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MORALITY BEFORE KNOWLEDGE

A web-based educational information system for urban agriculture management as a solution to urban land conversion

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ABSTRACT

Background: Urban industrial development is directly correlated with population density. Data from BPS (Statistics Indonesia) during 1998-2002 indicates a significant conversion of agricultural land to non-agricultural purposes, approximately ±110,000 hectares annually. This highlights the inevitability of urban infrastructure development. As urban expansion reduces agricultural land, population density and food security needs inversely correlate with current land availability. **Methods**: This research uses problem identification, literature review, potential analysis, and strategy design methodology to address agricultural challenges in urban settings. **Finding**: Based on these challenges, we propose the "Soperku (My Agricultural Solution)" website as an innovative solution. Soperku is an internet-integrated platform that facilitates knowledge exchange about urban agriculture preservation and agricultural entrepreneurship. The platform implements urban farming concepts such as vertical farming, hydroponics, and rooftop gardening for urban residences. A key feature is the involvement of competent stakeholders, ensuring the validity of information through a triple helix model, which includes academics, business practitioners, and government entities. These stakeholders collaborate within an integrated framework of information chains, public services, and product marketing. Academic institutions can disseminate research through the Soperku platform, while government support is crucial in creating favorable economic regulations to attract agricultural businesses. **Conclusion**: The Soperku website aims to provide educational services to society and foster agricultural environments in urban industrial settings, making it easier to learn and implement agricultural practices. This initiative benefits younger generations who will become future drivers of Indonesia's economy. **Novelty/Originality**: This article introduces an innovative digital platform that bridges urban development and agricultural sustainability. By integrating triple helix stakeholders and modern agricultural techniques, Soperku offers a novel approach to maintaining agricultural practices in increasingly urbanized environments. This research contributes to the growing body of knowledge on sustainable urban agriculture and digital agricultural education platforms.

KEYWORDS: urban agriculture, triple helix, digital platform

1. Introduction

Indonesia is a country with a high population density. The continuous increase in population density is driven by high birth rates that are not balanced by relatively low mortality rates. This phenomenon leads to various changes in social and economic

structures, particularly in urban areas. The increasing population density also accelerates the growth of the industrial sector, especially in urban infrastructure development. However, behind this rapid development lies a negative impact that must be addressed. The decline in agricultural land in urban areas resulted in shifts in agricultural production within the region (Dadi et al., 2023).

Land that was once used for agriculture is gradually being converted into non-agricultural land, repurposed for infrastructure development and public spaces. According to data from the Central Bureau of Statistics/*Badan Pusat Statistik* (BPS) during the 1998–2002 period, the conversion rate of agricultural land to non-agricultural land reached approximately 110,000 hectares per year. This highlights the rapid pace of land-use changes in Indonesia, especially in urban areas. The most significant decline in rice paddy area occurs in Java (Ganharum et al., 2024). This land conversion exacerbates Indonesia's food security issues, as the reduction of agricultural land area directly leads to a decrease in food production. Additionally, infrastructure development in urban areas poses potential threats to ecosystems. Green spaces, which play a critical role in maintaining environmental balance, are becoming increasingly scarce. The well-maintained ecosystem is being disrupted due to the intensive utilization of land. In this context, Indonesia faces the challenge of balancing infrastructure development with the sustainability of the agricultural sector and food security.

Zero Hunger, part of the Sustainable Development Goals (SDGs), is a global ambition that must be pursued through national development, including in Indonesia. The primary objective of Zero Hunger is to ensure that everyone has adequate access to nutritious and healthy food, eradicating hunger worldwide. However, one of the significant obstacles to achieving this goal is the shrinking agricultural land in urban areas. The rapid transformation causes productive agricultural land in urban areas to be swiftly converted into urban spaces (Dadi et al., 2023). Infrastructure development, the expansion of economic zones, and real estate development took precedence in large cities, reducing the availability of agricultural land and making land conversion inevitable (Li et al., 2024).

To address this issue, efforts are needed to preserve and optimize the use of existing land, enabling agriculture to thrive even amidst urban environments. Urban development should not solely focus on infrastructure but also consider the sustainability of the agricultural sector. By implementing sustainable practices, urban agriculture can contribute to improving social well-being, economic growth, and broader environmental sustainability (Pradhan et al., 2024). Collaboration between the food and industrial sectors is crucial to achieving this balance. This aligns with the Strategic Plan of the Agricultural Research and Development Agency/*Badan Penelitian dan Pengembangan Pertanian* (2010), which emphasizes the importance of superior industry-based agriculture to achieve food self-sufficiency.

In the era of the Fourth Industrial Revolution, technology can be one of the solutions to this issue. A significant positive impact of technological advancements is the rapid and easy dissemination of information. According to the Indonesian Internet Service Providers Association/*Asoiasi Penyelenggara Jasa Internet Indonesia* (APJII) in 2024, around 79,5% or over 221 million people in Indonesia had accessed the internet. This figure indicates that Indonesia has significant potential to utilize technology as a means of disseminating agricultural information, even in densely populated urban areas. The use of devices and sensors integrated with IoT greatly supports precision agriculture and enhances sustainability (Has et al., 2024). Therefore, it is essential for society to access accurate and relevant information on effective urban farming practices, particularly in increasingly developed residential areas.

Based on this perspective, the author proposes an idea that could serve as a solution for urban communities to continue farming amid rapid urbanization. The idea is the "SOPERKU (Solusi Pertanianku) Website," a web-based platform that provides educational and informational services about urban agriculture. Through this platform, the community can learn how to manage limited residential land for agricultural activities, such as vegetable gardening, hydroponics, or vertical farming systems. This study is similar to the

findings of the Digital Agricultural Knowledge and Information System (DAKIS), which primarily focuses on utilizing digital technology to integrate ESS aspects, biodiversity, and sustainability into farmers' decision-making processes (Mouratiadou et al., 2023). However, the SOPERKU system places greater emphasis on urban areas.

In its implementation, the SOPERKU platform will adopt the Triple Helix collaboration method, involving cooperation among three key sectors: government, academia, and industry. The government can act as a facilitator by providing policies and regulations that support urban agriculture. Academics can contribute research and innovations in agricultural technologies suitable for urban areas, while the industrial sector can supply the products or technologies needed by urban farmers. Through this collaboration, it is hoped that the available information and communication technologies can be effectively utilized to enhance urban agricultural productivity. At the same time, this cross-sector collaboration can prevent the misuse of technology that could harm society, such as the dissemination of incorrect information about farming methods or agricultural techniques unsuitable for local conditions.

The SOPERKU platform also aims to introduce urban communities to how agriculture can be an activity that not only supports food security but also offers entrepreneurial opportunities. With the growing scarcity of agricultural land in urban areas, people need to be encouraged to find innovative ways to farm, such as employing modern agricultural technologies that can be applied to limited spaces. Through this platform, urban communities will also be taught environmentally friendly and efficient farming methods, ensuring that urban agricultural activities are not only economically beneficial but also sustainable.

Additionally, the SOPERKU platform can serve as a medium for disseminating information about the importance of maintaining the sustainability of the agricultural sector amid the rapid development of cities. By providing a better understanding of the significance of urban agriculture and how to wisely manage land, it is hoped that the public will become more aware of the impact of land conversion and choose to support environmentally friendly agricultural programs. The SOPERKU platform can be a solution to support the sustainability of urban agriculture by providing useful information and education for the community. Collaboration among the government, academia, and industry is also crucial in creating a sustainable agricultural ecosystem, allowing urban communities to continue farming amidst rapid urban development. The author's rationale is as follows:

SOPERKU is a web-based platform adopting the Triple Helix concept, designed to provide innovative solutions to urban agriculture challenges. This website integrates information technology to offer education on urban farming, focusing on plant cultivation in limited spaces, which are common in urban housing areas. SOPERKU brings together three key elements—academia, business, and government—that work collaboratively to create a more efficient and sustainable urban agriculture system. What sets SOPERKU apart from other platforms is its application of the Triple Helix model, which combines the roles of academia, the business sector, and the government. These three parties work synergistically to achieve a shared goal: the development of better urban agriculture systems. Academia plays the role of a source of valid knowledge and information. In the context of SOPERKU, academics provide correct information about land management techniques, superior seed and seedling selection, and various innovations tested in the field of agriculture. They also act as agents for publishing research findings or new ideas beneficial to society, as well as educating the public on the importance of agriculture and ways to optimize limited land in urban areas.

The business sector or entrepreneurs act as agents providing materials or products needed for urban land management. They are the ones supplying various agricultural products, such as seeds, fertilizers, farming tools, and technologies supporting urban agriculture. Through SOPERKU, urban communities will no longer have difficulty sourcing the items or materials they need as these will be made available on this platform. The government serves as the policymaker supporting urban agriculture development. Government policies related to infrastructure and economic development in urban areas

greatly affect the agricultural sector. With SOPERKU, the government can facilitate policies that support urban farming, such as providing incentives for communities to farm on limited land, enacting regulations supporting sustainable agriculture, and offering agricultural outreach programs based on technology.

SOPERKU is designed to address various problems faced by urban communities, particularly the lack of educational information about agriculture. One of the main goals of SOPERKU is to provide insights and information about the potential of urban land, particularly in residential areas, to be converted into agricultural land. Under conditions of limited land, this platform will provide information on various agricultural techniques that can be applied in small spaces, such as hydroponics, vertical farming, or plant cultivation using pots. The SOPERKU website also aims to introduce the concept of urban agriculture to urban communities. Through this platform, people can access information about effective and environmentally friendly farming methods. Moreover, the website serves as a venue for academics to publish works or innovative ideas that can be implemented in society, as well as market products resulting from academic work and materials needed for farming activities. SOPERKU emphasizes the importance of collaboration among the three parties in urban agricultural development. The role of the Triple Helix on this website is to create a mutually supportive ecosystem between academics, businesses, and governments. Through close collaboration, these three parties are expected to develop effective innovations and solutions to tackle urban agricultural problems. One of the biggest challenges in developing urban agriculture is the lack of easily accessible information for the public. SOPERKU aims to solve this by providing a platform that can be accessed easily by all groups, including urban communities living in residential areas. Thus, SOPERKU can become a valuable resource for information about agriculture, accessible anytime and anywhere.

The main benefit of SOPERKU is as a means of connecting academics, entrepreneurs, and the government on an integrated platform. SOPERKU provides useful information about how to optimize limited residential land into productive farmland. Urban communities can learn farming methods that are efficient and environmentally friendly, not only for personal consumption but also to generate additional income. The surplus production in urban agriculture can be sold to increase household income or create employment opportunities for the local community (Yuan et al., 2022). This website connects three parties playing critical roles in urban agricultural development. Academics supply knowledge, entrepreneurs provide products and services, and governments create supporting policies. With this collaboration, information and innovations in agriculture can continue to develop and be practically applied. Through SOPERKU, communities can gain deeper insights into the potential of urban agro-industry. As technology-based agricultural industries continue to develop, urban communities can seize opportunities to become entrepreneurs in agriculture, such as by developing vertical farming, hydroponics, or aquaponics businesses. SOPERKU also provides a platform for academics to publish ideas or innovations in agriculture. Thus, urban communities not only receive existing information but also new ideas that can be implemented to improve agricultural productivity in limited spaces.

SOPERKU is a highly beneficial platform for urban communities who want to use their limited spaces for agriculture. By employing the Triple Helix model, this website integrates the roles of academics, entrepreneurs, and governments to develop sustainable urban agriculture. Furthermore, SOPERKU serves as a valuable information resource for urban residents regarding effective and efficient farming techniques in small spaces. With this platform, it is hoped that more productive, innovative, and sustainable urban agriculture can be achieved, supporting food security in Indonesia. Benefits of Writing: Provides a resource on the concept of transforming residential land into agricultural spaces for self-consumption or sale. Connects academics, entrepreneurs, and governments to create a correlation of updated information in the agricultural sector. Expands knowledge about agriculture, particularly in urban agro-industry potential. Generates ideas, innovations, and advancements in agriculture displayed through an integrated website, making them easily accessible via the internet.

2. Methods

The preparation of this scientific paper involved systematic steps to gather relevant information and data regarding the potential of the SOPERKU website as a solution for urban agriculture. These steps were crucial to ensuring that the concept and design of the website could be appropriately implemented according to its intended needs and objectives. The process began with identifying the issues in urban areas and proceeded to formulating recommendations useful for the website's development and its implementation in the community. In this section, the author explains each stage undertaken in detail.

The first step in the preparation of this scientific paper was to observe and analyze the issues faced by urban communities, particularly those related to the agricultural sector. Considering that agricultural land in urban areas is increasingly limited due to land-use changes, it was essential to understand how the management of urban agricultural land could be optimized. Additionally, the author observed the lack of available information for the community regarding efficient farming methods in limited spaces. Observations of these conditions formed the basis for determining the objectives and direction of the SOPERKU website development. These identified issues served as references for designing the website, focusing on providing practical and relevant information for urban communities.

After identifying the relevant issues, the author proceeded to the stage of determining the literature collection techniques. This was carried out by compiling various literature relevant to the topic of urban agricultural development and the potential of information technology to support the agricultural sector. The collected literature comprised printed and electronic sources, including academic journals, conference proceedings, textbooks, and trusted articles discussing innovations in agriculture and the use of technology in urban farming. In selecting the literature, the author focused on credible and relevant sources aligned with the topic of this scientific paper. Printed literature, such as books and scientific journals published by universities and agricultural research institutions, provided theoretical foundations necessary to understand basic concepts related to urban agriculture and agricultural technology. Meanwhile, electronic literature, particularly e-journals published by international research institutions, offered broader perspectives on the latest developments in agriculture and the application of information technology in the field. This literature collection technique also included searching digital databases providing access to various scientific publications that could support the understanding of the discussed topic.

After collecting the relevant literature, the next step was conducting a literature analysis. In this phase, the author examined and analyzed the content of each collected piece of literature to assess its credibility and relevance to the objectives of this paper. The purpose of the literature analysis was to find a robust theoretical basis and data that could be used to design the SOPERKU website. The analysis included evaluating existing information and exploring solutions already implemented in prior research or case studies related to urban agriculture. For example, studies on hydroponic cultivation, vertical farming, or the use of smart farming systems in limited spaces could serve as references for designing the features needed for the SOPERKU website. From this literature analysis, the author could uncover new concepts relevant to website development, offering practical solutions for urban communities.

After completing the observation and literature analysis stages, the next step was formulating strategies and designing the SOPERKU website model. In this phase, the author designed the structure and content of the website. The model design included layout arrangement, user interface design, and selecting features that would make it easier for users to access information about urban farming techniques. The SOPERKU website was designed to include various features facilitating urban communities to utilize limited land for farming. Key features considered in the website design included educational modules on farming techniques, a marketplace for agricultural supplies, and forums or discussion spaces for academics, entrepreneurs, and the community to share knowledge. The author also considered interactive elements, such as video tutorials or interactive articles, to help users better understand how to farm in small spaces. Additionally, the model design

included choosing the appropriate platform for developing this website, both technically (e.g., server and software) and in terms of design (e.g., appearance and usability). A simple, intuitive, and user-friendly design was deemed critical to ensuring that the website would be accessible to people from various technical backgrounds, from those familiar with technology to those less experienced with internet usage.

After completing the data collection, literature analysis, and website model design, the final step in preparing this scientific paper was formulating suggestions or recommendations. At this stage, the author provided recommendations focusing on the implementation and development of the SOPERKU website to achieve its intended goals. Potential recommendations included steps that the government, entrepreneurs, and academics could take to promote and optimize the website's use in urban communities. Other recommendations involved marketing strategies to introduce the SOPERKU website to urban residents living in residential areas and how to involve urban farming communities in developing and disseminating the platform. The author also suggested continuous evaluation of the website's use after its launch to determine whether it positively impacts urban agricultural development and identify potential improvements based on user feedback.

This scientific paper utilized document analysis as a data collection technique. This technique was employed to obtain information and data from various literature sources, both printed and electronic. The author collected data related to the topic of urban agricultural development, agricultural technology innovation, and the application of information technology in supporting the agricultural sector. The data obtained from these various sources were then analyzed to develop conclusions underlying the recommendations for the development of the SOPERKU website.

3. Results and Discussion

3.1 Urban land, especially residential areas, as agricultural land

The demand for land for non-agricultural activities continues to increase in line with rapid population growth and the expansion of economic sectors. The conversion of agricultural land into non-agricultural uses is an unavoidable phenomenon resulting from these trends. Often, this land-use change does not occur in isolation but spreads progressively to surrounding areas. This phenomenon highlights significant pressure on agricultural land, ultimately contributing to its reduction. This phenomenon frequently occurs in urban areas, whereas in rural regions, land conversion depends on farmers' decisions. In the case of Pandaan, East Java, farmers resist converting agricultural land due to deeply held values, viewing it as a family inheritance that must be preserved for agricultural purposes (Prayitno et al., 2021).

According to Setiawan (2016), land conversion is often closely tied to regional development processes. In fact, land-use change can be considered a consequence of such development. This phenomenon is typically driven by urgent needs for housing, industry, and other infrastructure, often implemented without considering long-term impacts on food security and environmental sustainability. In many cases, land conversion occurs on a massive scale, reflecting disparities in land ownership. This process is generally exploited by entities with significant capital, such as large corporations or wealthy individuals with easier access to government permits. Ironically, government policies related to the agricultural sector tend to be unsupportive. This is evident in the increasing conversion of agricultural land into residential, industrial, or other commercial areas. Governments prioritize fulfilling non-agricultural development needs, often at the expense of natural resources and food security. Consequently, the agricultural sector becomes marginalized and falls victim to poorly planned development. Land-use conversion is not merely a socio-economic issue but also encompasses environmental aspects. When agricultural land is repurposed for non-agricultural uses, the impacts can be substantial, particularly in terms of reduced food production capacity. Therefore, it is crucial to establish more prudent

policies and greater attention from both the government and society to balance development needs with the preservation of the agricultural sector.

More than half of the world's population resides in urban areas, indicating urban activities dominate large parts of the globe. According to Statistics Indonesia (BPS, 2013), the urban population in Indonesia has also been growing, with projections for 2025 indicating that six out of ten Indonesians will live in cities (Proyeksi Penduduk Indonesia 2015–2045 Hasil Supas 2015). Cities are perceived as offering more efficient economies because most development is concentrated in urban areas. However, continuous urban development has led to increasing land-use conversion, resulting in diminishing land availability. The urban population growth rate, averaging 2.18% per year, is significantly higher than the rural growth rate of only 0.64% annually.

Residential development in urban areas also contributes to land-use conversion. However, this trend is difficult to avoid due to the steadily increasing population. According to National Development Planning Agency of the Republic of Indonesia/*Badan Perencanaan Pembangunan Nasional Republik Indonesia* (Bappenas, 2013), Indonesia's population reached 265 million in 2018, a number that continues to grow each year. With an increasing population, the demand for housing and food also rises, while available land becomes increasingly scarce, and productive agricultural areas are repurposed.

The growing population density annually leads to productive agricultural land being converted into industrial development aimed at meeting human needs, such as housing and shopping centers like malls or supermarkets. The reduction of agricultural land, accompanied by a steady increase in food demand, has led to higher food import rates. Based on BPS data, food imports reached 21.64% from January to June 2018. This figure indicates that food dependency in Indonesia will continue to rise if productive land continues to be converted. According to Indraprahasta (2013), one of the main challenges in urban areas is food security. This issue arises from the high demand for food that cannot be met solely by agricultural land production. Factors such as shrinking agricultural land, a shortage of labor in the agricultural sector, and high production costs compared to low yields are the primary causes of this inability to meet urban food needs. Urban areas, with limited agricultural land, heavily depend on surrounding buffer zones to fulfill their food requirements.

However, as development encroaches upon these buffer zones, agricultural land diminishes, directly impacting agricultural production. Consequently, the food supply to urban areas becomes increasingly constrained. Addressing these issues requires urban areas to reduce dependency on buffer zone food supplies by enhancing food security at the household level. According to Yunastiti (2008), household food security is related to food availability, distribution, and consumption, which can be addressed by utilizing limited land for agricultural activities. One potential solution is to promote horticultural farming in urban areas, such as utilizing green spaces or household cultivation of vegetables and medicinal plants, which has recently experienced significant growth. Agrarian practices in urban environments create a new space known as urban agriculture architecture, where production generates not only private goods such as food but also public goods (Nowysz et al., 2022).

The use of limited land for urban agriculture, particularly horticulture, offers a relevant solution for maintaining food security in urban areas. Furthermore, advancements in agricultural cultivation techniques provide urban residents with opportunities to achieve independent food security, even on a household scale. Innovations such as vertical farming, hydroponics, and aquaponics are now accessible to urban communities. As a result, urban agriculture contributes to economic, social, and environmental aspects within the framework of sustainable development (Nowysz et al., 2022).

Setiawan (2016) notes that Indonesia's agricultural sector has been declining, even though some citizens still pursue agriculture. However, with the rapid pace of urban development, agricultural land is becoming increasingly scarce. This situation significantly impacts food security, particularly in urban areas, which are increasingly reliant on external food supplies. The massive land-use conversion, especially for infrastructure and

residential development, leaves limited space for agriculture. Thus, it is imperative for society and the government to seek long-term solutions to ensure the sustainability of agriculture and food security, both in urban and rural areas.

Moreover, technology plays a critical role in addressing food security challenges. E-learning, for example, offers a platform for educating and training urban communities on modern agricultural techniques applicable to limited land. According to Rosenberg (2001), e-learning refers to the use of internet technology to deliver solutions that enhance knowledge and skills. Cambell (2002) and Kamarga (2002) similarly emphasize the importance of internet use in education as the core of e-learning. Onno W. Purbo (2002) explains that the "e" in e-learning refers to the use of electronic technologies, such as the internet, satellites, audio/video tapes, interactive TV, and CD-ROMs, to support teaching and learning processes.

E-learning can be delivered synchronously (in real-time) or asynchronously (at different times). Learning materials may include text, graphics, animations, simulations, audio, and video, accessible to learners at any time. This method enables interaction and discussion among learners with the support of experts in their respective fields. Unlike traditional learning, where teachers are the primary source of knowledge, e-learning promotes active learner involvement. Learners must independently search for materials and plan their own learning.

Thus, e-learning holds significant potential to support education and outreach on household-level food security, particularly for urban residents. E-learning can enhance public knowledge of environmentally friendly, efficient agricultural techniques applicable to limited spaces, such as horticulture and urban farming. Households in Makassar, Indonesia, particularly the Women Farmers Group, engaged in urban agriculture, primarily hydroponics, which helped enhance family income and food security (Mardiana et al., 2024). By leveraging this technology, urban communities are expected to achieve greater independence in food security, reduce dependence on buffer zones, and contribute to the sustainability of Indonesia's agricultural sector.

3.2 Concept, implementation, and implications of the SOPERKU website for urban communities

3.2.1 Concept of the SOPERKU website

According to Romney (1997), as translated by Krismiaji (2002), an information system is an organized set of methods for collecting, inputting, processing, and storing data, as well as managing, controlling, and reporting information to help organizations achieve their predetermined goals. An information system combines people, information technology, and organized procedures to provide information necessary for managerial decision-making and support operational activities. Simply put, an information system is an organized and managerial method of storing, managing, and reporting required information. Information systems play a critical role in efficiently collecting, storing, and managing data while facilitating data modification for research or observation purposes. These systems also simplify access to reliable and accurate data for the general public, especially academic communities. Additionally, information systems support modern marketing systems by allowing product and service information to be easily accessed by consumers.

According to Jovan (2007), a website is a medium for delivering information via the internet. Jasmadi (2006) explains that a website consists of a collection of web pages and supporting files, such as images, videos, and other digital files, stored on a web server and accessible via the internet. Yuhefizar (2008) further states that a website, or the World Wide Web (WWW), is a collection of web pages containing information. Based on these perspectives, a website can be defined as a collection of web pages presenting information in various formats, including text, static or dynamic images, animations, sound, video, or a combination of these media. These web pages are hosted on web servers and accessible via the internet to anyone seeking the information they contain. Thus, both information

systems and websites are crucial for disseminating information that can be accessed by diverse parties, supporting business, academic, and other sectors requiring effective data and information management.

A website is a versatile solution as it is accessible anytime and anywhere, making it an effective medium for disseminating information on a global scale. Websites encourage users to actively engage with internet-based information systems, enabling a deeper understanding of such systems. The SOPERKU website features an initial homepage displaying various concepts of land management and innovative works from academic research (faculty, students, and researchers) and products marketed by business agents. Challenges faced by the community can be communicated through a chat room, which connects users with academic experts. The academic contributors are primarily from university agricultural faculties, ensuring that information provided is valid, as it originates from academic data and opinions.
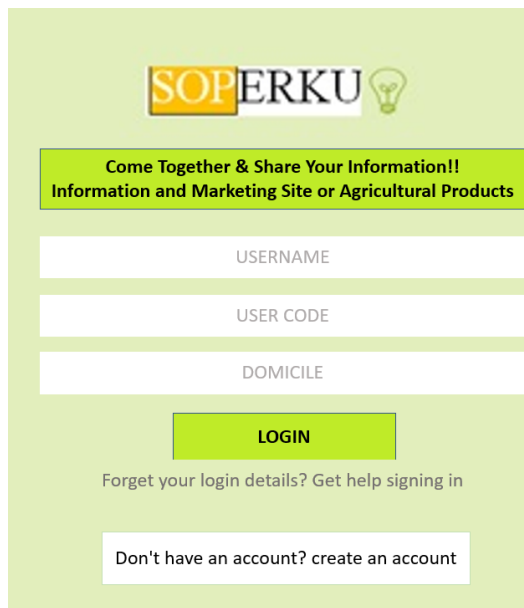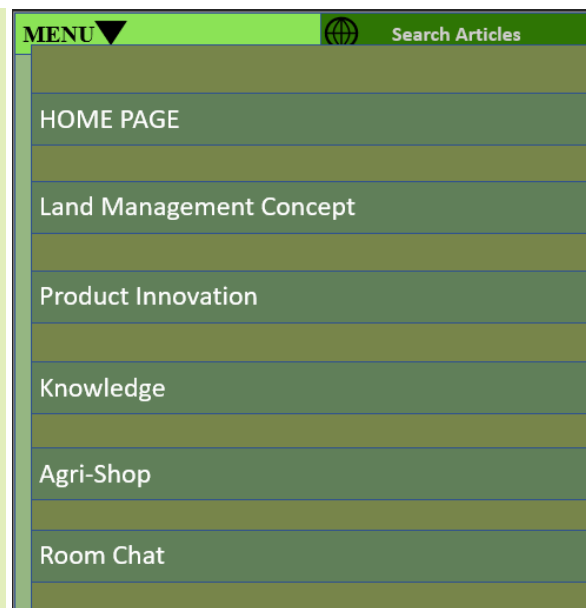
Fig. 1. Website concept   Fig. 2. Menu of SOPERKU

The SOPERKU website login system is categorized into four user types: academics, businesspeople, the general public, and the website's founders (Fig. 1). The website offers six primary features: Homepage, Land Management Concepts, Product Innovations, Knowledge, Agri-Shop, and Chat Room (Fig. 2). Homepage: Displays the latest and most popular information posted by contributors or producers; Land Management Concepts: Contains various land management concepts, such as vertical farming or hydroponic cultivation techniques. When users click on a specific technique, they are presented with detailed information, including processes, materials, required equipment, and tips for maintaining healthy plants; Product Innovations: Highlights innovative research products developed by academics that the community can apply to urban agriculture. This feature is divided into four categories: New Posts, Faculty, Students, and Researchers/Institutes. The faculty and student categories are further subdivided by university origin; Knowledge: Provides information from student, faculty, and institutional writings, journals, theses, or articles to disseminate agricultural knowledge. Subcategories include Agricultural Cultivation Techniques, Fisheries, Animal Husbandry, and Forestry. This feature aims to help users easily find the information they need; Agri-Shop: Offers information on agricultural products, including academic innovations, food products, vegetables, spices, and fruits sold by entrepreneurs. Entrepreneurs must undergo verification procedures to ensure the authenticity of their accounts and products. Each product listing includes a chat button, enabling communication between customers and entrepreneurs.; Chat Room: Serves as a platform for users to ask questions, provide suggestions, and offer feedback to

information providers, product producers, and the SOPERKU founders. This feature can also be expanded into a discussion room, fostering idea generation, collaborative problem-solving, and the exchange of knowledge and technology among the triple helix participants and the broader community.

3.2.2   Implementation of the SOPERKU website

3.2.2.1 Overview of services and features

In In the modern era, the agricultural sector is increasingly transforming and adapting to technological advancements. Automation and internet integration in agricultural production demonstrate that the sector is not only a traditional activity but also a contributor to the fourth industrial revolution (Industry 4.0), where real-time data exchange serves as the foundation of production processes. Consequently, advanced technology and digitalization are becoming integral to agriculture, which historically relied on manual and conventional methods.

Irianto (2017) identifies several key challenges for Industry 4.0. These include the readiness of industries to adopt and adapt to new technologies, the availability of skilled labor, cultural and social acceptance of change, and the diversification and creation of new jobs. Opportunities in Industry 4.0 arise through ecosystem innovation, the development of competitive industrial bases, technological investment, and the integration of small- and medium-sized enterprises (SMEs) with entrepreneurship.

In this context, collaboration among multiple stakeholders is critical. The triple helix concept—uniting academics, government, and industry—emphasizes the importance of such partnerships. Dewi (2009) highlights that the triple helix fosters creativity, innovation, and technology in society. Educated and intellectual human resources are essential to drive creativity and technological advancements. Collaboration among academics, the government, and business stakeholders offers a comprehensive solution to address challenges and propel progress in agriculture and other sectors.

Aribawa (2016) notes that the triple helix concept is central to the government's creative economy development goals for 2025. In this framework, society becomes an essential element alongside the government, business sectors, and academia. The triple helix aims to promote sustainable economic growth, inform appropriate policy directions, and maintain a competitive business environment in the global market. This model underscores the need for multi-stakeholder involvement in addressing agricultural challenges and optimizing technological solutions.

Technological integration, such as e-government, also supports agricultural transformation. Al-Hakim (2007) defines e-government as the use of information and communication technology (ICT) to make governance more accessible, effective, and accountable. This transformation integrates organizational changes with skill development, public service improvements, and democratic participation in policy-making. E-government redefines government-public relationships through technology and strategic organizational resources.

In terms of legal aspects, Indonesia has a strong legal framework for land management in agriculture. Law Number 5 of 1960 concerning Basic Agrarian Principles (UUPA) provides a legal foundation for land management. The UUPA regulates state control over land to sustain agricultural sector development and ensure sustainable land management. Article 2 of the UUPA explicitly emphasizes the importance of land management for national development, particularly in the agricultural sector, which remains vital for the country's economy. Therefore, the conversion of agricultural land to non-agricultural use must be more strictly regulated (Gandharum et al., 2022).

Furthermore, the development of information systems in agriculture often utilizes the System Development Life Cycle (SDLC) methodology. SDLC is a structured method comprising planning, analysis, design, and implementation phases used to develop information systems. According to Azhar (2004), SDLC is commonly applied to solve issues

in system development. In agriculture, SDLC can be used to design systems that support agricultural data management, such as three-dimensional modeling of crops, which facilitates monitoring and care through computer technology. Suryowinoto (2017), in his research on agriculture, states that SDLC can be utilized to design and analyze three-dimensional crop modeling, offering advantages in efficiency and accuracy in technology-based agricultural management.

Thus, Indonesia's agricultural sector, through technological adoption and the collaboration of various stakeholders via the triple helix model, is prepared to address challenges and capitalize on opportunities presented by Industry 4.0. The implementation of e-government, clear land management policies, and methodologies like SDLC will propel the agricultural sector toward significant advancements, enhancing efficiency and supporting national food security in the future.

SOPERKU is a service platform that integrates agricultural information and product marketing through a website. It serves as an educational medium, a space for discussions with experts, and a marketplace for agricultural products, ensuring fair and transparent transactions. The following describes the workflow of the SOPERKU website for its three main user groups: 1) Academics (faculty, students, researchers): Share ideas, upload innovations, and provide expert insights on agricultural techniques. 2) Entrepreneurs: List and sell verified agricultural products and tools. 3) General Public: Access educational materials, purchase agricultural products, and engage with experts through discussion forums.

3.2.3 Implications of the SOPERKU website

The utilization of the SOPERKU website as an educational and product marketing platform for agricultural materials and tools offers several advantages over other platforms. These advantages include enabling urban communities to utilize available land, especially in residential areas, for cultivating crops. This cultivation activity can result in food products for personal consumption or sale, thereby increasing awareness of the importance of preserving agricultural land. For Academics: Faculty, students, and researchers can contribute agricultural techniques and innovations to the website, enhancing creativity and advancing Indonesia's agricultural sector with the help of cutting-edge technology. SOPERKU allows academics to share research outputs directly with the public, fostering innovation and collaboration. For Entrepreneurs: The platform enables the sale of essential items needed for urban agriculture. Entrepreneurs listing products undergo a rigorous verification process, ensuring authentic and credible accounts. The marketplace feature includes tools, seeds, fertilizers, and other resources necessary for urban farming. For the Public: The public can access expert agricultural knowledge, purchase tools and materials, and participate in interactive discussions. These activities aim to empower urban communities to maximize limited land for productive agricultural use, improving food security at the household level. Urban agriculture plays a role in enhancing food security by providing easier access to fresh fruits and vegetables for households vulnerable to food shortages (Arogundade et al., 2020). The government's role is also crucial in supporting the platform by creating regulations to protect fertile agricultural land, providing financial support for agricultural ventures, and ensuring consumer and producer protection. With support from universities as information agents, entrepreneurs as producers, and the public as users, SOPERKU is poised to become a transformative platform for urban agricultural development.

3.3 The Triple Helix collaborative framework

The Triple Helix collaborative framework for SOPERKU represents a comprehensive, synergistic approach to urban agricultural development, strategically integrating four key stakeholders: academicians, businesses, government, and community. Academicians serve as knowledge generators, providing scientifically validated cultivation techniques,

innovative research insights, and impact assessments for urban agricultural practices. Academic institutions can make a significant contribution to the development of urban agriculture by offering training programs and conducting research (Richardson et al., 2024) Business actors function as critical infrastructure providers, supplying essential agricultural inputs, facilitating product marketing, and sharing market-oriented agricultural entrepreneurship perspectives. Government entities play a pivotal regulatory and supportive role, developing strategic policies, monitoring agricultural product pricing, managing agricultural investment frameworks, and attracting potential investors to urban agricultural initiatives. The community, positioned as both information recipients and active implementation agents, transforms theoretical knowledge into practical agricultural interventions, simultaneously serving as consumers and drivers of urban agricultural innovation. This multifaceted collaborative model ensures a holistic, sustainable approach to addressing urban agricultural challenges by creating an integrated ecosystem that promotes knowledge transfer, technological innovation, and practical implementation across different societal sectors.

3.4 Introduction of the SOPERKU website to urban communities

The information is readily accessible, especially with the presence of the internet (Fig. 3). In cyberspace, various types of information can be found, not only enhancing knowledge within Indonesia but also globally. The utilization of the internet as an information medium has grown rapidly, creating significant opportunities to establish platforms focused on specific topics. One such platform is the SOPERKU website, which aims to provide information about urban agriculture and educate the community on this topic.

Fig. 3. The information in SOPERKU

The SOPERKU website was developed with a primary focus on urban agriculture, using a memorable name to make it easier for users to find it via search engines like Google. The design of the SOPERKU website was carefully considered, employing non-distracting colors and avoiding excessive features. Too many features can make a website cumbersome, affecting access speed and potentially leading to visitor impatience and abandonment of the site. Thus, a simple yet efficient design is crucial to ensure visitors feel comfortable navigating the site.

Additionally, SOPERKU employs online promotional strategies supported by social media tools to introduce the website to a broader audience. Social media promotion enables greater interactivity, increasing follower engagement. The use of the internet, particularly social media platforms such as WhatsApp and Instagram, in agricultural product marketing

helps reduce costs, improve efficiency, and drive sales growth by increasing demand (Inegbedion et al., 2020). This approach attracts visitors to the site, not through compulsion but by demonstrating that the products and services offered by SOPERKU are genuinely useful and trustworthy. One of the flagship features of the SOPERKU website is its question-and-answer section on agriculture. This feature facilitates interaction between the public and experts or academics specializing in agriculture. Additionally, the "sharing" feature allows visitors to share content they find helpful with others and direct them to the website's links. This feature encourages more traffic to the SOPERKU website, as visitors can engage directly, share knowledge, and obtain relevant information for their needs.

Introducing the SOPERKU website to urban communities requires a well-planned strategy, one of which is establishing online business credibility. This can be achieved through media coverage or positive reviews from influential blogs. Strong statistics and favorable reviews of SOPERKU's products or services will enhance the website's visibility. Visitors are more likely to trust testimonials and reviews from others who have already used the website, as this provides reassurance about the products offered. Customer testimonials play a vital role in introducing the website. Positive reviews from customers can serve as references for potential users considering purchasing products or services via SOPERKU. As more visitors express satisfaction with their experiences, they are likely to provide testimonials that enhance the website's reputation among prospective users. An introduction strategy that combines credibility-building, online promotion, and interactive features such as Q&A and content sharing will help the SOPERKU website gain recognition among urban communities. This approach is critical to creating a platform that not only offers relevant information but also fosters meaningful interactions among stakeholders involved in urban agriculture.

4. Conclusions

The SOPERKU website addresses the issue of urban land conversion by leveraging internet technology as an information system in the era of Industry 4.0. This platform facilitates collaboration within the triple helix framework (academics, government, and businesses) to interact directly with the public. The website explores the potential of urban residential areas to be transformed into promising agricultural spaces. Additionally, it offers features tailored to meet the needs of urban communities.

The Chat Room feature is a particularly valuable addition, serving as a forum for discussions and Q&A sessions among triple helix participants (academics, entrepreneurs, and the public). The features available on the website aim to educate urban communities about agriculture. The SOPERKU website's design is crafted to attract visitors; however, its successful launch requires strategies to introduce it to urban communities. Therefore, SOPERKU will collaborate with media outlets to enhance discoverability. Simultaneously, content quality, innovation, and features must be continuously improved to ensure visitor satisfaction with the website's services.

The following recommendations are proposed based on this research. For Academics: Increase research efforts on urban agriculture. For Entrepreneurs: Develop businesses and innovate products, tools, and materials for agricultural support. For the Government: Incorporate urban agriculture considerations into policy strategies. For the Public: Pay greater attention to the agricultural sector, as it is a crucial source of food.

Author Contribution
Conceptualization, N.I.D.A. and R.H.; Methodology, R.H. and R.A.J.P.; Investigation, N.I.D.A., R.H., and R.A.J.P.; Data curation, R.A.J.P.; Writing – original draft preparation, N.I.D.A.; Writing – review and editing, R.H. and R.A.J.P.

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