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THE VISION OF THE IDEAL STUDENT CAMPUS FROM AN INTERANTIONAL PERSPECTIVE

Abstract: This article discusses a study on the concept of the ideal university campus from an international perspective. The study uses the Large Language Model (LLM) to analyze student survey responses and investigate if the concept of the ideal campus is universal. Specifically, the study examines the University of Warmia and Mazury (UWM) in Olsztyn to determine if it reflects elements of this universal campus vision. The effectiveness of the LLM in identifying key themes and patterns in student responses is also assessed. The study analyzes both positive and negative aspects of campuses as identified by Polish and international students and explores whether these elements can be applied in different academic contexts. Additionally, the study examines if the UWM campus can serve as a reference model for other universities while considering the diverse needs and expectations of students worldwide. The article also highlights the evolution of university campuses and emphasizes the importance of on-campus services in enhancing student satisfaction. Furthermore, three-dimensional visualization is discussed as an effective tool for presenting the analyzed results and spatial data, aiding in understanding student expectations for academic spaces.

Keywords: AI Chat, Large Language Model (LLM), 3D visualization, 3D modeling, university campuses, Poland, University of Warmia and Mazury in Olsztyn

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Introduction

In today's academic world, where students from various parts of the globe strive to acquire knowledge and skills, the concept of the ideal academic campus is becoming increasingly significant. An academic campus is more than just a collection of educational buildings – it is a space that shapes students' daily lives, influences their satisfaction, and supports personal development. An ideal campus not only provides infrastructure for learning but also fosters integration within the academic community, ensuring accessibility to key services and a connection with the surrounding environment.

As universities evolve, so do students' expectations regarding campus infrastructure, service availability, and spatial organization. However, many universities, especially in large cities, lack a cohesive campus area. In such cases, educational buildings may be scattered across different parts of the city, leading to resource fragmentation and hindering student interactions. Historically, university campuses often suffered from spatial inconsistency, where key buildings and services were not concentrated in a single location, making it challenging to create a unified academic environment.

Understanding the elements that contribute to an ideal campus is therefore essential for designing academic spaces that align with contemporary student needs. While the advancement of digital solutions has transformed the way students engage with education, physical spaces remain crucial. In this context, artificial intelligence tools such as ChatGPT, a large language model capable of processing and generating human-like text, can play a key role in analyzing and interpreting student opinions. By leveraging AI, universities can gain deeper insights into student preferences and campus usability, ultimately improving their infrastructure and services.

In the era of globalized education, an important question arises: is there a universal model of an ideal campus that can be applied across different cultures and educational systems? Such an analysis requires consideration of diverse local conditions, including urban structures, social needs, and the specific characteristics of academic institutions.

This study aims to explore students' perceptions of an ideal academic campus by analyzing feedback from various universities worldwide, utilizing modern analytical tools, including ChatGPT. The research seeks to assess current campus conditions and identify areas for improvement to make these spaces more functional and student-friendly.

The study focuses on the campus of the University of Warmia and Mazury in Olsztyn as a case study due to its spatial diversity and the relative concentration of buildings and services within a single area. By using ChatGPT to analyze student survey responses, key themes and patterns can be effectively identified, leading to a better understanding of student expectations.

Furthermore, the study incorporates three-dimensional visualization techniques to present findings in a compelling graphical format. This approach not only enhances the interpretability of the results but also provides a conceptual framework for designing academic spaces that meet modern students' needs. The final analysis will determine to what extent the structure and organization of the UWM campus can serve as a reference

model for other universities, offering solutions that accommodate the diverse expectations of students worldwide (De Jesus et al., 2018).

ChatGPT is a natural language processing system managed by OpenAI. It is designed to generate human-like conversations by understanding the meaning of statements in context and producing contextually appropriate responses [...] (Deng & Lin, 2022).

According to the dictionary definition, a University Campus is: a complex of university buildings and grounds (Glosbe: kampus (*campus*)).

Literature review on university campus planning and development

A university campus is typically a designated part of a city or area where educational buildings such as the main university building, faculty buildings, student dormitories, and sports facilities are located. University campuses play a pivotal role in the academic community by providing spaces for learning, research, student life, and recreation. Their structure and functions have evolved over time, reflecting the changing needs of students, society, and technology.

In the context of Polish universities, the term "campus" may raise certain ambiguities since many operate in a dispersed model where educational buildings, laboratories, and other facilities are often scattered across different parts of a city. Classical university campuses are compact areas where all key university functions – education, research, housing, and recreation – are integrated into one location. A prime example of such a campus in Poland is the University of Warmia and Mazury campus in Olsztyn, a cohesive student town. This chapter reviews the literature on university campus planning and development, with a particular focus on changes in the perception of their roles and functions over the years (Działek et al., 2020).

Access to essential services and recreational opportunities, such as shops, sports facilities, or libraries, should ideally be available within a 15-minute walk. Studies indicate that planning functional campuses that incorporate all necessary spatial elements should adhere to the "15-minute city" concept. Paul Barratt and Ruth Swetnam, in their article “A civic and sustainable 15-minute campus? Universities should embrace the 15-minute city concept to help create vibrant sustainable communities”, discuss this approach: "The 15-minute campus approach marks a distinct change from the idea of a ‘sticky campus’ where the university is seen as an enclosed one-stop resource for staff and students – an environment often set apart and secured from its host city”. This concept emphasizes a shift in campus design, contrasting the traditional model – a self-contained, resource-rich environment isolated from it is surrounding city – with the new "15-minute campus" approach. The traditional campus model fosters a self-sufficient unit detached from its community, which can lead to social isolation and limited interaction with local populations. The 15-minute campus model promotes openness and integration with the surrounding area, advocating that all essential services and amenities should be accessible within a 15-minute walk or bike ride. This fosters greater engagement with the local community and creates a more sustainable and vibrant urban environment.

Campus spaces play a vital role in the academic lives of students – not only as places for learning but also for social integration and relaxation. Winnicka-Jasłowska et al., in their study "Campus as a green space supporting university activities: Presentation of assumptions and results of a PBL project – Case study", discuss various approaches to campus design aimed at improving students' quality of life by creating sustainable, functional, and aesthetically pleasing environments. This chapter summarizes these concepts and provides additional recommendations based on other studies, such as "Mission and Place: Strengthening Learning and Community through Campus Design" (Kenney et al., 2005).

Green spaces on campuses play a crucial role in creating a friendly and relaxing environment that supports both relaxation and social interaction. An example of this is the green-blue infrastructure at Silesian University of Technology, featuring sensory gardens with aromatic herbs and seating areas that combine aesthetics with functionality. Such designs are significant as green environments have been proven to reduce stress and improve students' well-being while encouraging them to spend more time outdoors.

Additionally, the authors of "Mission and Place: Strengthening Learning and Community through Campus Design" suggest that well-designed campuses should attract students to spend time on university grounds beyond their classes. Green spaces around campuses promote integration and a sense of community. Thus, continuing the development of green infrastructure as social and relaxation spaces strengthens the campus's identity as a social space.

To serve as a hub for interactions, a campus must reflect the needs and expectations of its users. At the Silesian University of Technology, focused group interviews were conducted to better understand the preferences of students and staff, enhancing their engagement and sense of belonging. Studies from "Mission and Place: Strengthening Learning and Community through Campus Design" emphasize the importance of creating academic spaces that encourage integration through shared learning areas and spaces open to the local community.

An example of implementing this approach is the concept of "porous" campus boundaries, allowing local communities access to university facilities such as libraries, sports venues, and parks. This fosters relationships between students and residents, enriching the campus with new social interactions and aligning with the "15-minute city" model.

Aesthetics and functionality are equally important for campus spaces, which must adapt to students' evolving needs. Innovative urban furniture designs presented in this study highlight how aesthetic and functional features can coexist, such as benches that double as bike racks, catering to students' needs for bike storage while encouraging active lifestyles (Barratt & Swetnam, 2023).

The authors of "Mission and Place: Strengthening Learning and Community through Campus Design" also stress the importance of density and design coherence in campus layouts. Properly arranged buildings and infrastructure make a campus more compact and user-friendly. A compact layout encourages walking, fostering spontaneous

interactions and increasing safety, which positively influences visitor experiences and boosts student recruitment and satisfaction.

Effective campus design should also include the creation of “binding zones” that connect different university areas and enhance student mobility. At the Silesian University of Technology, proposals included pedestrian paths and pergolas with seating in key locations to encourage interaction and ease of navigation. Similarly, the authors of “Mission and Place: Strengthening Learning and Community through Campus Design” suggest that expanding pedestrian and cycling infrastructure, along with integrating public transport, can significantly contribute to creating more accessible and sustainable campuses. Such infrastructure reduces reliance on cars, decreases campus traffic, improves safety, and fosters a more user-friendly environment.

University campuses are essential spaces for the academic community, offering opportunities for learning, research, student life, and recreation. Their development reflects the evolving needs of society and technology. The literature reviewed emphasizes the growing importance of campus functionality, integration, and the "15-minute city" concept, which envisions key services and locations accessible within a 15-minute walk radius.

The incorporation of 3D modeling and visualization technologies into the planning of university campuses is gaining importance, enabling precise design and efficient management of university space. The use of 3D models allows for detailed spatial analysis, optimization of building placement and integration with existing urban infrastructure. The technology also supports decision-making processes, allowing planned investments to be visualized in a realistic and intuitive way. This makes planning more precise and space management more efficient, leading to campuses that better meet the needs of users.

There are many works in the scientific literature discussing the importance of 3D modeling in the design of academic spaces. Piotr Kisiel's article “Designing 3D models in high school using Blender open source software” highlights the importance of open source tools in education and design, which is also applicable in academia. The article points out the role of Blender software as a tool that enables the creation of three-dimensional spatial models, which can be used not only in education, but also in professional space design, including academic campuses.

In their article, Molga & Krawczyk (2021) analyze various three-dimensional modeling techniques, highlighting their usefulness in creating complex architectural structures. In the context of campus design, these techniques are crucial, as they enable the creation of accurate and functional building models, which are the basis for further analysis and design decisions. The use of advanced 3D modeling tools makes it possible to effectively plan the spatial layout of campuses and integrate new facilities with existing infrastructure.

The article, “Energy Efficiency in Agricultural Production-Experience from Land Consolidation in Poland and Finland” (Balawajder et al., 2023), points out the importance of geoinformatics tools in spatial analysis and land use optimization. Although the context of the article is agriculture, similar tools can be used in the planning of university

campuses, especially in energy efficiency analysis and optimal land use. These tools, including 3D modeling, can support campus design processes, providing precise positioning of facilities and analysis of their environmental impact.

Additionally, the paper "Use of 3D technology in underground tourism: example of Rzeszow (Poland) and Lviv (Ukraine)" (Bieda et al., 2021) discusses the use of TLS laser scanning and 3D modeling for inventory and visualization of underground spaces. A similar approach can be used in the creation of digital replicas of university campuses, enabling both the documentation of architectural objects and their promotion through interactive visualizations and virtual tours. 3D technologies make it possible to accurately replicate the existing structure of campuses, which supports both management processes and university advertising.

The use of appropriate 3D modeling methods is becoming crucial to the effective design of campus spaces, enabling the creation of realistic visualizations of planned developments, supporting decision-making processes, and spatially integrating new facilities with existing academic and urban infrastructure. These technologies also have the potential to create more sustainable and customized campuses, making them an integral part of modern urban planning.

Materials

Historical perspectives on university campuses. Traditional university campuses were often designed as closed enclaves, primarily focused on learning and education. Their architecture was characterized by monumental buildings, meticulously planned spaces, and a clear division into educational, residential, and recreational zones. Grand structures dominated the landscape, creating an organized environment aimed at fostering efficiency and order. Student life revolved around key facilities such as lecture halls, libraries, and dining halls, which served as central hubs of daily academic activity. Walking was the primary mode of transportation within these campuses, promoting social integration within the academic community and ensuring students had convenient access to all necessary resources. Moreover, traditional campuses were intentionally designed to remain insulated from external influences. This isolation was meant to provide students with a tranquil environment conducive to focus and academic rigor. The carefully curated layout of these campuses reflected their primary mission: to create a dedicated space for intellectual and personal development, free from the distractions of the outside world (Szczepański & Nyka, 2023). Examples of Historical Campuses:

1. University of Oxford, United Kingdom – Founded in 1096, the University of Oxford is the oldest English-speaking university in the world. Its collegiate system and historic architecture exemplify the traditional concept of a university as an enclosed academic enclave.
2. Jagiellonian University, Kraków, Poland – Established in 1364 by King Casimir III the Great, Jagiellonian University is the oldest university in Poland. Its campus reflects the medieval European tradition of integrating academic buildings into the heart of urban environments while maintaining a distinct academic identity.

3. Harvard University, Cambridge, USA – Founded in 1636, Harvard University is the oldest institution of higher learning in the United States. Its historic campus layout, characterized by central green spaces surrounded by academic and residential buildings, illustrates the enduring influence of traditional campus design principles.

Oxford, Jagiellonian, and Harvard Universities despite their differing geographic locations and historical contexts, Oxford, Jagiellonian, and Harvard Universities share several common traits characteristic of prestigious institutions with long-standing traditions. Their campuses serve both educational and cultural purposes, blending academic excellence with historical and aesthetic significance. The historic architecture, often Gothic or Renaissance in style, imparts a unique character to these campuses, reflecting their centuries-old legacy. Their libraries house extensive collections, including rare manuscripts and early printed books, making these universities global centers of knowledge and research excellence. Green spaces such as gardens and parks not only enhance the aesthetic appeal of these campuses but also provide areas for relaxation, contemplation, and social interaction. These features foster an academic atmosphere conducive to learning, debate, and intellectual growth. The prestige and traditions of these universities are well-documented, and their alumni have played pivotal roles in shaping the course of history. Together, these elements create an unparalleled academic environment that continues to inspire generations of scholars (Białek, 2022).

A good example is the interior of the historic Bodleian Library at the University of Oxford, which in the past played a key role as a center of learning. It was here that students had access to resources that enabled them to acquire knowledge and skills, contributing to their later achievements. The Bodleian Library, as one of the oldest institutions of its kind, had a significant impact on the development of science and education at Oxford (www.medsci.ox.ac.uk).

Contemporary university campuses. Modern university campuses are evolving into more open and integrated urban spaces that foster collaboration and interaction with their surroundings. The design of these spaces places a strong emphasis on functionality, accessibility, and sustainability, contributing to the creation of environments that are welcoming both for students and the local community. The architecture of contemporary campuses is increasingly diverse, addressing the needs of a variety of users. These spaces encourage interaction, integration, and collaboration among students, faculty, and city residents. Additionally, they offer a wide range of services and amenities that enhance the quality of campus life (Szczepański & Nyka, 2023).

Modern campuses are also transforming into hubs of innovation, where academia intersects with business and culture, creating environments that foster creativity and talent development. By adopting sustainable approaches to architecture and urban planning, campuses minimize their environmental impact while promoting eco-friendly practices. The integration of modern technologies, such as smart buildings and energy networks, further highlights their role as leaders in the pursuit of a sustainable future. A well-designed campus can subtly influence user behaviour and attitudes, supporting the educational mission of the institution. As outlined in the article “Campus as a Green Space Supporting University Activities: Presentation of Assumptions and Results of a PBL

Project – Case Study", the modern campus is no longer seen merely as a collection of buildings but as a complex system that meets the demands of sustainability, technological advancement, and social development. Challenges such as environmental protection and combating the effects of climate change play a key role in campus design, becoming priorities for architects. (Winnicka-Jasłowska et al., 2024).

One example of a modern campus is the campus of Nanyang Technological University (NTU) in Singapore. The School of Art, Design, and Media is housed in a glass building with a green roof covered in grass and vegetation. This building serves not only an educational function but also represents an innovative architectural solution with a focus on environmental care. It inspires students, faculty, and visitors to the Nanyang Technological University (NTU) campus (www.ntu.edu.sg).

Another example of a modern student campus is Molloy College in Rockville Centre, New York, where the main university building was designed in the last decade by BRB Architects from New York. This location serves as a public hub for educational meetings. Its educational functions are supported by various spaces, including a café, lounges, study rooms, a student club, a bookstore, and an art gallery. The building also houses a 550-seat theatre, offices, and a music department. This campus offers a rich student life with over 50 student organizations and a variety of cultural and educational events. The university emphasizes the personal and professional development of its students, providing career support and programs related to volunteering and social engagement (Kampus studencki (*Student campus*), 2012).

A noteworthy case is the Lahti Student Campus in Finland, a modern educational environment that effectively integrates historical elements with innovative solutions. Located in a renovated factory, this campus is shared by LUT University and LAB University of Applied Sciences, fostering knowledge exchange across different fields of science and technology. Lahti, as a student city, is known for its dynamic campus and urban life, with a rich offering of cultural and sporting events. The city is recognized as a pioneer in the circular economy, earning the title of European Green Capital in 2021. Lahti places a strong emphasis on combining design with digitalization and promoting an active lifestyle, making it an attractive destination for both students and residents (LUT University, 2024).

Choosing a student campus today is influenced not only by the quality of education offered by the institution but also by many other factors that affect a student's comfort and development, such as location and accessibility, the atmosphere and culture of the educational center, and the individual needs of each student.

The evolution of the campus by key aspects: a historical and contemporary comparison. The Table 1 illustrates the evolution of university campuses, highlighting key differences between traditional and contemporary models. Monumental buildings and rigid spatial divisions, typical of older campuses, have been replaced by diverse architecture fostering interactions and open spaces. The focus has shifted from the traditional model of knowledge transmission to support the holistic development of students and provide rich experiences.

Table 1. Comparison of campus in the past and today

No.	Aspect	Historic campus	Current campus
1	Function	Main focus on learning and education. Emphasis on the traditional teaching model (knowledge transfer from the teacher).	Integrated space for learning, student life and recreation. The environment engages students in collaborative activities, social interactions, and extracurricular activities.
2	Architecture	Monumental buildings, orderly spaces. A symbol of academic prestige. Educational institutions were designed to inspire admiration Historic architecture accommodating extensive library collections.	Diverse architecture for interaction. Architecture is not just about constructing buildings. Structures incorporating modern technologies, such as green roofs that care for the environment, or dining facilities enrich student life.
3	Accessibility	Closed enclaves. Organized around a central courtyard or square, with buildings grouped by faculties.	Open spaces. Anticipated mobility within the campus, use of technology, integration with the city.
4	Emotional engagement	Formality and tradition in interpersonal communication. Distance between students and lecturers.	A sense of community and belonging to a group. Encouraging the formation of emotional bonds among students.

Source: Own elaboration based on literature review

Modern campuses serve not only educational purposes but also become hubs of innovation where new ideas and technologies are developed. The growing importance of collaboration between universities, businesses, and non-governmental organizations, as well as sustainable development, have become key aspects of campus design.

The evolution of university campuses reflects the changing needs of students, society, and technological progress. Contemporary campuses are increasingly open and integrated with urban environments, fostering diversity. It is essential that campus planning, and development take these changes into account, creating spaces that meet the needs of today's students.

The historic architecture of campuses, symbolizing prestige and inspiring admiration, has over time transformed into functional, modern designs that go beyond merely

constructing buildings. They now incorporate environmental protection measures and dining facilities that enrich student life. While the size of libraries and their collections has not diminished, they have adopted digital formats, enabling access to literature on any device.

Formality in communication in the past created a distance between students and lecturers. Tradition and its associated culture hindered the development of closer interpersonal relationships. However, emotional engagement in today's universities is much greater. Both students and lecturers emphasize a sense of community and belonging to a group. Emotional bonds among students are now more commonly formed, and facilitated by various communication platforms.

Methodology

Description of research procedures. The study focuses on evaluating the effectiveness of using the Large Language Model (LLM) for survey analysis and examining the extent to which the vision of a campus can be perceived as universal. Specifically, the research aims to determine whether and to what extent elements of this universality are present in the structure and organization of the University of Warmia and Mazury campus in Olsztyn. Following the research framework outlined in Diagram 1, the study employed a multi-stage methodology, allowing for a comprehensive and multifaceted approach to data analysis and visualization. Each stage had a clearly defined role within the research process, and their complementarity ensured the reliability and accuracy of the results obtained.

Data: online survey. As part of the first stage of the study, an online survey was conducted among students to gather information about their preferences and evaluations related to university campuses. The survey, prepared in English, targeted students from various years and fields of study, representing twelve countries: Poland, Turkey, Taiwan, Romania, Germany, Croatia, Italy, Spain, Lithuania, Slovenia, the United Kingdom, Hungary, and Australia. A total of 44 respondents participated in the study, allowing for data collection from a diverse group of participants representing various academic and cultural backgrounds.

The survey was designed to collect detailed information about both the subjective preferences and evaluations of students regarding their experiences on university campuses. It consisted of 21 closed-ended questions and eight open-ended questions, divided into three main sections.

The first section focused on demographic data, such as gender, age, university name, city, country, and year of study. In the second section, respondents evaluated various aspects of their campus, including the availability of green spaces, the presence of nature, and their favourite places on campus. The third section consisted of open-ended questions, where participants could describe their vision of an ideal campus and suggest changes, they believed could make the campus more functional and student-friendly.

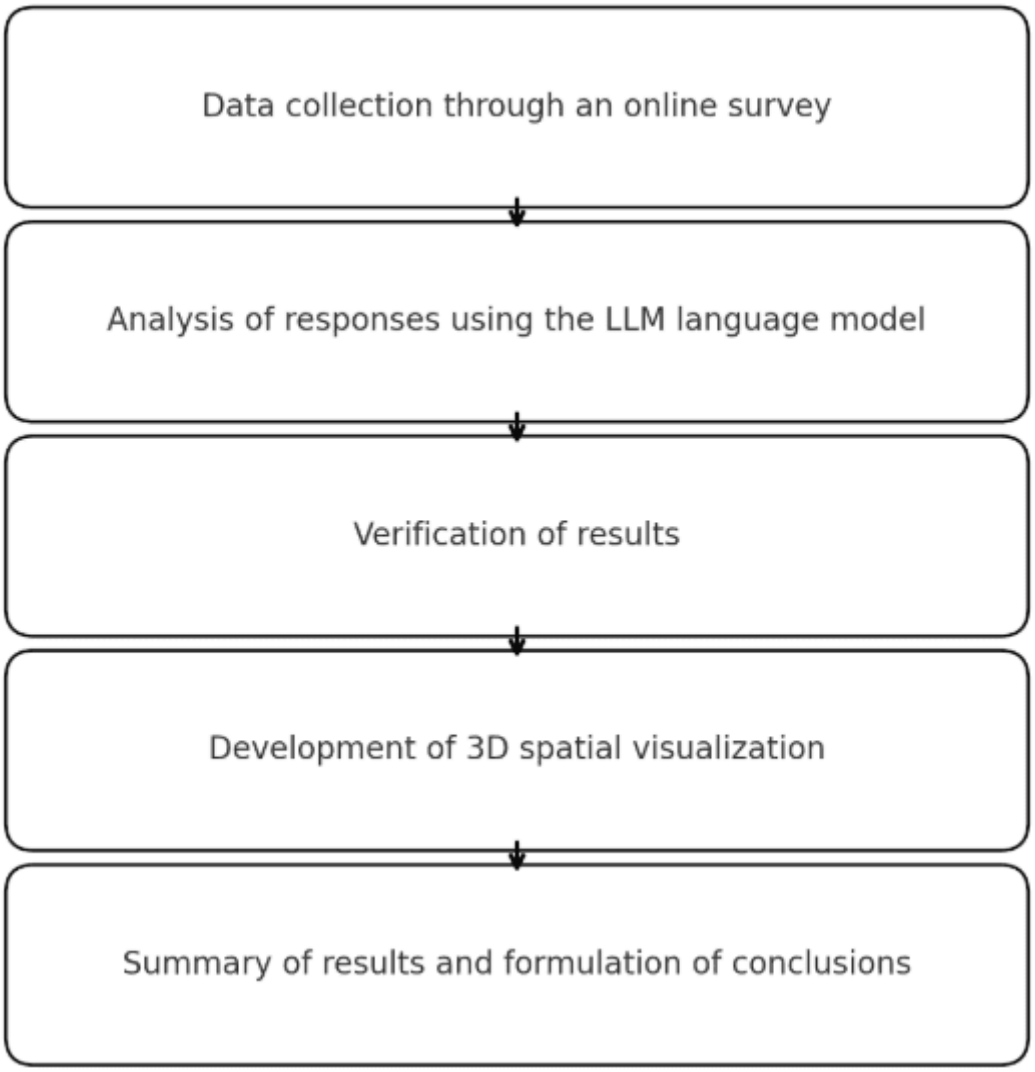

Diagram 1. Framework for assessing campus universality and spatial visualization utilizing LLM-based analysis
Source: Own elaboration

This survey structure allowed for the collection of both quantitative and qualitative data, enabling a comprehensive analysis of student preferences and evaluations regarding their academic environment. The results obtained provide valuable insights into the diverse expectations of students and their perceptions of an ideal campus, which can serve as a foundation for further initiatives aimed at improving student conditions at universities.

Analysis of survey responses utilizing a Large Language Model (LLM). The second stage of the study involved a qualitative analysis of the collected responses using a Large Language Model. LLM to a large language model that has been trained on huge text datasets to distribute and generate the basic language. These models of modern AI techniques such as transformers allow them to (Yao et al., 2024):

- Understand the linguistic context – LLM can analyse the meaning of effects from their impact;
- Generate human text – Creates a human-related response, which causes it to occur in conversation or content creation;
- Contextual awareness – Contextual knowledge can be used, for example in specialized trades (medicine, finance, programming);
- Ability to follow instructions – LLM can perform various tasks such as translation, answering questions, summarizing results, or generating.

  LLM is a term used to describe large language models such as GPT-4 (from OpenAI), PaLM (from Google), LLaMa (from Meta) or Claude (from Anthropic). In this case, Chat GPT was used.

The goal of this stage was to extract key themes and patterns present in the students' answers, enabling the identification of the most significant factors influencing their satisfaction with the university campus. The analysis conducted using the GPT chat facilitated the processing and synthesis of data, which was subsequently presented in both tabular and textual formats. This approach simplified the subsequent stages of the research process, allowing for a deeper understanding of student preferences and the areas that require improvement. The instructions for the GPT chats were meticulously designed to ensure the effective processing of textual responses from the study participants. The model was employed to identify recurring motifs and topics, which formed the basis for drawing conclusions regarding potential improvements to university campuses. The results of the analysis provided valuable insights that can be used to develop recommendations for enhancing student conditions at various universities.

The next stage of the study involved verifying the conclusions generated by the Large Language Model (LLM) by comparing them with an analysis conducted by the survey designers. The objective of this phase was to assess the accuracy and quality of the AI model's interpretations in comparison to those made by humans. In this stage, the survey designers, who had a deep understanding of the study's objectives and the specifics of the questions, conducted an independent analysis of the students' responses. The results of this analysis were then compared to those obtained using the LLM. This process enabled an evaluation of whether the AI model accurately identified key themes and patterns and whether its interpretations aligned with the intuitions and conclusions drawn by the researchers.

The comparison of results from both sources aimed to evaluate the extent to which the language model could match or potentially surpass- human capabilities in analysing qualitative data. The findings from this verification provided valuable insights into the effectiveness of AI tools in academic research while identifying areas where human intervention remains indispensable. Ultimately, this stage of the study contributed to ensuring the high quality and reliability of the final conclusions, which is crucial for applying the results in practice.

Development of 3D Spatial Visualization The fourth stage of the study involved the development of a 3D visualization of a university campus using GIS tools and data obtained from the www.geoportal.gov.pl platform, which serves as the central hub of the

Spatial Information Infrastructure, facilitating access to spatial data and related services. The goal of this stage was to create a detailed 3D model of the campus that incorporated the suggestions provided by students during the earlier stages of the study. The campus of the University of Warmia and Mazury in Olsztyn was selected as the base model, serving as an example of a universal model of an ideal campus, which could also be applied to other academic institutions. The process of creating the 3D visualization consisted of several key steps. First, spatial data were collected, including the Topographic Object Database (BDOT10K), Digital Terrain Model (DTM), and LOD2-format building data related to the campus, obtained from the national Geoportal. These data will be further detailed in the subsequent sections of the article. Next, the collected data were imported into QGIS, where they were analysed and prepared for further processing and visualization. Advanced spatial analysis functions available in QGIS were used for precise data processing.

The subsequent step involved transforming the spatial data into a 3D model using the QGIS plugin called qgis2threejs. This plugin enabled the export of the processed data into a three-dimensional format, facilitating further refinement of the model.

Finally, the resulting 3D model was imported into Blender, where an attractive and interactive presentation format of the results was created. By utilizing GIS tools and advanced spatial visualization techniques, the 3D model allowed for a spatial interpretation of the collected information, which was crucial for a deeper understanding of the research topic and the visualization of an ideal campus from the student's perspective. The outcomes of this stage can serve as a reference model for other universities, enabling the adaptation and implementation of best practices in designing academic spaces in accordance with user preferences.

The selection of a multi-stage research methodology was driven by the need for a comprehensive and detailed analysis aimed at ensuring reliable and accurate results. Each stage of the methodology contributed a unique perspective to understanding the research problem, ultimately enabling the creation of a holistic view of the phenomenon. The first stage, based on data collection through an online survey, provided foundational information regarding students' preferences and evaluations of university campuses. A diverse sample of respondents, representing various countries, fields of study, and academic levels, allowed for capturing a wide range of opinions. This diversity facilitated the identification of key factors influencing student satisfaction and the representation of varied perspectives.

The second stage involved analysing the collected responses using the Large Language Model (LLM), enabling an in-depth exploration of qualitative data. Through advanced natural language processing techniques, recurring themes and patterns were extracted, providing valuable insights into the main topics raised by respondents and areas requiring improvement.

The third stage of the study was a critical step in verifying the conclusions, involving a comparison of the results generated by the LLM with those obtained from an analysis conducted by the survey designers. This process not only enhanced the reliability and

validity of the findings but also evaluated the effectiveness of artificial intelligence in analysing qualitative data.

The fourth stage, focused on developing 3D visualizations using data from Geoportal and GIS tools, provided a means for spatial interpretation of the collected information. The creation of three-dimensional campus models enabled the presentation of results in an engaging and interactive manner, significantly facilitating the understanding and implementation of recommendations derived from the study.

Each of these stages contributed essential data and perspectives that complemented one another, resulting in a fuller and more nuanced understanding of the research topic. The multi-stage methodology employed in the study was critical for achieving the research objectives and provided a robust foundation for formulating recommendations to improve the university campus environment.

Developing a vision of an ideal campus. This chapter presents a project resembling an optimal model of a student campus, inspired by the structure of the Campus of the University of Warmia and Mazury in Olsztyn. The aim of the study was to create a campus model that not only reflects the current needs and expectations of students but also integrates modern technologies and innovative spatial solutions.

Based on the analysis of feedback collected from students from various countries and universities, as well as the results of advanced analysis conducted using the LLM language model, a range of solutions was developed to optimize the academic space. These solutions were subsequently translated into 3D visualizations, enabling a spatial representation of the suggested changes and improvements. The use of advanced GIS tools and 3D technologies, such as Blender, facilitated the creation of a realistic and interactive campus model. This approach allowed for an in-depth analysis of student expectations and testing of the impact of proposed changes on the functionality of the academic space.

As a result of the research, a universal campus model was developed, which can serve as a benchmark for other academic institutions striving to enhance the quality of life and the efficiency of the educational process within their facilities.

Online survey. The analysis focused on the results of a survey aimed at evaluating university campuses by respondents and identifying features that should be included in the concept of an ideal campus, with spatial visualization based on the example of the University of Warmia and Mazury campus. The study was conducted among students from both Poland and abroad, with 44 respondents participating in the survey. The questionnaire consisted of 29 questions covering various aspects of campus functioning and student life. The first figure presents a sample section of the survey.

The questions were divided into a closed section, where respondents answered basic questions such as country of origin, gender, year, and level of studies, as well as questions regarding campuses, e.g., safety levels, satisfaction, campus and building facilities. There was also an open section where participants could evaluate different attributes of their campus and propose changes to improve it. The open-ended questions, in particular, were a critical component of the visualization process. Their responses were highly diverse and

could not be easily expressed in numerical form, which limited the possibility of processing them using software like Microsoft Excel.

Results

The obtained data is presented in the form of tables and charts, which allow for a better understanding of the respondents' preferences and expectations.

Table 2 shows the average level of student satisfaction with campuses based on their place of residence. Respondents living in dormitories reported slightly higher satisfaction levels compared to those living off-campus.

Table 2. Average level of student satisfaction with campuses based on place of residence

No	Residence Status	Avarage Satisfaction Level
1	Off campus residents	3,53
2	Dormitory residents	3,64

Source: Own elaboration

The respondents identified elements they particularly liked about their campuses. The results are presented in Table 3.

Table 3. Campus elements liked by students

No	Element	Percentage Share
1	Green spaces	**28,57%**
2	Other	**26,19%**
3	Libraries	**14,29%**
4	Canteens	**9,52%**
5	Overall	**9,52%**
6	Sports facilities	**7,14%**
7	Social facilities	**2,38%**
8	Accommodation	**2,38%**

Source: Own elaboration

The table presents the most liked campus elements among students, with green spaces (28.57%) being the most favored. Other aspects (26.19%) and libraries (14.29%) also received significant appreciation. Canteens and overall campus atmosphere (9.52% each) were equally valued, followed by sports facilities (7.14%). Social facilities and accommodation (2.38% each) were the least mentioned. The results highlight the importance of natural spaces and study environments in student preferences.

The study indicates that over 70% of respondents believe their campuses are located close to the city center, which is a significant factor influencing satisfaction.

The data is presented in Chart 1.

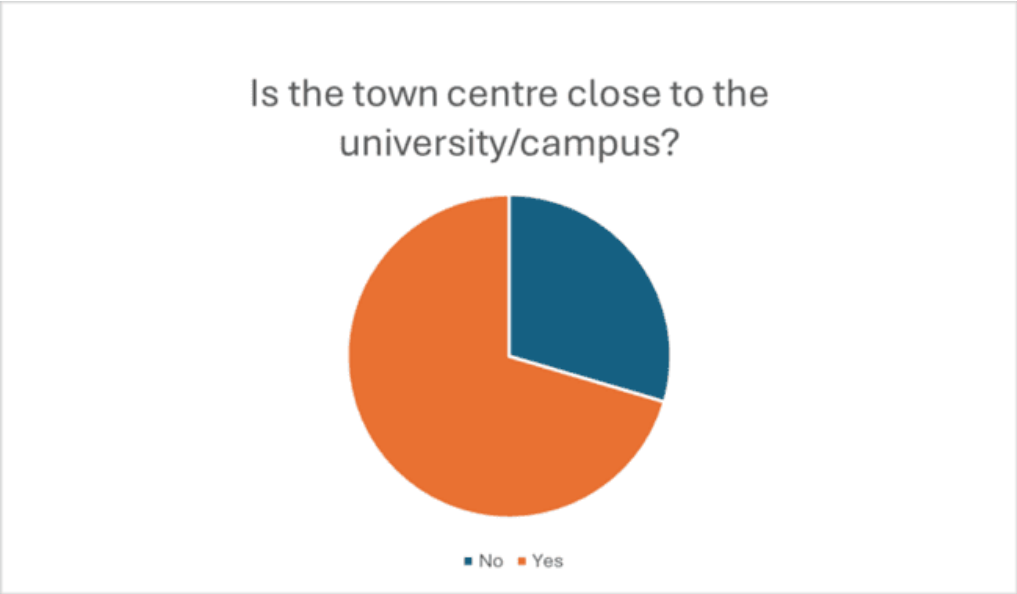

Chart 1. Campus Location Relative to the City Center
Source: Own elaboration

In response to the question about shortcomings on campuses, respondents identified the following elements, are presented in Chart 2.

The table highlights the key deficiencies identified by students on their campuses. Green spaces (32.14%) and canteens (25.00%) were the most frequently mentioned shortcomings, indicating a need for improved outdoor areas and dining facilities. Other concerns included general amenities (10.71%), study spaces (7.14%), and lecture halls (3.57%). Accommodation and recreation (3.57% each) were also noted as areas needing enhancement. The results suggest that students value both functional and social aspects of campus infrastructure.

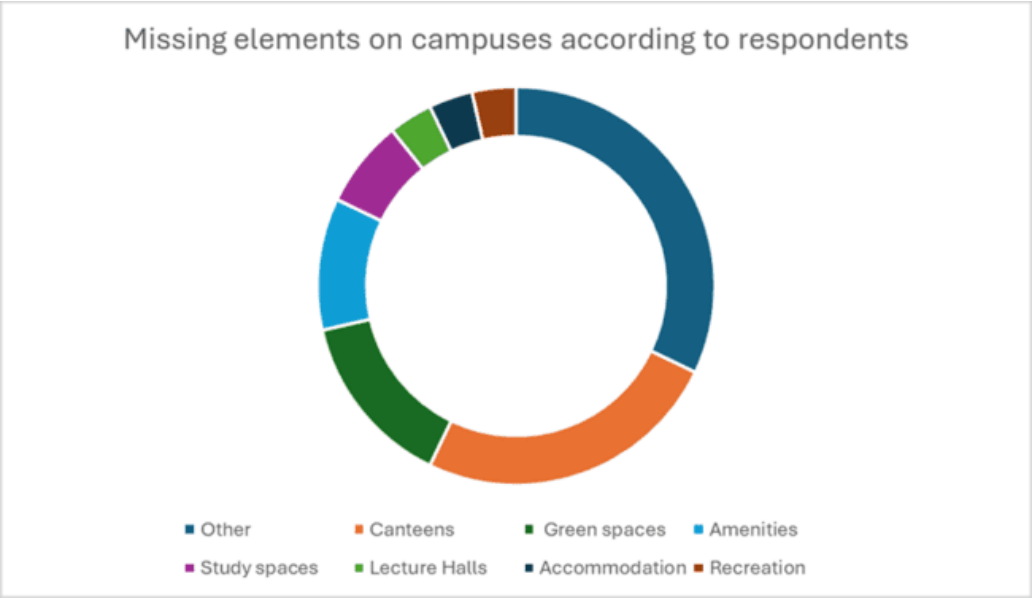

Chart 2. Campus deficiencies identified by students
Source: Own elaboration

Students evaluated whether their campuses possess the characteristics of an ideal campus. The results are presented in Chart 3:

- Assessment by UWM students: 62.5% consider UWM an ideal campus.
- Assessment by non-UWM students: 19.44% consider their campuses ideal.

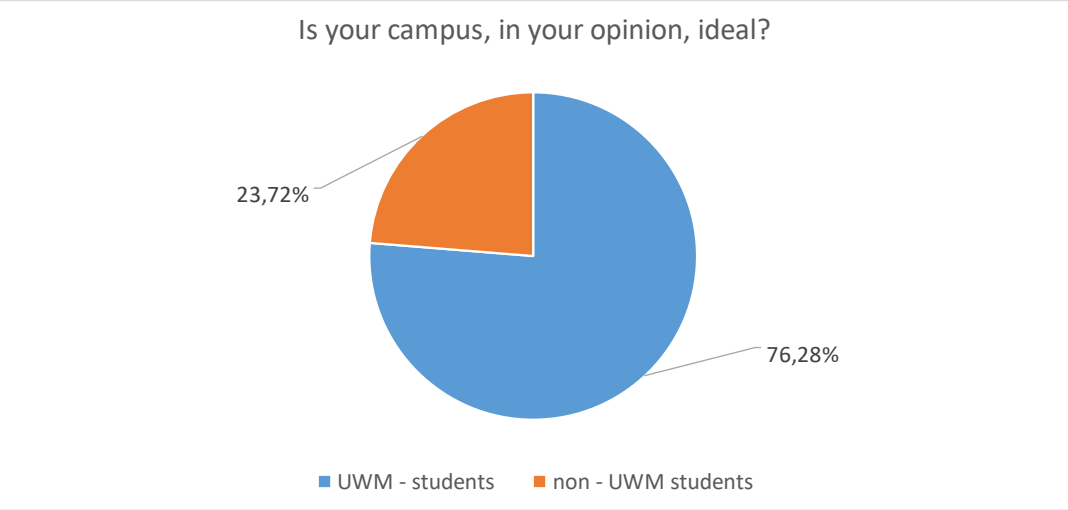

Chart 3. Evaluation of Campuses as Ideal Campuses
Source: Own elaboration

The study conducted among students of the University of Warmia and Mazury (UWM) and students from other universities highlighted differences in the missing infrastructural elements of campuses. Table 4 presents the percentage distribution of responses regarding campus deficiencies at UWM compared to other campuses. This analysis provides insights into specific needs and areas requiring improvement for both groups.

Table 4. Comparative analysis of missing infrastructure elements on the UWM campus

No	Missing Elements	UWM (%)	Other Campuses (%)
1	Accommodation	0,00	4,00
2	Canteens	33,33	24,00
3	Amenities	0,00	12,00
4	Green spaces	0,00	16,00
5	Lecture Halls	0,00	4,00
6	Other	66,67	28,00
7	Recreation	0,00	4,00
8	Study spaces	0,00	8,00

Source: Own elaboration

The table presents a comparative analysis of missing infrastructure elements at the University of Warmia and Mazury (UWM) and other campuses. The most significant deficiency at UWM is in the "Other" category (66.67%), while canteens (33.33%) also

appear as a major concern. In contrast, other campuses report shortages in green spaces (16%), amenities (12%), and study spaces (8%). UWM students did not report issues with accommodation, green spaces, lecture halls, or study spaces, unlike respondents from other universities. The results highlight differing infrastructure priorities and potential areas for improvement at UWM.

The "Other" category (66.67%) at UWM represents a broad range of missing infrastructure elements essential for student interaction and academic collaboration. This includes student integration spaces, rooms for scientific club meetings, and general student gathering areas. Additionally, it covers benches with tables for eating during breaks, well-designed individual study spaces, and multifunctional areas that support both academic and social engagement. Other campuses reported similar but less pronounced deficiencies in infrastructure, suggesting that UWM students particularly emphasize the need for improved social and collaborative environments. Addressing these gaps could enhance both academic and extracurricular experiences on campus.

3D visualization of a student campus. To create a 3D visualization of the campus, publicly available spatial data from https://www.geoportal.gov.pl was used.

2D data, such as the Topographic Objects Database (BDOT10K), served as the foundation for developing the model. Layers corresponding to the campus were selected from BDOT10K, including roads (SKJZ_L), trees (OIPR_P), buildings (BUBD_A), and plazas (PTPL_A).

These data were imported into QGIS software and adjusted to match the campus area (Khayyal et al., 2022). Additionally, 3D data such as the Digital Terrain Model and buildings in LOD2 (Level of Detail) the format was utilized. LOD is a level of detail that informs us of the degree of representation and complexity of a model through 3D visualisation, enabling us to visualise and analyse it more accurately for our purposes. The fidelity of the representation of the building geometry increases with the LOD level. The first level of detail (LOD1) represents a model with a flat roof structure without any textures. The second level of detail (LOD2) shows a model but with a faithful roof structure. The third level of detail (LOD3) adds doors and windows to the model. The fourth level of detail (LOD4) combines the other three levels of detail but adds an element inside the building (Figure 1).

This data was used to create a realistic 3D model of the campus terrain and buildings. The integration of 2D data from BDOT10K with 3D data enabled the creation of a comprehensive 3D campus visualization, incorporating terrain topography, the layout of roads, buildings, and greenery.

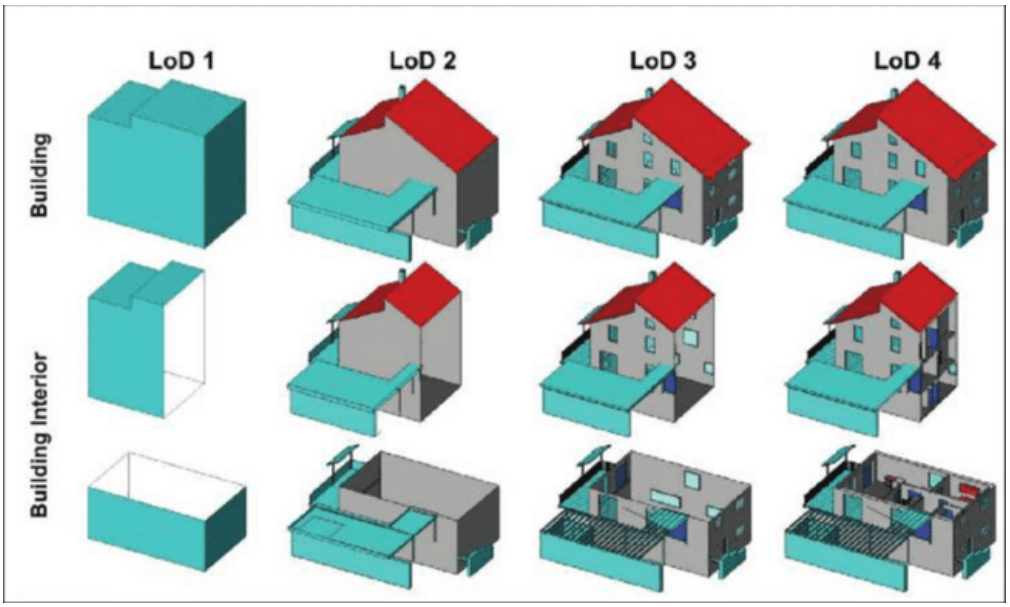

Figure 1. Presentation of LOD Levels (Level of Detail)
Source: Agugiaro et al., 2015

Data Introduction and Processing. Before proceeding with the visualization, the data was prepared using QGIS software. Selected layers were spatially restricted to the campus area and filtered for visualization purposes (Figure 2).

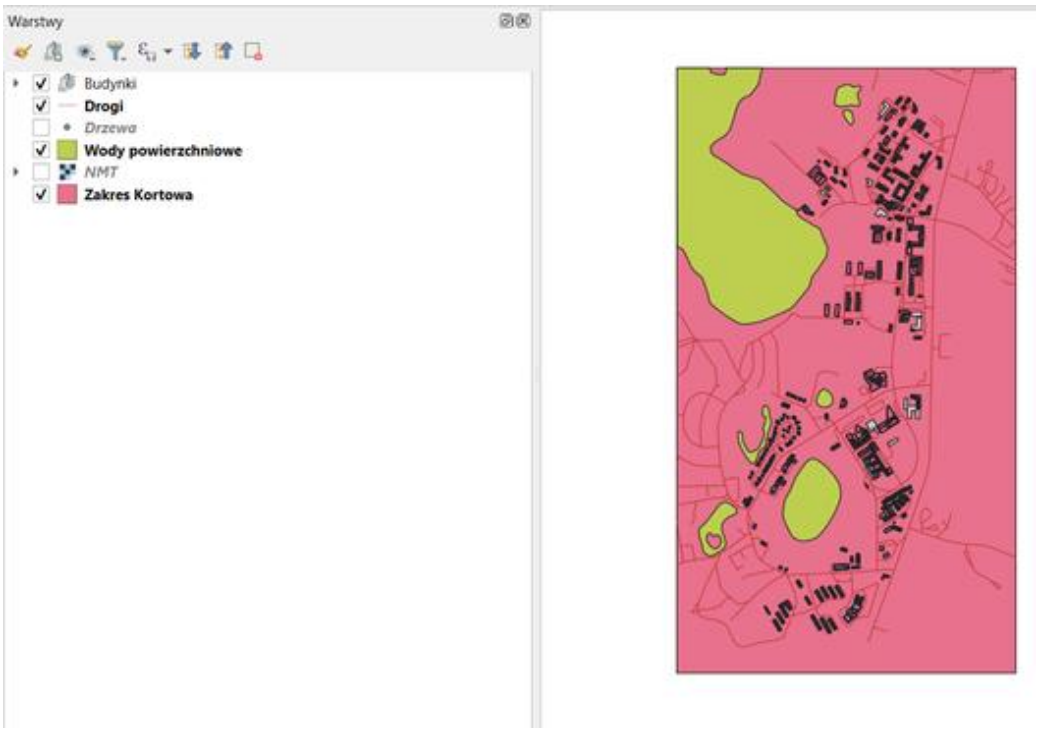

Figure 2. Selected layers cropped to the campus area in QGIS software
Source: Own elaboration

The graphical representation of the campus aimed to illustrate the current state of the University of Warmia and Mazury's infrastructure as of 2024 and to evaluate how

tools like the LLM language model could be useful in planning and implementing changes in a selected campus area, based on data collected from student surveys. The use of such tools could significantly accelerate decision-making and planning processes for both student councils and university authorities, ultimately leading to more effective campus space design and cost optimization for project implementation.

The core component of the visualization was to present the current state of the University of Warmia and Mazury campus, without incorporating the changes proposed by the LLM model, utilizing spatial data obtained from Geoportal (Figure 3).

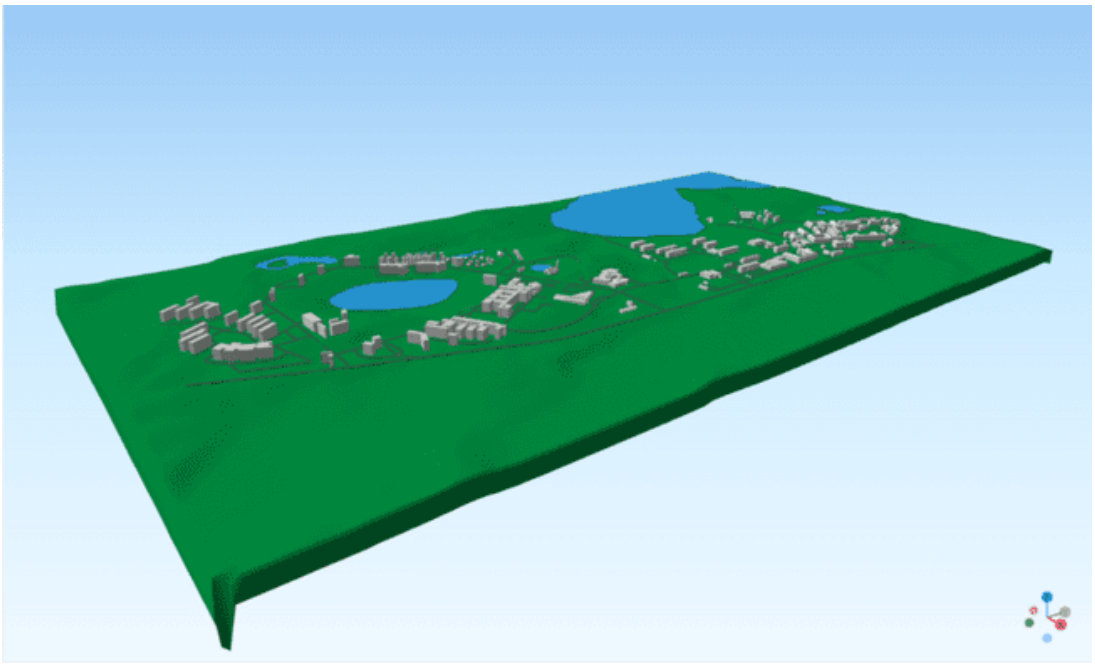

Figure 3. Basic visualization of the UWM campus using data obtained from Geoportal
Source: Own elaboration

3D visualization with implemented solutions resulting from the online survey. Based on the analysis of surveys conducted using LLM technology, the following features were identified and will be showcased in the visualization of the UWM campus after the proposed changes by the respondents:

- Increased number of parking spaces on campus;
- New dining facilities offering a diverse menu;
- Expansion of parks on campus (e.g., near the conference center and library due to underutilized areas);
- Healthcare facilities such as pharmacies and medical clinics;
- New social spaces, such as cafes and student clubs.

The above-mentioned changes were transformed from textual descriptions into objects incorporated into the UWM campus visualization. The changes focused on improving nearly all aspects of campus life that, according to respondents, required enhancement, ranging from expanding dining options to the proposal for developing green spaces. Consideration was given to changes that could be effectively visualized (Figure 4, 5, 6).

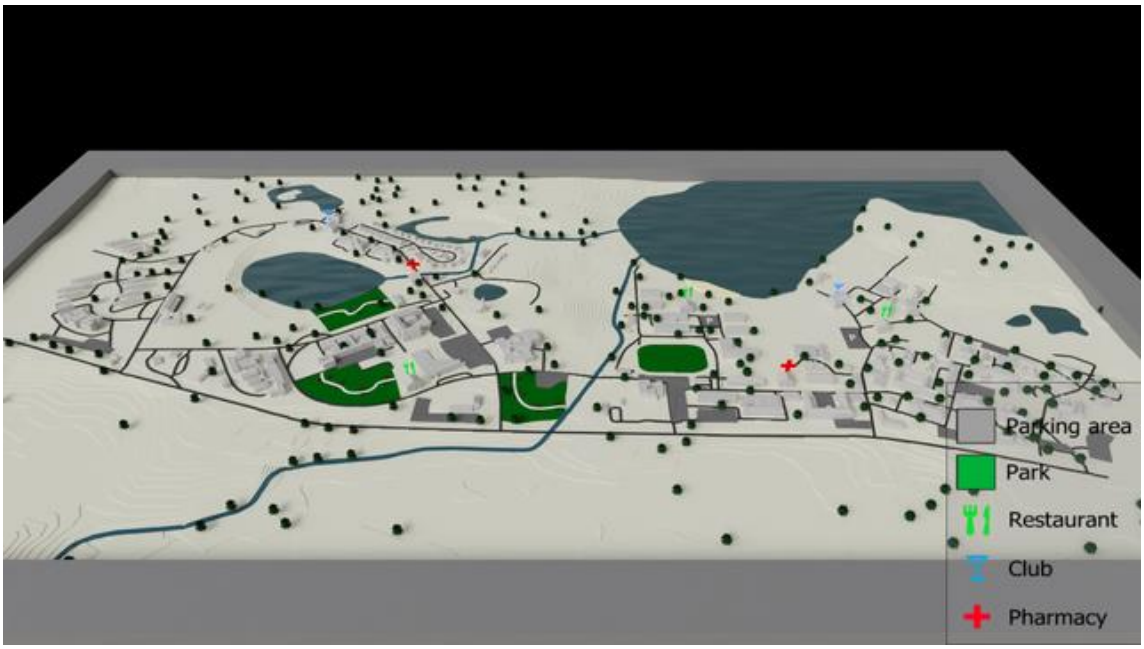

Figure 4. Visualization of the UWM campus after the changes proposed by respondents generated in Blender software
Source: Own elaboration

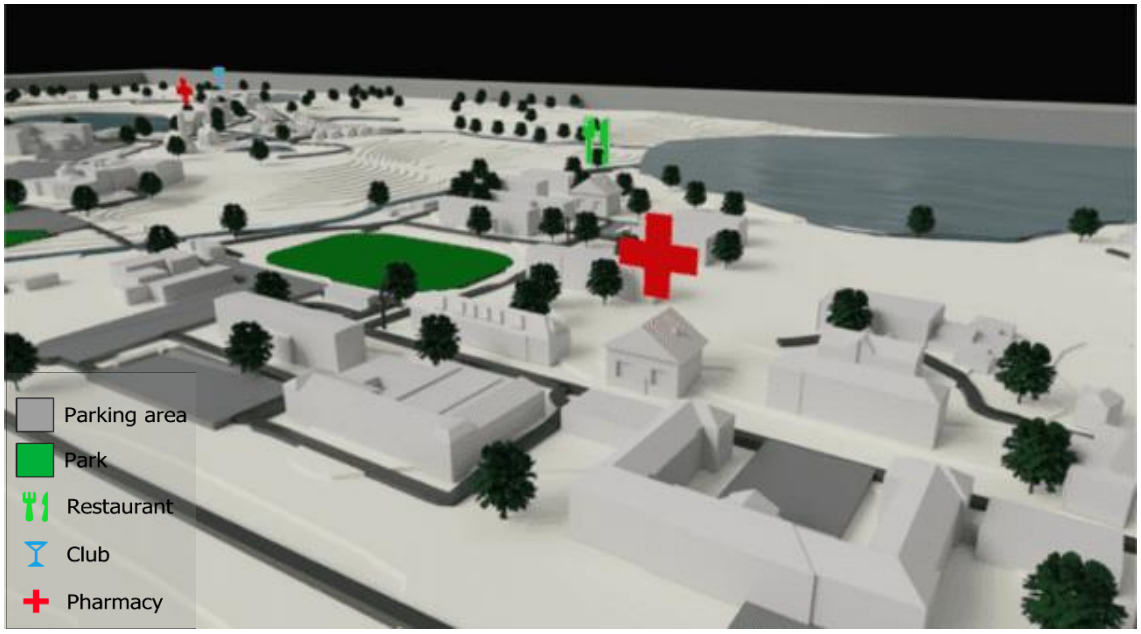

Figure 5. Proposal for the location of new buildings based on survey analysis
Source: Own elaboration

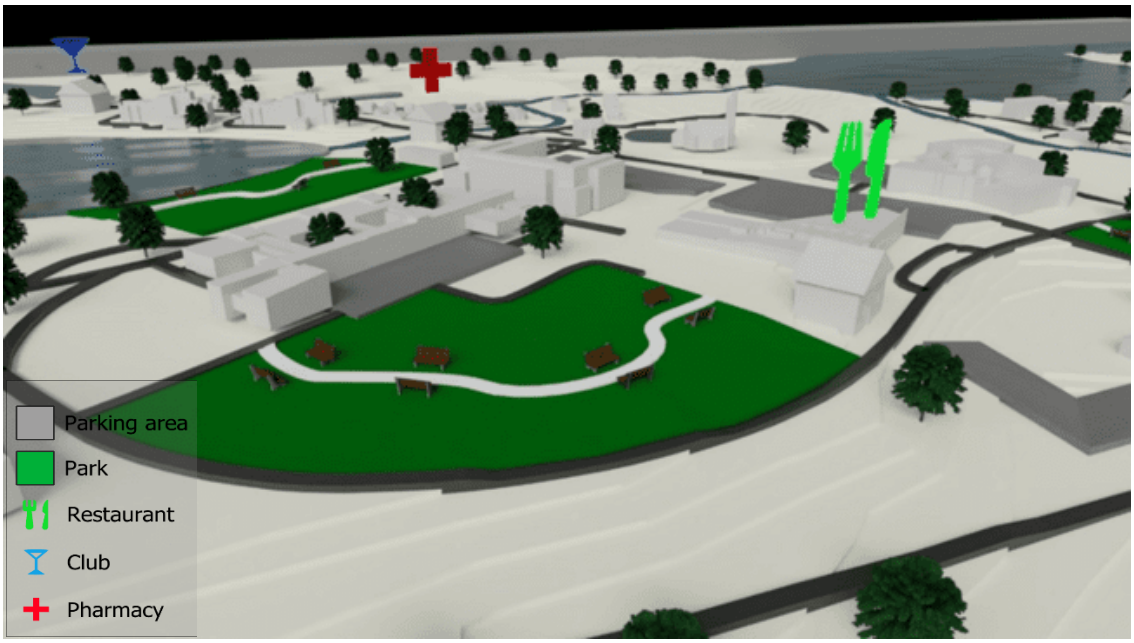

Figure 6. Proposal for land development on Michał Oczapowski Street
Source: Own elaboration

For the purpose of the campus visualization, buildings were created, some of which were equipped with functions corresponding to their specific types. These categories include medical facilities, restaurants, and meeting spaces. Symbols representing each type of building were adapted from QGIS software, enabling the representation of their functionality and characteristics.

The proposal for the development of green spaces on the campus stems from an understanding of unused land resources. The campus has such green areas with the potential to be transformed into parks and other recreational spaces. A key factor supporting these changes is the availability of open spaces that can be developed in accordance with the needs of the academic community.

Administrations of other campuses should therefore consider the potential of underutilized land in their areas and conduct detailed analyses of the needs of students and academic staff. Transforming these spaces into functional areas can significantly contribute to improving the quality of life on campus and enhancing the attractiveness of the educational offer, which can, in turn, impact the competitiveness and development of the university.

A similar methodology was applied in the context of the proposed construction of parking spaces. Analysing the needs and available space on campuses is essential for effective planning and implementation of investments that meet the requirements of students and staff on campuses (Surendra et al., 2013).

Conclusions

This study set out to investigate whether there exists a universal vision of an ideal university campus, using the University of Warmia and Mazury in Olsztyn as a case study. The analysis confirmed that there are consistent elements valued by students across diverse backgrounds, such as accessibility, green spaces, and service availability. The use of Large Language Models (LLMs) proved to be a useful tool in identifying these patterns, although it requires structured and standardized input data. Despite limitations in fully autonomous AI reasoning, the study demonstrates that AI-supported tools can significantly support campus planning processes. Thus, the objective of the study – to explore the potential for a universal model of an ideal campus and evaluate the utility of LLMs in such analysis – was achieved. Further research should refine AI methods and explore broader datasets to enhance accuracy and applicability.

The following conclusions were drawn from the conducted research:

1. Key factors defining the vision of an "Ideal Campus":

- The level of satisfaction among people residing on campus (in dormitories or off-campus).
- The availability of services and environmental elements that shape the ideal campus.
- The location of the campus in relation to the city center.

2. People living on campus or within close proximity to it are more satisfied with its presence compared to those living farther away.

3. Essential elements contributing to the ideal state of a campus include: green spaces (parks or squares), educational, academic, and cultural buildings (libraries, educational exhibitions), and commercial and service facilities (stores, supermarkets, restaurants).

4. Campuses located near the city center are advantageous for students in terms of accessibility, offering better access to public transportation and various urban services.

5. Regardless of students' origins and locations, a notable consistency can be observed in the valued and desired improvements on campuses. This suggests the existence of universal elements that can be utilized in constructing a model of the "ideal campus".

6. Artificial intelligence, based on provided datasets and appropriately expressed user queries, can generate answers to specific questions and formulate conclusions from its analysis using its algorithm.

7. In the present day, the process of artificial intelligence in analysing and drawing conclusions is similar to human intelligence. However, due to its inability to acquire continuous experience from learned knowledge or verify the correctness of information from unofficial sources, it may lead to generalized or inaccurate conclusions.

8. Conclusions generated by artificial intelligence are often accurate and helpful. However, they are rarely entirely autonomous and usually require human intervention. In practice, conclusions formulated by artificial intelligence may exhibit certain shortcomings, such as inconsistency, generalization, or the presence of incorrect information. These issues highlight the need for human supervision in the data analysis and interpretation process. While artificial intelligence is a powerful tool that can significantly accelerate work, its limitations prevent it from fully relieving humans of the responsibility of monitoring and verifying its conclusions.

9. Factors influencing logical and accurate results in AI data analysis:

- Precise and accurate formulation of user queries (minimizing the occurrence of generalized responses).
- Standardized structure of information provided for analysis (avoiding typos, unique values, and categorizing characteristics inconsistently with others).

10. The process of 3D visualization of campus changes based on information obtained from AI analysis should be grounded in appropriately selecting the generated conclusions. These conclusions allow for determining the attractive and accurate placement of spatial objects within the campus.

11. In the context of campus design, many changes desired by students can be integrated into visualizations. However, some changes, such as improving dormitory conditions or the campus's location, may require adjustments to the scale of visualization. Such adjustments may negatively impact other aspects that should be presented within the visualization. Striking a balance between introducing desired changes and maintaining visualization coherence and clarity is key.

12. The University of Warmia and Mazury in Olsztyn demonstrates considerable flexibility in introducing visible changes in its visualizations. This university serves as a solid foundation for analysing potential modifications that could improve the quality of student life. However, there are many areas where the university still falls short of the "ideal campus" criteria. This highlights the need for further development and infrastructure expansion to fully meet the expectations of the academic community.

13. Despite its usefulness in conducting analyses and providing conclusions, artificial intelligence is currently not equipped to independently generate and logically assign relational spatial objects based on statistical data. These processes still require human intervention to ensure data structure integrity and accuracy in introducing spatial objects. Over time, the existence of AI specialized in these domains is highly probable as technology advances.

14. The analysis of large language models (LLMs) in the context of statistics and inference reveals both their potential and limitations. LLMs, as advanced AI tools, offer significant improvements in data analysis, but their effectiveness depends on the quality, quantity, and structure of input data.

Potential of LLMs in data analysis:

- Enhanced Statistical Analysis: LLMs can efficiently process large datasets, enabling rapid conclusion generation. With their ability to identify patterns and relationships in data, these models can support statistical analyses crucial for scientific research and user satisfaction evaluation.

Drawbacks of LLMs in the context of surveys:

- Data Recognition Issues: LLMs encounter difficulties in interpreting country names formatted in various ways. Such inconsistencies can lead to erroneous statistical analyses, undermining result reliability. For instance, if campus satisfaction data contains different entries for the same country, the model may improperly group responses, affecting overall assessment.

- Inaccuracy of Results: In analysing responses regarding campus satisfaction, LLMs may disproportionately consider individual positive opinions. This selectiveness can result in a university with more votes dropping in rankings despite positive feedback, rendering results unreliable. Additionally, the absence of depreciation considerations in data may lead to an incomplete picture.
- Need for Data Standardization: For LLMs to operate effectively, data must be presented in clearly defined intervals and standardized formats. For example, surveys should include closed-ended questions with a pre-prepared list of countries, minimizing the risk of typos and interpretive errors. Such data collection methods enhance result accuracy and allow for more precise analyses.

LLMs are a powerful tool for data analysis and inference generation. However, their effectiveness is closely tied to the quality, quantity, and structure of input data. To maximize the potential of these models, it is essential to implement standards for information collection and processing. This approach not only improves analysis accuracy but also ensures greater reliability of results obtained through LLMs.

15. Future research directions and Implementation Possibilities

Based on the obtained research results, further analyses can be planned to optimize campus spaces and improve students' living conditions. In particular, future research may focus on:

- Further analysis of student preferences regarding campus development, for example, through more detailed surveys on infrastructure and facility priorities.
- Using artificial intelligence for spatial change modeling and predicting future student needs, which can help better adapt campuses to their expectations.
- Testing different urban planning scenarios using 3D visualizations to examine how infrastructure changes affect functionality and user comfort.
- Developing methods for standardizing input data used in AI analyses, which will increase the accuracy of obtained results and minimize interpretative errors.

The implementation of research findings can take place through collaboration with universities and institutions responsible for academic space planning.

Specifically:

- The results can serve as a basis for designing and modernizing campuses at local and international levels, ensuring better conditions for students.
- Artificial intelligence could be used to create intelligent campus space management systems, improving resource efficiency at universities.
- Recommendations from the analysis may be implemented by university administrations to enhance transport accessibility, organize green spaces, and optimize the location of key service facilities.

Further research in this area may contribute to developing a universal model of the ideal campus, which could serve as a reference point for future investments in academic infrastructure.

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