (large undertakings) and groups of companies (large groups). They were carefully picked because the majority of them operate in many member states and have a significant impact on the environment and society, making them entities of public interest.

The Directive specifies a minimal set of data that must be provided for non-financial reporting, including: "a brief description of the company's business model"; a description of the policies that the company has implemented regarding "environmental aspects, social and personnel aspects, respect for human rights, and the fight against corruption and bribery"; an analysis of the primary risks related to the previously mentioned aspects, not only at the level of the company's operations but also with regard to "its business relationships, its products or services that could have a negative impact"; non-financial performance indicators that are pertinent to the company "submissions and additional explanations regarding the amounts reported in the annual financial statements"[1].

Another component of Directive 2014/95/EU refers to diversity policy, which is embodied in the mandatory inclusion of "a description of the diversity policy applied to the administrative, management, and supervisory bodies of the company" in the "statement on corporate governance" (according to article 20 of Directive 2013/34/EU). This description

must be written and include information such as "age, gender, education, and professional experience, the objectives of the diversity policy, how it was implemented, and the results during the reporting period" (art. 20, point (1), letter (g)). This obligation, established by Directive 2014/95/EU, is the focus of European institutions' efforts to promote gender equality at the level of management and control in the case of companies and groups of companies, with provisions that specifically target companies listed on European stock exchanges.

In compliance with this directive, the Public Finance Minister's Order No. 2844/2016, and the Minister of Public Finances' Order No. 1938/2016, which approve the Accounting Regulations regarding individual annual financial statements and consolidated annual financial statements in accordance with International Financial Reporting Standards, cover the accounting of autonomous governments and institutions in which the state holds a majority stake. These entities are considered to be of public interest from the standpoint of OMFP 1802/2014. Commercial companies whose securities are admitted to trading on a regulated market, and which employ an average of more than 500 people, have to publish information in two ways.

As a result, these companies have the option of preparing a separate report that is either published within a maximum of 6 months of the balance sheet date, or they can choose to include a non-financial statement in the Directors' Report. The non-financial statement specifies the reporting framework to be utilized, and this has to be adhered to.

The category of public entities that are credit institutions (with more than 500 employees) are required, as of 2018, to include in the Administrators' Report a non-financial statement that includes details on the economic, social, and environmental performance related to the previous financial year. This is in accordance with Order No. 7/2016 of the National Bank of Romania regarding the amendment and completion of NBR Order No. 27/2010 for the approval of the Accounting Regulations in accordance with the International Financial Reporting Standards, applicable to credit institutions, and the NBR Order no. 6/2015 for the approval of Accounting Regulations compliant with European directives.

Additionally, the Administrators' Report needs to include:

a. a brief description of the entity's business model;
b. an explanation of the entity's policy in relation to these topics, including the screening techniques used;
c. the outcomes of the relevant policies;
d. the principal risks associated with these problems resulting from the entity's operations, including, if relevant and appropriate, its business partnerships, products or services that may have a negative impact on those sectors, and how the company manages those risks;
e. Non-financial key performance indicators that are pertinent to the particular operation of the company. The non-financial statement must include a precise and well-reasoned explanation of this alternative if the business chooses not to adopt policies pertaining

to any one or more of the factors listed in paragraph (1).

According to Romanian law, non-financial reporting must be completed and submitted as a non-financial statement for inclusion in the directors' report. Additionally, there are guidelines regarding how diversity-related content, particularly gender-related content, must be presented. In 2018, the Minister of Public Finance's Order No. 470/2018 introduced points 492–6 to OMFP 1802/2014, adding a new section. The European Commission's Communication "Guide on reporting non-financial information (methodology for reporting non-financial information)" (2017/ C 215/01) should be followed when providing non-financial information. It was published in the Official Journal of the European Union, series C, no. 215 of July 5, 2017.

A separate declaration or report may be prepared using a proprietary approach or in accordance with specific European or international frameworks. It should be noted that the technique utilized considers every need of the particular Romanian legislation concerning the non-financial information declaration. Companies that already publish a Sustainability Report have the option of using an international reporting framework such as the Global Reporting Initiative - GRI Standards; however, the report does not have to be based on a national, European Union, or international framework. In other words, the company can choose to utilize and develop its own tool.

Only public interest enterprises described as "large companies" or "large groups" are required by Directive 2014/95/EU to prepare the non-financial declaration, i.e. the separate report. Subsidiaries of major firms and groups are exempt from Directive 2014/95/EU if their operation is evaluated on a non-financial basis in the parent company's or another company's report (articles 19a, point 3, and 29a, point 4, established in Directive 2013/34/EU). Therefore, even though a Romanian subsidiary may be able to employ more than 500 people, the existence of a non-financial report at the group level permits it to avoid disclosing detailed information on events in Romania.

Regarding the diversity report, the applicability is established only at the level of public interest entities, respectively "companies that are subject to the legislation of a member state and whose securities are admitted to trading on a regulated market in any member state," according to Directive 2014/95/EU, art. 1, point 2, respectively Directive 2013/34/EU, art. 20, point 1, and art. 2, point 1, lit. (a). As a result, only companies listed on European stock exchanges are required to create a statement of their diversity policy and incorporate it into their corporate governance report.

The new guideline is not restrictive in terms of the non-financial reporting model and the diversity policy reporting model. It allows companies and groupings of companies to choose their reporting model, but only once a few conditions are met. Directive 2014/95/EU defines a minimum set of information that should be included in the consolidated management report's non-financial statements.

A company or group of companies can put together a separate report using one of the following formats: a national framework, if one exists (Romania lacks one), the United

Nations Global Compact (UNGC), ISO 26000, the Tripartite Declaration of Principles concerning Multinational Enterprises and Social Policy, the Guiding Principles on Business and Human Rights, the OECD Guidelines for Multinational Enterprises, or the Global Reporting Initiative. In the case of a separate report, the reporting framework must be specified as such in the management report.

Where companies or large groups of companies do not have policies in place to reduce risks related to environmental, social, and personnel issues, or those related to human rights and the fight against corruption and bribery, and the report on diversity policy, the non-financial statement or separate report must "provide a clear and reasoned explanation of this.".

In terms of non-financial reporting, Directive 2014/95/EU requires member states, including Romania, to take steps to ensure that the authorized auditor or statutory audit firm verifies whether the non-financial statement or report exists separately. The authorized auditor or auditing firm, on the other hand, just validates the existence of the documents in question without rendering an opinion on their substance. In terms of content, the new directive also refers to a so-called "tertiary audit," in which it is demonstrated that member states have the option to provide, as a measure, the verification of the information from the non-financial statement, i.e. the separate report, by an independent assurance services provider (assurance services provider). (Articles 19a, point 6, and 29a, point 6).

Because the financial strategy is not integrated with the non-financial strategy, non-financial reporting is only a matter of compliance for most Romanian listed companies, while few economic entities see this as an opportunity to present the sustainability strategy or have a strategy implementation plan. Climate and environment, employee issues, corporate governance, and the linked area of anti-corruption efforts are all covered in non-financial reporting, followed by social and human rights issues and cyber security and their impact on long-term growth. In other words, only a small proportion of listed companies take a Directive 2014/95//EU approach to climate and environmental issues, with the majority of them failing to have an adequate environmental strategy, preferring to report social, wage, and rights issues human, having codes of ethics, remuneration policies for all employees, audit policies for suppliers, and anti-corruption and bribery policies, areas where they are better prepared.

7. Conclusions.

Non-financial data is used to measure business performance using metrics that are unrelated to a company's finances. Sustainability reporting is a type of integrated reporting in which financial and sustainability data are gathered and combined into a single report, as well as a model that reflects a company's economic, social, and environmental performance, or people and profit.

The sustainability report is another technique to assess business performance using

financial and non-financial information. This paradigm incorporates four distinct viewpoints: financial, customer, internal company process, and learning and growth.
The **following is a summary of the advantages of using non-financial data** and information:

- It encourages companies to think beyond profits;
- It provides a broader view of business performance;
- It assesses sustainability and Corporate Social Responsibility (CSR), both of which are essential considerations for investors;
- It can strengthen relationships with customers and stakeholders, as well as their loyalty;
- Creates positive publicity and media exposure;
- Can improve the company's reputation;
- Differentiating the company from competitors;
- Attracting and keeping a satisfied workforce;
- Involves everyone in the business;

The following are **some of the drawbacks of employing non-financial data and information**:

- There could be a problem with the reliability and validity of the measurement of certain factors;
- It is not a requirement to report these factors in many countries, so companies are not so concerned about reporting them;
- It might be difficult to balance the measurement of financial and non-financial data;
- The company must ensure that it does not set too many different goals, as this can be confusing for management and employees.

Non-financial and sustainability reporting that is transparent, complete, and fair benefits the company, the reporting group of companies, and its external domain. According to the Global Reporting Initiative's classification, some benefits of non-financial reporting include drawing in new capital and boosting competitiveness because prospective investors can access more pertinent information than what is required to be disclosed. Additionally, easy access to information on all aspects of the environment, human rights, and anti-corruption measures is provided to both internal and external stakeholders, including customers, suppliers, the local community, investors, and civil society.
One of the issues identified so far regarding non-financial reporting published in recent years is the low level of *relevance of non-financial information*, and it is critical that the new standards consider the needs of different categories of users, namely the recipients of information and non-financial data. To minimize unfair competition, non-financial reporting rules should be extended to non-EU enterprises operating in the EU.
International reporting standards (for example, the GRI Standards, which are already

widely utilized in Romania) should also be considered to ensure effective information sharing at the international level. In creating the need to prepare and publish a non-financial report for SMEs, proportional consideration should be given to their size and the fact that it would result in extremely high compliance costs, which are often difficult to undergo.
For shareholders and investors to make well-informed decisions about their investments, the European Union wants them to have access to clear and accurate non-financial information from businesses. In order for trade unions, civil society organizations, and other interested parties to hold companies accountable for their effects on society and the environment, non-financial data must also be readily available.

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