

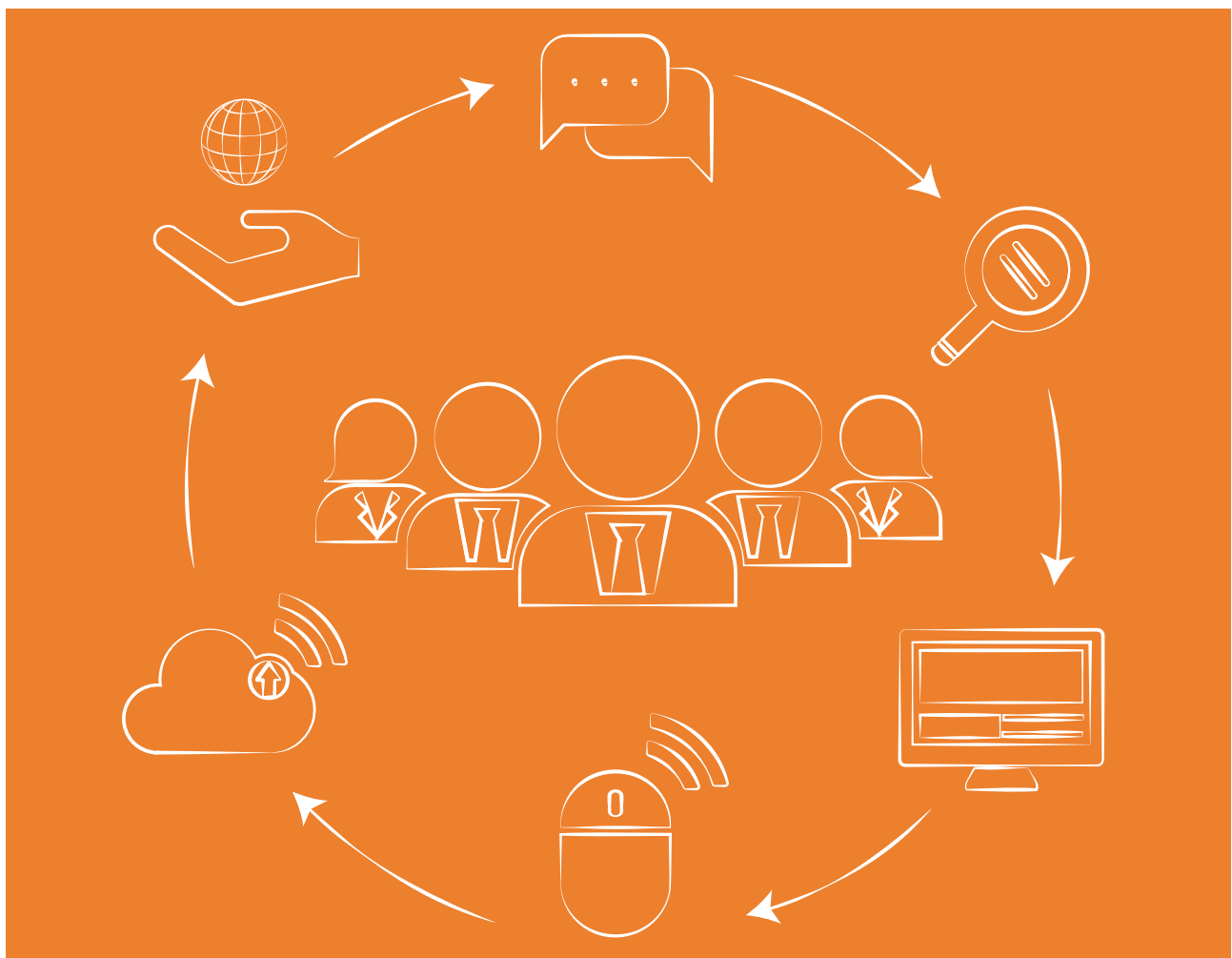


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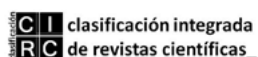
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/01/

THE APPLICATION OF RIVET, HAP, AND ECOTECT PROGRAMS FOR THE ANALYSIS OF BUILDING ENVELOPE PARAMETERS TO OPTIMIZE ENERGY EFFICIENCY AND ENERGY SAVINGS: A CASE OF BAGHDAD-IRAQ

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ABSTRACT

With the growing emphasis on energy conservation and emission reduction in Iraq, there has been a rising focus on the consumption of energy in buildings. This phenomenon is attributable to its substantial contribution to aggregate energy consumption within society. Consequently, the primary focus of energy conservation research has been directed towards this particular domain. There has been a growing emphasis in energy conservation research on public buildings characterized by elevated levels of energy consumption. The examination of energy conservation in expansive public structures carries substantial practical significance and societal value. This study employs a building in Baghdad City - Iraq, as a case study. The research was centred on the execution of experiments pertaining to insulation, the ratio of windows to walls, and the thickness of window glass. A comparative analysis was undertaken through the implementation of simulations that considered the climatic conditions of the Baghdad- Iraq region. In order to evaluate energy efficiency, a variety of software applications were utilized, namely Revit, Ecotect, and Hap. The results showed that when analyzing the climate of Baghdad, it was observed that the total cooling savings ranged from 2.34% to 2.45%. As a result, it was determined that the optimal insulation thickness is 11cm. Additionally, it was observed that the energy savings in cooling remained consistent. The analysis of window-to-wall ratios has shown that the highest level of savings can be achieved by maintaining a window-to-wall ratio of 50%. During the calculation of window glass thickness, it was discovered that in the city of Baghdad, the ideal glass thickness is 2mm. This thickness leads to a 1% reduction in annual energy consumption for cooling purposes. The results of this study are significant as they can significantly contribute to reducing energy consumption. Furthermore, the authors highlight the potential for improving energy efficiency in the buildings situated within the specified study area.

KEYWORDS

Energy Saving Optimization; HAP; Ecotect; Revit; Building Envelope; Sustainable Buildings.

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1. INTRODUCTION

The role of energy is of utmost importance in the social and economic advancement of any given nation [1]. Based on data provided by the International Energy Agency (IEA), the final energy consumption of the worldwide building sector in 2007 amounted to 2,794 million tons of oil equivalent (Mteo). According to [2], the building sector is responsible for approximately 34% of the global final energy consumption, thus establishing itself as the most significant consumer sector. Based on the reference scenario provided by the International Energy Agency (IEA), it is projected that the building sector will continue to be the primary consumer by the year 2030, accounting for a consumption share of 32% (equivalent to 3,639 million tons of oil equivalent). According to [2], the energy demand is projected to increase at an annual average rate of approximately 1.2%, while the overall final energy consumption is expected to grow at a rate of 1.4%.

The demand for indoor environments and comfortable buildings has experienced a gradual increase among individuals as Iraq's economy continues to grow. It is anticipated that there will be a subsequent rise in the energy consumption of residual buildings in the future. The aforementioned rise in energy production poses a significant obstacle to both the preservation of national energy security and the promotion of environmental sustainability. The management and mitigation of energy usage in residual infrastructure play a pivotal role in fostering sustainable development within the context of Iraq.

The main sources of potential energy savings in residual buildings include the energy saved through building envelopes and equipment systems, as well as the energy saved through effective management and behaviour in equipment operation and maintenance [3, 4]. The transfer of heat between buildings and the external environment takes place through the building envelope. The efficiency of the building envelope has a direct impact on the amount of heat exchange that occurs, which in turn affects the overall energy consumption of the building. Therefore, improving the performance of the envelope of a residual building on a large scale is a practical method for increasing the building's energy efficiency ratio.

Numerous studies have examined and evaluated energy-saving schemes by conducting energy consumption simulations. The study conducted by [5] investigated the sensitivities of energy consumption for building heating and refrigeration across four distinct climate zones in Turkey. The researchers also examined the effects of various design parameters on the system, such as the heat transfer coefficient of the building envelope, the orientation of the building, the depth of the structure, the height of each story, and the ratio of windows to walls. The findings of the study prompted the formulation of precise recommendations for each parameter. [6] Utilized DeST's methodology in their study to develop dynamic energy consumption simulations. Yi and Malkawi [7] proposed a methodology with the goal of optimizing the design of building forms. This methodology focuses on the energy consumption related to heating and cooling systems. The goal of the genetic algorithm is to optimize the

reduction of heat transfer between indoor and outdoor environments. A windowless hypothetical structure was used to study the use of natural daylight and artificial lighting. In their study, [8] conducted an optimization procedure that failed to take into account the effects of energy and transmitted solar radiation. The purpose of this study was to investigate how building form and urban patterns affect the energy consumption of air-conditioned buildings in different desert environments. In the study conducted by [9], a selection of three innovative insulation materials was made, namely gypsum, vermiculite, and an ethylene-vinyl acetate (EVA) copolymer. Subsequently, an assessment was conducted to gauge the efficacy of said materials in tropical regions of Brazil, with a comparative analysis against traditional envelopes frequently employed within the region. The researchers of the study observed that the novel materials exhibited a reduction in the thermal load of buildings by 38%. [10] Introduced a nondestructive testing technique for assessing the integrity of insulation walls. This methodology entails the quantification of air temperature and humidity levels within both internal and external building environments, as well as the interstitial spaces between insulation panels and walls. A novel instrument has been devised for the purpose of quantifying the thermal and humidity properties of architectural building envelopes. The measurement results that were obtained were subsequently subjected to analysis using mathematical techniques. The study conducted by Yang et al. [11] examined the influence of the window-to-wall ratio (WWR) on the energy consumption for heating and cooling in residential buildings located in the hot summer and cold winter climate zone of China. According to their report, the critical factors in determining the optimal window-to-wall ratio (WWR) include the air conditioning system, window orientation, and the types of glazing used. The study of [12] focused on optimizing energy consumption in buildings by improving the building envelope parameters for a default residential building in Konya- Turkey.

Energy efficiency is widely regarded as the most efficacious strategy for effectively addressing both economic growth and environmental preservation on a global scale. The exponential growth in global fuel demand has substantial implications for elevated international prices and its contribution to the phenomenon of global warming. Therefore, it has become imperative to redirect our attention towards tactics that facilitate fuel conservation and investigate alternative energy sources, all the while embracing innovative technologies that are more compatible with our evolving requirements. At present, there exists a multitude of global advancements that place emphasis on the adoption of policies and strategies with the primary objective of fostering energy utilization efficiency [13]. This study proposes the use of three essential simulation tools, namely Revit, Ecotect, and Hap, to assess energy efficiency and providing optimized solutions for insulation, window-to-wall ratio, and window glass thickness specifically tailored for the city of Baghdad.

There exists a discrepancy between energy-efficient design and program design within the realm of architectural design. Architects typically formulate the program for a given project by drawing upon their professional acumen and established principles of energy efficiency. Frequently, the examination of energy consumption is deferred to

a subsequent phase within the design process. The efficacy of energy-saving design as a fundamental principle in program design is called into question due to the irreversible nature of the design process. Furthermore, the predominant focus of research in the field of energy-efficient design for residential buildings has been on multi-story and high-rise structures situated in urban and suburban regions. Conversely, there exists a dearth of scholarly investigations pertaining to energy-efficient design methodologies tailored specifically for rural structures. Residential structures account for a significant amount of energy consumption in urban areas.

Residential structures necessitate a consistent supply of energy to fulfil a range of functions, including illumination, temperature regulation, and the facilitation of various operational processes and activities. Residential buildings account for the majority of energy demand in Iraq. In the city of Baghdad, the energy consumption attributed to residential buildings constitutes approximately 48% of the overall energy usage. Industrial buildings are responsible for 29% of overall consumption, whereas office buildings constitute 13% of the total. According to [14], the energy consumption of commercial buildings accounts for 6% of the total, while agricultural buildings contribute 4%. In the city of Baghdad, residential buildings allocate 69% of their total annual energy consumption towards cooling activities, with an additional 26% dedicated to heating purposes. The aforementioned rates exhibit a notable disparity in magnitude when juxtaposed with the energy requirements for illumination, household appliances, and other domestic necessities, which merely constitute 5% of the aggregate annual energy consumption in residential dwellings, as stated by [15].

The objective of this study is to examine the quantitative relationship between the envelope structure, and the energy consumption of buildings in the urban area of Baghdad- Iraq during periods characterized by very hot summers and cold winters. The rationale for adopting this approach was to support the construction of residential buildings in urban areas that experience high temperatures during summers and low temperatures during winters. The aim was to reduce energy consumption throughout the duration of the year.

The manuscript is organized in the following structure: The following section of this report provides a thorough overview of the subject area being examined and discusses the datasets that were used. The demonstration highlighted the various processes and analyses that can be performed using Revit, HAP, and Ecotect Techniques. The third section succinctly outlines the key findings derived from our research. The fourth section will discuss the outcomes of the processing and analysis conducted on the study area regarding energy conservation and consumption. The fifth section presents a thorough analysis and interpretation of the findings.

2. MATERIALS AND METHODS

2.1. MATERIALS

Baghdad city is $33^{\circ} 19' N$, $44^{\circ} 25' E$, part of the Middle East region. Its climate is classified as hot and dry in summer and cold and humid in winter [16]. The present study employed a residential building with a total area of 80 square meters, as illustrated in Figure 1. The building's design was implemented by employing appropriate software to optimize several parameters, such as the ratio of windows to walls within the building envelope, Revit software was used to design it. Table 1 presents the structural parameters of the building in the study area, along with comprehensive information regarding the selected properties of the windows and walls.

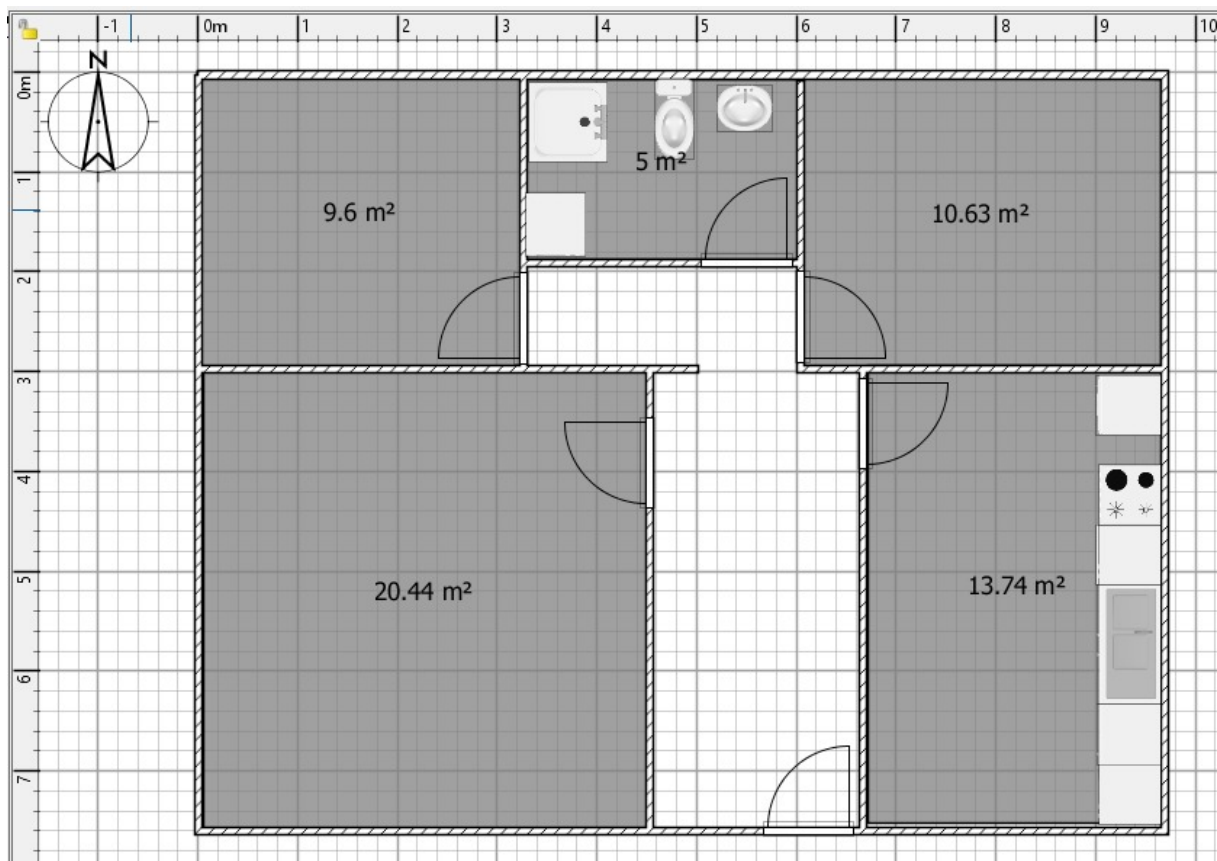


Figure 1. Plan of the default building [12]

Table 1. Details of the inputs of the used building

Building Features	Value
The total area of the building	80 m ² , It was chosen because the aspect ratio of the building is very close to 1:1, and it is the smallest and most suitable area in single house building designs in Turkey.
Building height	3 m
Total exterior wall area	107.28 m ²
Window/wall ratio	North/ South %30 East %50 West %10
The volume of the building	240 m ³ 1:1.5 aspect ratio
Total window area	15 m ²
Number of floors	1 floor

2.2. METHODS

To investigate the impact of residential building envelope parameters on energy consumption in hot climates, it is necessary to conduct a thorough analysis and assessment of commonly accepted assumptions. Furthermore, it involves quantifying the effects of building envelope parameters on energy consumption to determine their validity. The research inquiry focuses on investigating how residential building envelope parameters affects energy consumption in hot climates, specifically in the city of Baghdad as a case study. The building sectors are widely recognized as major contributors to global warming and climate change because they consume a substantial amount of energy. In developed nations, the building industry is responsible for both 40% of total energy consumption and 40% of carbon dioxide emissions. Researchers from around the world are currently involved in studying energy management and conservation. They are using simulation software as a tool to develop strategies with the goal of significantly reducing energy consumption in buildings. In order to fulfil the objective, three indispensable simulation tools, specifically Revit, Ecotect, and Hap, were utilized:

2.2.1. REVIT

The Revit software (see Figure 2) is a Building Information Modeling (BIM) software program developed by Autodesk. It incorporates a range of tools specifically designed for conducting energy analysis, enabling users to evaluate the energy efficiency and performance of a building design. This study offers valuable insights into various factors, including heating and cooling loads, energy consumption patterns, and potential strategies for energy conservation. Designers possess the capability to conduct an analysis of various components within a building, including walls, roofs, windows, and HVAC systems, with the aim of enhancing energy efficiency. Revit's

analysis and simulation capabilities provide designers and engineers with the tools they need to make informed decisions, optimize designs, and improve the performance and sustainability of buildings. By identifying potential issues proactively during the design process, individuals and organizations can take the opportunity to reduce costs, minimize energy consumption, and create environments that are both comfortable and sustainable. Revit also offers a range of tools specifically designed for simulating and analyzing heating, ventilation, and air conditioning (HVAC) systems.

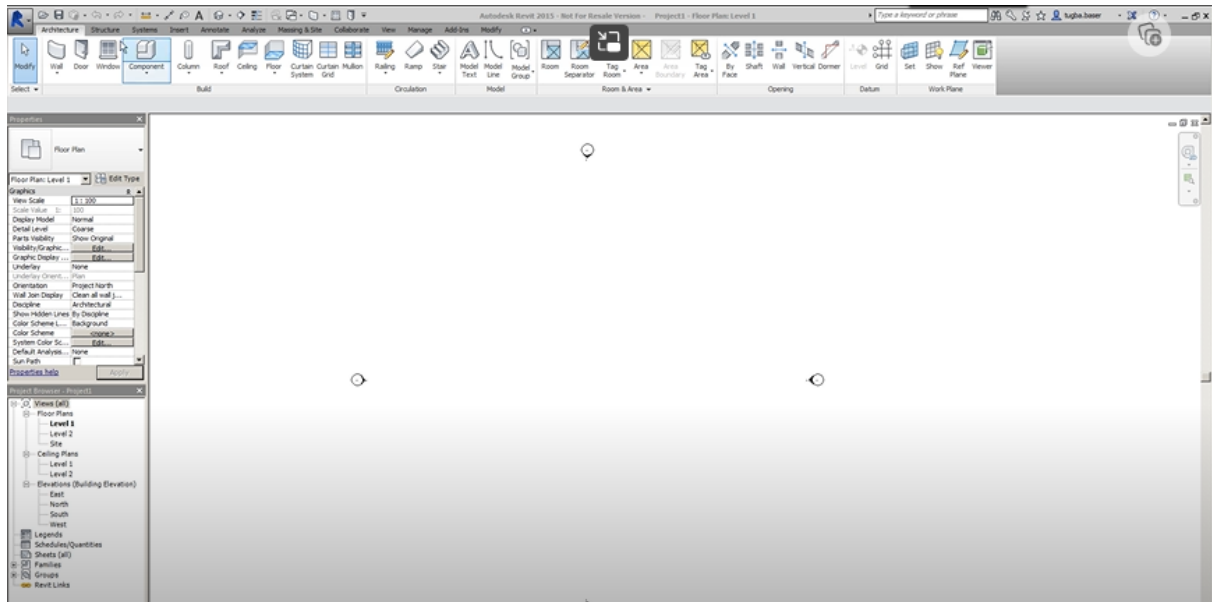


Figure 2. The view of the Revit software

2.2.2. ECOTECT

The Ecotect energy simulation software offers the ability to create geometric models and perform thermal and lighting analysis within the same program. It is designed to be user-friendly and intuitive, making it easy to use. It is a proprietary application developed and maintained by Autodesk, a leading company in the field. The Ecotect program is a highly efficient computer-based application that offers various features for accurately assessing the thermal performance of a building. It also boasts a user-friendly interface that is particularly well-suited for architects [17]. Ecotect is a powerful tool used for simulating and analyzing the energy efficiency of buildings and their surrounding environment. It provides comprehensive simulations for various climatic conditions, including solar radiation, daylighting, and thermal comfort [18]. An Ecotect analysis (see Figure 3) was performed to simulate and evaluate the performance of the building, with the aim of assessing the effects of reduced energy consumption and the utilization of sustainable power sources. The task at hand encompassed the coordination and optimization of the existing energy conservation technology systems within the building.

It has the capability to function in conjunction with other building energy analysis software applications. The program has the capability to incorporate intricate three-

dimensional computer-aided design (CAD) models, albeit in a simplified representation. Additionally, it has the capability to serve as input data for 3DS and DXF files. The analysis results have the capability to be stored in various formats such as Meta, Bitmaps, and visual animations or can be visually represented. Even with a rudimentary model, it is possible to conduct a fundamental energy analysis, which can provide guidance to users during the initial phases of the design process. The utilization of detailed modelling in the final stages of design facilitates decision-making for users in complex system solutions. One of the program's limitations is that it requires the user to possess a proficient understanding of its intricate software. Without such expertise, the outcomes produced by the program may potentially misguide the designer [19].

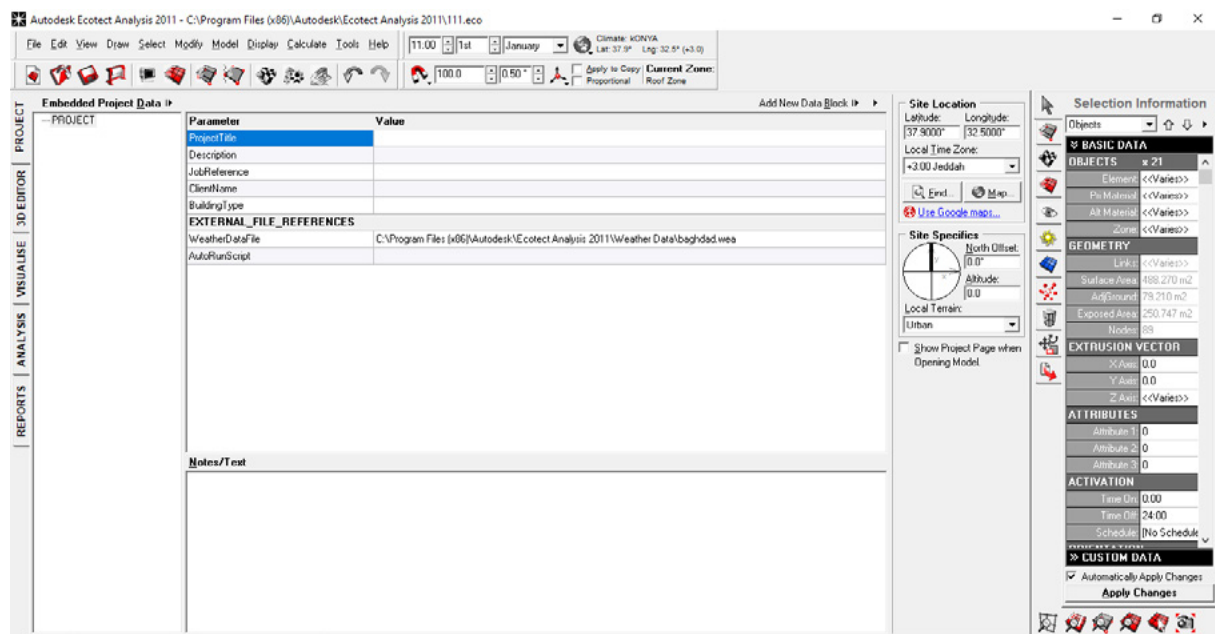


Figure 3. The main interface of the ECOTECT software

2.2.3. HAP

The Hourly Analysis Program (HAP) is a computer software application developed by Carrier, a renowned company specializing in providing comprehensive solutions for air conditioning, heating, and refrigeration systems. The objective of this program is to provide support to engineers in the process of designing HVAC systems tailored explicitly for commercial buildings. The tool integrates two primary functions, namely load estimation and system design, alongside energy use simulation and computation of energy costs. The program can be categorized into two main components: HAP system design features and HAP Energy Analysis Features, as described in [20].

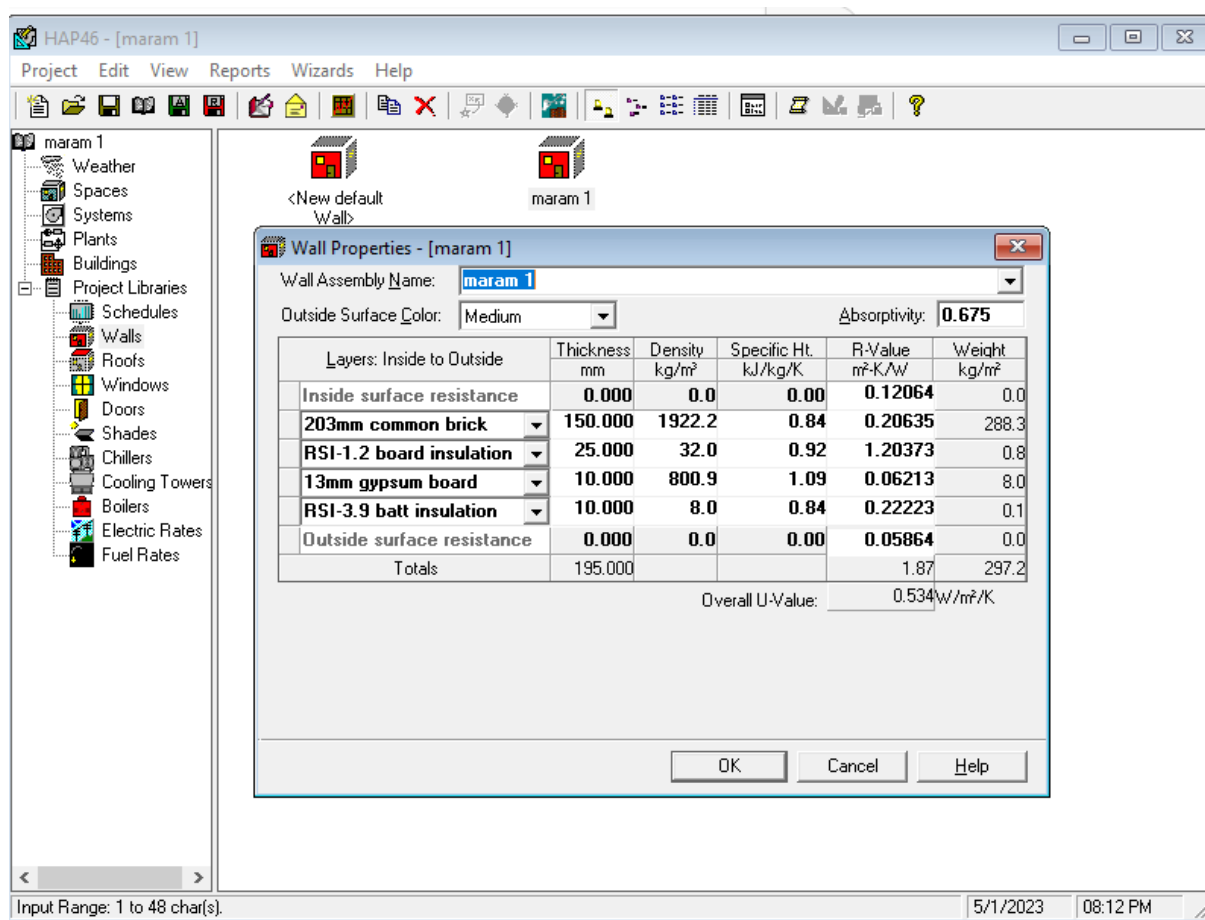


Figure 4. The main screen of the HAP air conditioning calculation program

The aforementioned calculation methods are made according to ASHRAE's standards.

2.2.4. MODELS APPLICATION AND THE MOST SUITABLE PROGRAM

We considered a residential building located in the Baghdad region- Iraq. This building is known for its property and dimensions, measuring 8.9 x 8.9 meters, resulting in a total area of 80 square meters. After identifying all the relevant information in the program, the calculation table is prepared. The amount of solar energy was calculated by taking into account various factors, including wall thickness, window/wall ratio, and window glass thickness. The collected information was used to make these calculations. Once all the required data was entered into the program, the chart was utilized to calculate the annual thermal energy. The obtained result provides information about the total amount of heat loss. Therefore, a comparison was conducted among the programs that were used, and the most appropriate one was selected for the optimization procedure.

Hence, the Ecotect software was chosen as the most similar program. Upon comparing the outcomes derived from the Revit software with those of the Ecotect software, it becomes apparent that the Revit program exhibits a notable augmentation

of approximately 22%. Conversely, the observed increment in the Ecotect program is minimal, with a maximum value of 1%. The Hap program produced a result that exhibits a significant divergence. Based on comprehensive comparisons, it has been ascertained that the Ecotect program is the most appropriate choice for the intended objectives. This is due to its capacity to yield the most precise outcomes in the context of thermal regulation. The thesis conducted at Yıldız Technical University elucidates the utilization of a cooling program, which enables the attainment of the aforementioned conclusion. This is accomplished through a comparative analysis of the calculations performed in the Antalya and Diyarbakır regions of Turkey. The selection of the Ecotect program was based on its specific design to deliver precise outcomes utilizing the cooling load factor (CLF), as exemplified in Table 2.

Table 2. Outcome of the used programs

ECOTECT max heating W	Revit max heating W	HAP max heating W
49,196	77,759	11,700
ECOTECT max cooling W	Revit Max cooling W	HAP max cooling W
31,314	62,982	4600
ECOTECT Total Max load W	Revit Total Max load W	HAP Total Max load W
71,039	140,741	16,300

After the Baghdad climate file was imported into the Ecotect program, the chosen building underwent necessary preparations for subsequent analysis. The utilization of the drawing tools within the Ecotect drawing interface facilitated the completion of this task, as depicted in Figure 5 and Figure 6.

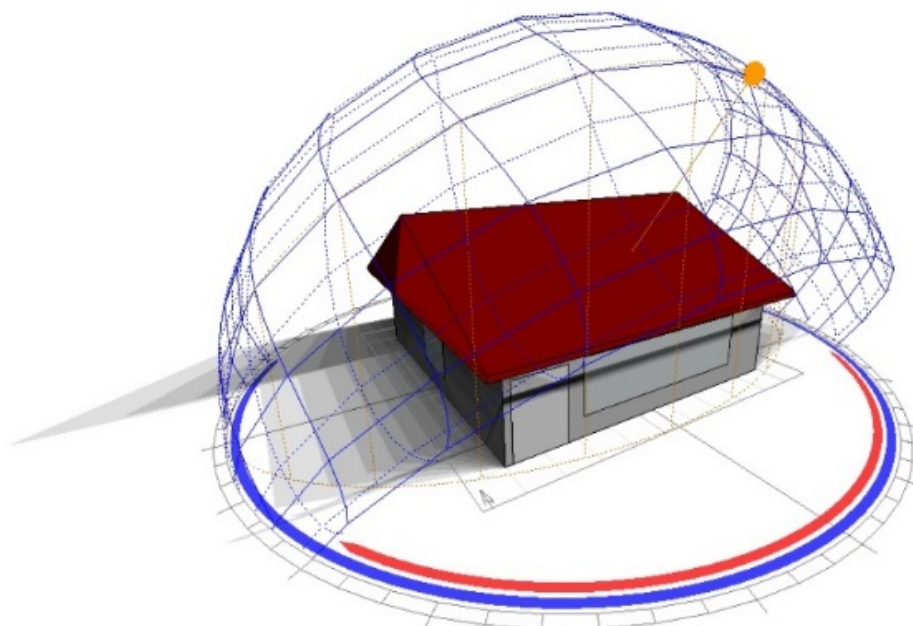


Figure 5. View of the study building using ECOTECT software

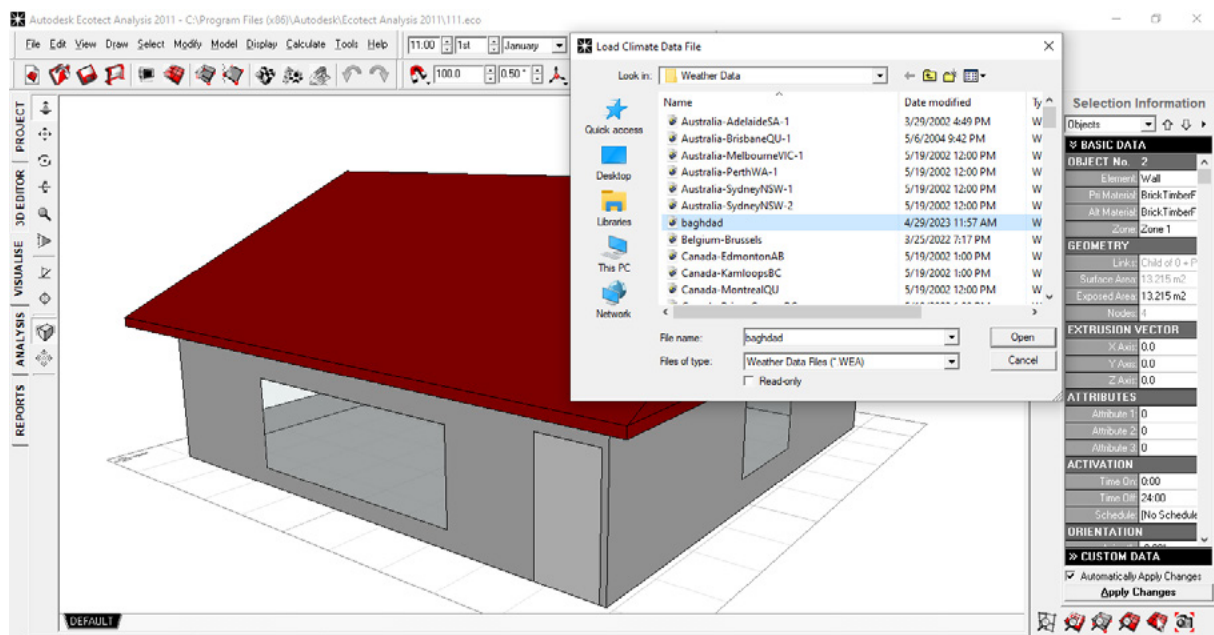


Figure 6. Display of Baghdad climate file uploading

2.2.5. BUILDING ENVELOPE PARAMETERS

After determining that the Ecotect program produced the most favourable results in the experiments mentioned earlier, a thorough analysis of the parameters was conducted, dividing them into three separate groups. The main focus of this analysis was to optimize the building envelope. The table shows the optimum trials and measurements conducted on selected parameters.

Table 3. Ideal tests and measurements conducted on each used parameters

Trials	Shell element	Parameter Types	Measurements
1-	Wall insulation thickness	TSE-825 Proper insulation	1cm, 2cm, 3cm, 4cm
2-	Window glass measurement	Glass/Wall ratio	%25, %50, %75, %100
3-	Window glass thickness	Pure-glass SHGC %80	2mm, 4mm, 6mm, 8mm

Wall Insulation Thickness

Proper insulation of a building's envelope is crucial. Inadequately insulated walls, roofs, or foundations, as well as drafts and low-quality doors and windows, can lead to significant heat loss. Specifically, poorly insulated walls can account for 40% of total heat loss, while roofs and foundations can contribute to 25% and 30% of heat loss, respectively. The existing walls of the building exhibit inadequate or nonexistent insulation. The XPS insulation with thicknesses ranging from 1 to 15 cm was chosen for testing purposes based on its cost-effectiveness and low thermal conductivity factor (K factor). Following the creation of the initial building envelope through the

utilization of the Ecotect software, an assessment was undertaken to evaluate the energy efficiency of the insulation envelope within the specific climatic conditions of Baghdad. The Ecotect Weather program format was used to load the annual hourly climate files of Baghdad for experimental purposes. After the completion of the climate file preparation, the thickness of the wall insulation in the building shell was altered in each experimental trial. This was achieved by substituting the initial uninsulated shell with 15 different shells, as illustrated in Figure 7, which can be accessed via the wall-window properties. Prior to conducting an energy analysis using the software, the thermal properties panel was utilized to specify a building that is fully air-conditioned. The temperature settings for the air conditioning system in Baghdad city were selected to encompass a set point range of 22-24°C, taking into consideration the hot climate prevalent in the region.

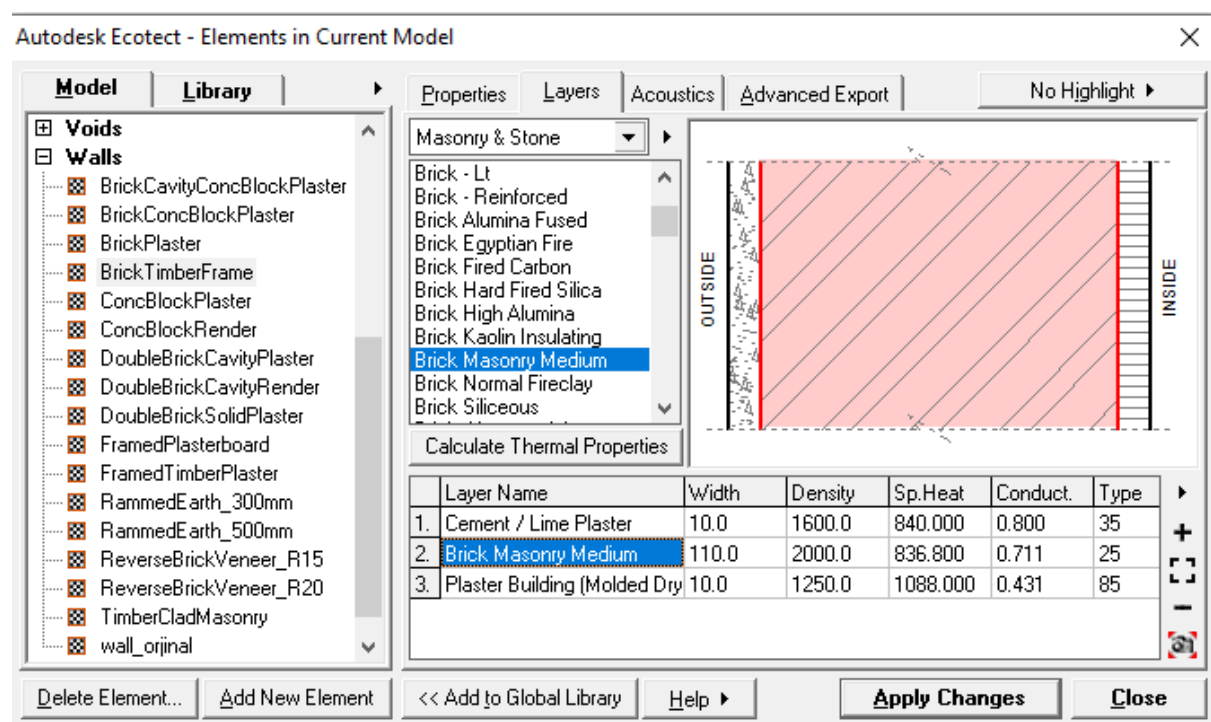


Figure7. Materials of the building original wall

Window/ Wall Ratio

This examination encompassed ratios of 25%, 50%, 75%, and 100% and was conducted for all orientations of the building in Baghdad. The objective of this analysis was to attain an optimal outcome. The window-to-wall ratios (WWR) for each of the four facades of the building were determined by quantifying the total area of windows in relation to the total area of walls. This information is presented in Table 4. The values depicted in Table 5 were obtained through the utilization of Equation 1. Subsequently, the aforementioned values were employed in the optimization experiments conducted for the purpose of window design. To ensure accurate calculations for the southern window area, adjustments were made in the dimensions shown in Table 5. This was done by reducing the ratio to account for the presence of a door on the southern facade.

$$WWR = \frac{\text{Area of Window}}{\text{Area of Wall}} \quad (1)$$

The aforementioned equation was employed to determine the proportion of windows in the structure in relation to the walls of the building. The calculation was performed on each individual room within the building to ascertain the proportion of windows that were being utilized.

Table 4. Window/Wall ratios, area and measurements

Direction	Area(m ²)	Measurement (m)
North	0.3 x 889 x 3 = 8.01	5.34 x 1.5
South	8.01 – 2 = 6.01	4 x 1.5
East	0.5 x 8.9 x 3 = 13.35	8.9 x 1.5
West	0.1 x 8.9 x 3 = 2.67	1.78 x 1.5

Table 5. Window/Wall ratio details on the southern facade

WWR	area(m ²)	Dimension (m)
25 %	6-675	4.45 x 1.5
50 %	13-35	8.9 x 1.5
75 %	20-025	2.5 x 8.01
100 %	267	3 x 8.9

Window Glass Thickness

The study involved conducting simulations on windows that are frequently employed in building envelopes, varying in thickness from 2 mm to 8 mm. The objective of the study was to evaluate the potential of the subject under investigation in terms of attaining the utmost level of energy efficiency see Figure 8 and Table 6.

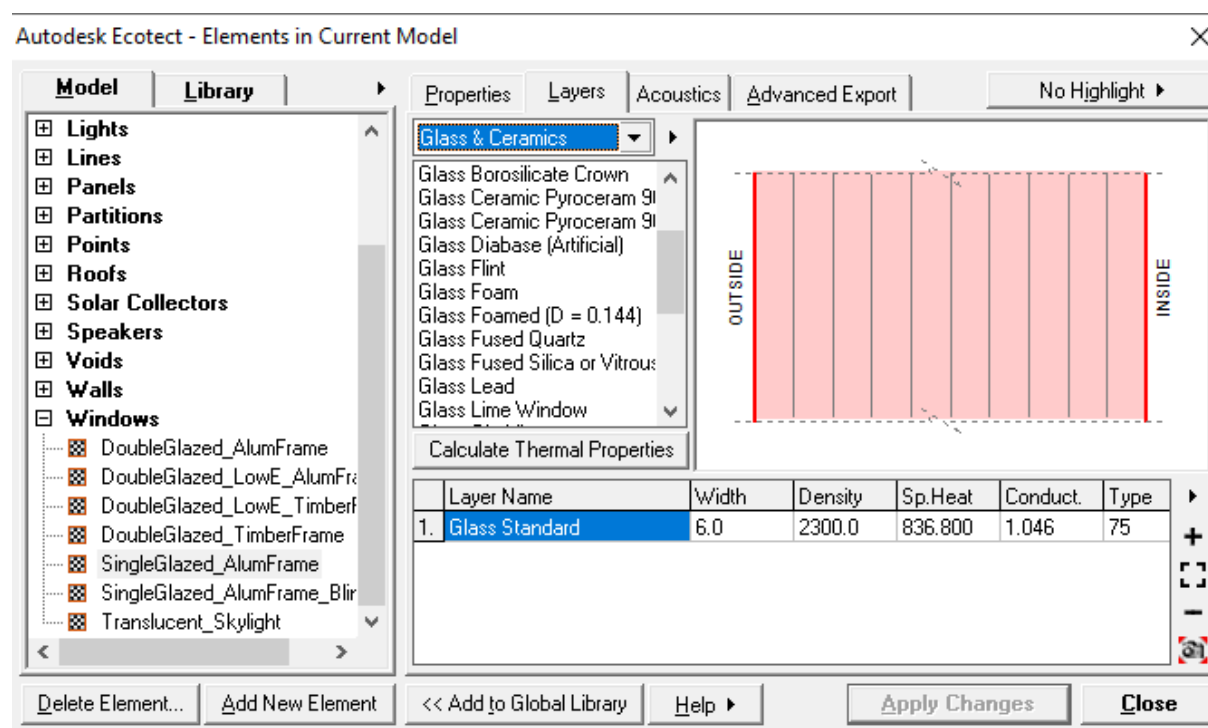


Figure 8. Display of the window glass thickness optimization process

Table 6. Window Features

Structural Element	Material	Thickness	U value (W/m ² K)	SHGC	SHGC
Window system	Ordinary glass, Aluminum joinery	Glass 4mm, The air gap is 16mm, Glass 4mm	2,73	0,60	80 %

3. RESULTS

Before conducting experiments in this specific section, a comprehensive analysis was performed on the outcomes obtained from each of the three programs (HAP, ECOTECT, and Revit). The study objectives led to the conclusion that Ecotect is the most suitable program. The heating and cooling energy consumption of the building was calculated by considering the annual meteorological data of Baghdad, Iraq, and taking into account the ASHRAE limit values. Three optimization parameters were taken into consideration, and the resulting outcomes are presented below:

3.1. OPTIMIZATION OF WALL INSULATION THICKNESS

This study aimed to assess the thermal insulation properties of various wall materials within a representative building through a series of experimental tests. The insulation levels exhibited a range of minimal to nonexistent, with the thickness of the insulation varying between 1 and 15 cm. The results of our observations indicate a

positive correlation between the thickness of insulation and energy savings across various energy conditioning loads, such as heating, cooling, and overall energy consumption.

After conducting an analysis focused on Baghdad, Iraq, a region characterized by high temperatures, it was observed that the energy savings achieved in heating loads were more substantial than those in cooling loads. The cooling load determined in Baghdad was found to be approximately three times greater than the corresponding heating load. The observed variation in the total savings in cooling load was approximately (2.34 - 2.45) per cent, as determined through our calculations. Interestingly, the magnitude of these savings was found to be greater than that observed in the heating load.

In contrast, our analysis also revealed that the heating load in Baghdad is relatively low, amounting to approximately 4.65% at the optimal thickness. In conclusion, upon examining the overall annual energy conservation achieved through air-conditioning in the urban area of Baghdad, it is evident that employing insulation with a thickness ranging from 1 to 15 cm results in a reduction in energy consumption by approximately 2.92% to 3.067%, as shown in Figure 9.

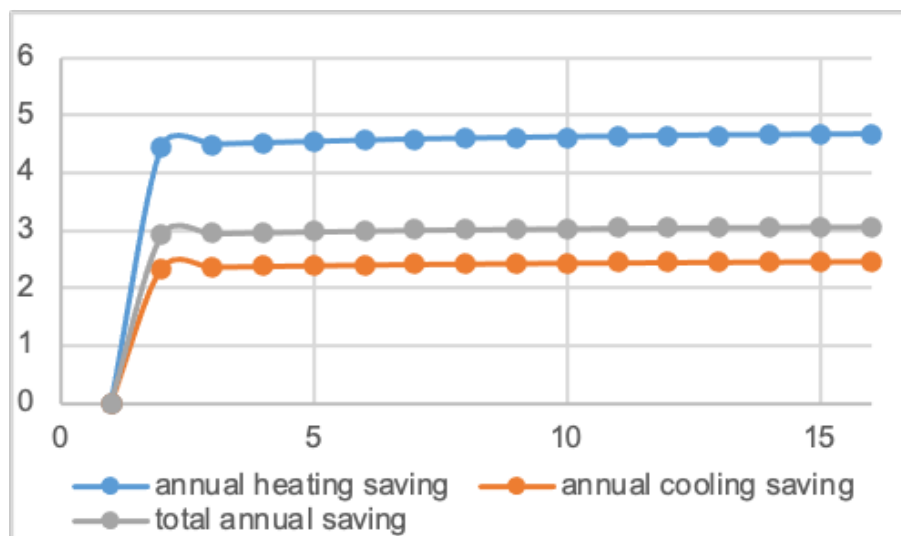


Figure 9. The relationship between the thickness of wall insulation and the rate of energy savings in air conditioning within a building

3.2. WINDOW/WALL RATIO OPTIMIZATION

The building envelope was examined with four distinct window-to-wall ratios: 25%, 50%, 75%, and 100%. Modifications were made to all four facades, and the air conditioning loads were calculated using the Ecotect program (see Figure 10). The analysis of the climate data for Baghdad revealed a direct correlation between the window-wall ratio and energy consumption in buildings. As the window-wall ratio increased, there was a corresponding increase in overall energy consumption and cooling energy requirements. This observation can be attributed to the high

temperatures in the Baghdad region, which necessitate more significant energy expenditure for cooling purposes.

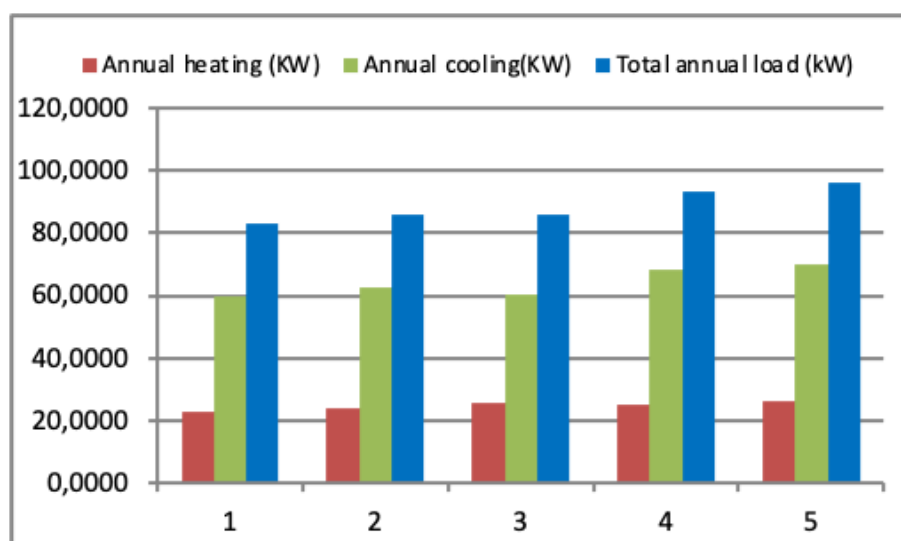


Figure 10. The energy loads associated with air conditioning in the climate of Baghdad were examined for four distinct window-to-wall ratios that were employed

3.3. WINDOW GLASS THICKNESS OPTIMIZATION

Different results are obtained when conducting analyses on the thickness of glass in the climate of Baghdad. Due to its location in a hot region, Baghdad experiences a cooling load 2.5 to 3 times greater than its heating load. One of the most significant energy savings observed is the reduction in total cooling requirements. After considering the climatic conditions in Baghdad, it was observed that increasing the glass thickness from 4mm to 6mm and 8mm led to higher annual cooling savings within the building. The savings reached 1.2% and 1.344%, respectively, as shown in Figure 11. The impact of reducing the glass thickness from 4mm to 2mm is illustrated in Figure 12. Surprisingly, it was observed that this reduction in glass thickness led to a slight decrease in savings and energy consumption. The cooling savings achieved from 4mm to 2mm glass thickness was approximately 1%. This finding suggests that thinner glass may compromise insulation properties, leading to higher cooling energy requirements in the hot climate of Baghdad.

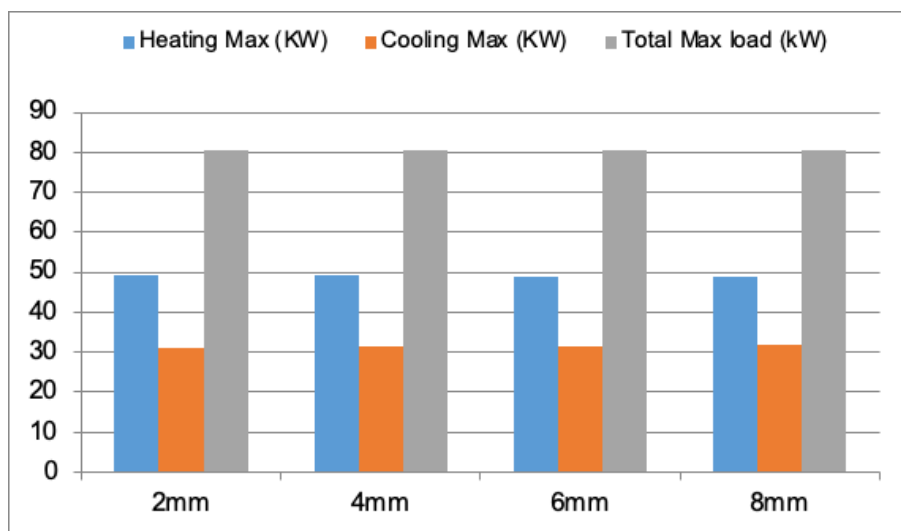


Figure 11. Window glass thickness and energy consumption in Baghdad climate

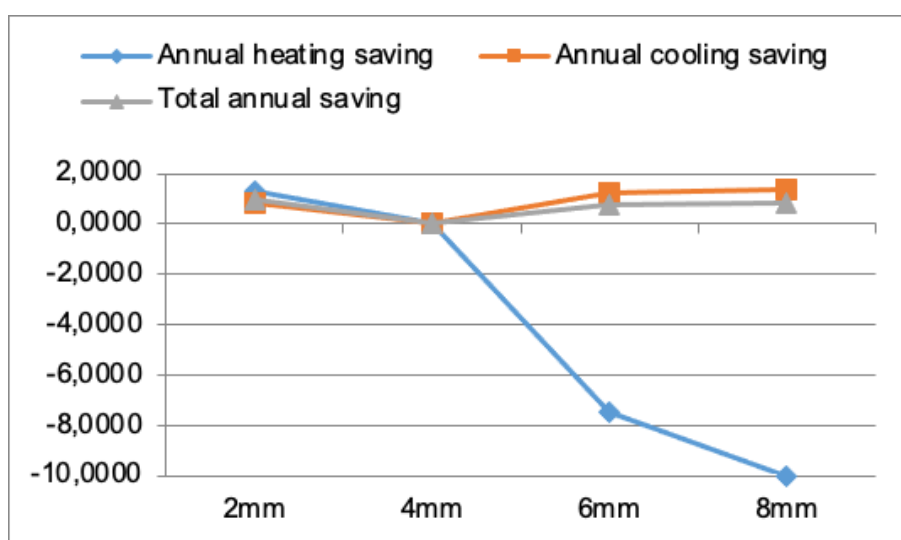


Figure 12. Window glass thickness and energy saving in Baghdad climate

Additionally, it was observed that as the thickness of the glass increased in Iraq, there was a decrease in heating savings, which was opposite to the yearly reduction in cooling expenses. Studies have shown a direct relationship between reducing the thickness of glass in a building and the resulting increase in annual savings on air conditioning energy consumption.

4. DISCUSSION

Our research findings show that increasing the thickness of wall insulation is an effective method for energy conservation in heating and cooling needs. This discovery aligns with the existing research on the correlation between building insulation and its impact on energy consumption. A consistent pattern of energy savings in both heating and cooling loads was observed in the Baghdad region as the insulation thickness increased from minimal to 13 cm. The reason for the improved energy efficiency in

heating loads in Baghdad, despite the predominantly warm climate, can be attributed to several factors. One possible hypothesis suggests that having insulated walls during colder months helps to keep heat inside the building, reducing the need for energy consumption for heating.

On the other hand, during high temperatures, the insulation acts as an obstacle, reducing the heat transfer from the outside to the inside of the space. As a result, this leads to a relatively minor decrease in the cooling load. The study's findings emphasize the significance of adequate insulation in hot climate regions like Baghdad. They demonstrate a significant increase in cooling load savings when the wall thickness reaches 13 cm. Based on the analysis, it is evident that a thickness of 13 cm provides an ideal level of insulation. This thickness offers substantial energy savings for both heating and cooling needs. Figure 13 illustrates the relationship between wall thickness and energy savings. It highlights that the most significant energy savings in both cooling and heating loads were observed at a wall thickness of 13 centimeters. This figure is a valuable reference for architects, engineers, and policymakers when designing and constructing buildings in similar climatic conditions.

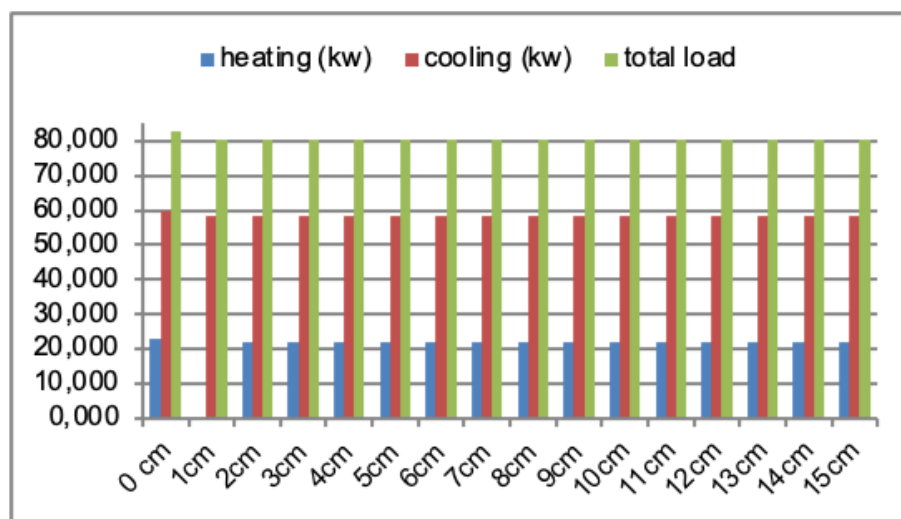


Figure 13. The diagram illustrates the energy consumption of the building as influenced by the insulation present on its walls

The window-to-wall ratio also significantly determines the energy consumption and cooling energy requirements of buildings in the Baghdad region. An increase in the window-to-wall ratio results in a greater influx of solar heat into the building, necessitating an increase in cooling loads to sustain a desirable indoor temperature. This phenomenon is notable in areas characterized by high temperatures, such as Baghdad. Our analysis determined that a window-to-wall ratio of 100% yielded the most significant overall energy consumption and cooling energy demands. This discovery suggests that an entire glass exterior in a building would result in a notable rise in heat absorption, consequently necessitating a higher demand for cooling energy. Nevertheless, the cooling energy requirements were significantly lower when employing a window-to-wall ratio of 25% due to its effective reduction of solar heat

gain. Nevertheless, it is crucial to acknowledge that this ratio could potentially lead to increased heating energy consumption in colder periods.

The optimal equilibrium between natural lighting, solar heat gain, and energy efficiency was determined to be a window-to-wall ratio of 50%. The energy consumption for both cooling and heating exhibited a more equitable distribution at this particular ratio, rendering it the most appropriate choice for architectural structures in Baghdad. The data presented in Figure 14 demonstrates that the window-to-wall ratio of 50% corresponds to the threshold at which energy performance is optimized.

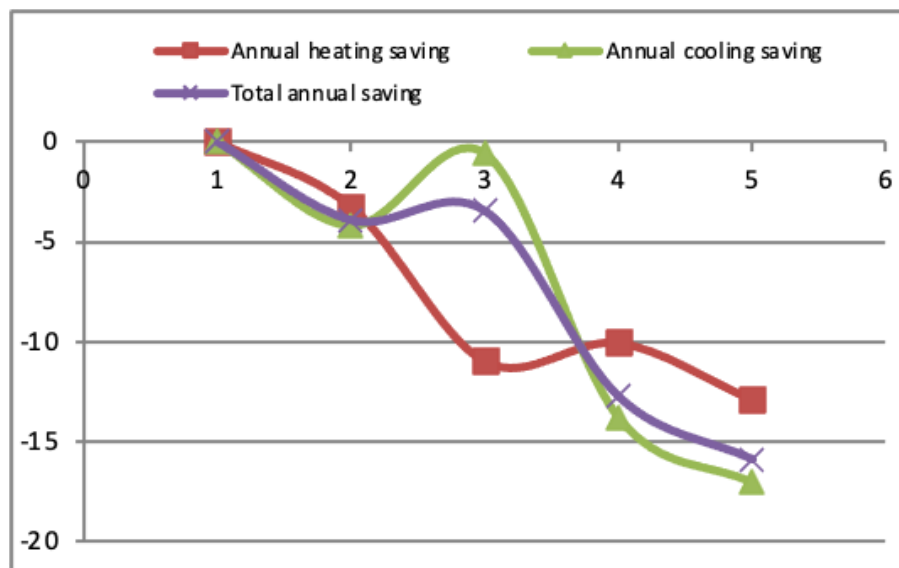


Figure 14. The correlation between the varying ratios of window-to-wall and the resulting increase in energy consumption saving

Moreover, a notable energy-conservation strategy that was observed involved the augmentation of glass thickness. As the thickness of the glass increased from 4mm to 6mm and 8mm, significant reductions in annual cooling requirements were observed, leading to cooling savings of 1.2% and 1.344%, respectively. Thicker glass exhibits enhanced insulation characteristics, thereby diminishing the transmission of heat from the external environment to the internal space. As a result, the demand for cooling energy is reduced. In contrast, a marginal decline in cooling savings and energy efficiency was noted upon reducing the glass thickness from 4mm to 2mm. This discovery suggests that thinner glass may not offer sufficient insulation, resulting in increased energy consumption for cooling purposes. Hence, the selection of an optimal glass thickness holds significant importance in order to enhance energy efficiency and optimize cooling performance within the context of Baghdad's high-temperature climate.

The results obtained from this study hold significant potential value for professionals in architecture, engineering, and building ownership, particularly in regions characterized by high temperatures, such as Baghdad and other similar areas. Through the careful selection of appropriate glass thickness, it is possible to

optimize energy efficiency, mitigate cooling demands, and diminish overall energy usage, thereby fostering the development of sustainable and ecologically conscious architectural structures.

5. CONCLUSION

Energy is a vital resource that serves society and industry, providing quality and cost-effective solutions. It is an essential requirement for human life, enhancing the overall quality of community living, improving people's comfort levels through reduced energy consumption, and creating healthier environments. Energy consumption also plays a crucial role in facilitating economic and social development, as highlighted in this review. In recent times, the topic of energy efficiency has garnered significant significance as a result of the depletion of energy reserves and the adverse environmental consequences associated with primary energy sources. In this context, it is imperative to optimize the utilization and allocation of energy in binaural applications in order to achieve maximum cost efficiency. The adoption of energy-efficient practices in the construction sector is becoming more prevalent on a global scale. Nations consistently engage in the transfer of technological advancements to energy systems with the aim of mitigating costs and minimizing environmental harm, particularly in relation to the phenomenon of global warming.

The research focused on improving energy efficiency and was conducted in an 80 m² residential building. The objective of this study was to analyze the energy performance of buildings and determine the most suitable optimization programmes. In order to accomplish this, a variety of simulation software was used, such as Ecotect, Revit, and Hap. The design of the building took into account various architectural parameters such as the total area, height, window-to-wall ratio, and building volume. Various factors influence the properties of building components, including windows, roofs, walls, and floors. These factors include the type of material used, the thickness of the components, the U-values (which measure thermal conductivity), and the solar heat gain coefficient (SHGC). The investigation utilized specific software programmes to simulate and analyze the energy performance of buildings. The climate data for the Baghdad region was obtained from the Ecotect Weather programmes. The annual energy consumption for heating, cooling, and total loads was determined using modelling techniques in the Ecotect and Revit software applications. A comparative analysis was conducted to evaluate the outcomes of different programmes. The analysis determined that Ecotect is the most suitable programme for accurately estimating heating and cooling loads.

After selecting the most suitable programmes, optimization tests were conducted on three specific parameters: wall thickness, window-to-wall ratio, and window thickness. The evaluation of the energy efficiency of the building envelope required adjusting the insulation thickness of the walls. The window-to-wall ratio has been adjusted for different facades to achieve the best possible results. In addition, a thorough examination has been conducted to assess the energy efficiency potential of

various window thicknesses commonly used in building envelopes. The study has focused primarily on the energy performance of the building, explicitly examining optimized parameters. The effectiveness of the optimization procedure was evaluated by comparing the annual energy consumption for heating, cooling, and overall loads.

In addition, it is crucial to evaluate the effectiveness of passive building designs in the city of Baghdad and their impact on the overall cost, as shown in the invoice. Evaluating passive designs can play a significant role in constructing sustainable buildings and promoting energy efficiency. The purpose of these recommendations is to clearly identify the specific areas that should be given priority for future research and scholarly investigations. In the field of building design, it is crucial to prioritize the optimization of building elements, the improvement of energy efficiency, and the implementation of necessary measures for sustainable structures.

The investigation findings have emphasized the importance of optimizing building components to enhance the energy efficiency of the building envelope. Optimizing parameters such as wall thickness, window-to-wall ratio, and window glass thickness can significantly enhance energy savings and overall energy performance. The findings mentioned above emphasize the importance of considering the characteristics of building components in addition to architectural entrances when designing a building.

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ENTERPRISE ACCOUNTING STATEMENT PRODUCTION AND FINANCIAL CALCULATION FOR INTELLIGENT PLATFORMS

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ABSTRACT

The increasingly complex structure of enterprise economy highlights the drawbacks of traditional accounting, and this paper builds an intelligent platform to meet these challenges. Based on the overall objective, the design constructs the functional framework of full-scene reporting, budget control, intelligent filling and automatic accounting. In terms of technology application, OCR is applied to intelligent accounting, and bills are automatically filled through image processing and character recognition. Meanwhile, the enterprise financial process is reshaped based on process reengineering, and intelligent financial calculation methods are proposed. The study shows that the financial accounting intelligent platform significantly improves the total asset turnover rate of the enterprise, and the positive correlation between the two reaches 0.257. After the introduction of the intelligent platform technology in the accounting work, its technological advantages have brought a positive impact on the accounting work of the enterprise, and has brought substantial benefit improvement for the enterprise.

KEYWORDS

Intelligent reporting; OCR technology; process reengineering; intelligent platform; enterprise accounting

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1. INTRODUCTION

The general sense of the "intelligent management accounting platform" is based on digital technology, based on the software service development model, the traditional software services on the cloud, to provide users with data resources and software resources to share the information integration platform [1-2]. Using this comprehensive management platform, it can carry out information integration synthesis and management optimization for enterprises, and provide good data support for enterprise decision support. On this basis, based on the cloud computing shared information platform, with the premise of enterprise financial integration, artificial intelligence technology and risk early warning technology is applied to the decision support system, through digital technology and data sharing as a means to provide managers with digital interactive information platform support [3-5].

The construction and implementation of intelligent financial management system can enhance the efficiency of the traditional financial processing process, reduce the financial staff's complicated documents processing, report approval and other financial work, reduce the asymmetry of accounting information, and promote the change of financial management mode [6-7]. At the same time, under the application of big data technology information technology, the enterprise financial management process will be more transparent, real, more conducive to supervision and control, reduce irregular financial behavior, and safeguard the safety of enterprise funds and the stability of the financial environment [8]. The construction of enterprise intelligent financial management mode is an effective way to establish core competitive advantages in the fierce market competition environment and complex and changeable economic environment, therefore, enterprises should strengthen the basic computer software and hardware construction, enhance enterprise profits through the application of intelligent financial management mode, and guarantee the realization of strategic objectives [9-10]. At the same time, in the process of constructing intelligent financial management mode, enterprises also face the problems of insufficiently comprehensive system construction, insufficiently reasonable application of big data technology, and insufficiently scientific financial management methods. Therefore, enterprises should, on the basis of market prediction and future target analysis, actively introduce professional information talents and accounting talents, integrate scientific information technology such as big data technology into financial management activities, and then comprehensively enhance the competitive advantage and operational efficiency of enterprises [11-12].

Corporate accounting's and financial management research is of great significance to the overall efficiency and operation of enterprises. Literature [13] launched a 3-stage closed study, inviting 272 eligible people to fill in the questionnaire, exploring the relationship between investment literacy and financial management behavior, revealing the deep logic of financial behavior. Literature [14] analyzes the importance

of financial management in green project financing for natural resource markets, and takes Pakistan as an example, proposes that a wide range of money supply and other related financial management measures can effectively escape from the "resource trap" problem. Based on the theory of Gendron and Rodrigue, [15] analyzed the boundary of corporate financial accounting, pointed out that the concept of "imagination" explains the key role of financial accounting in the composition of corporate entities, and made a phenomenological explanation of the financial links between individuals and organizations. Literature [16] discusses the social responsibility of corporate accounting from a realist critical perspective, choosing an Australian packaging company as the subject of the study, and proposing a new structuralist understanding of the expressive nature of corporate social responsibility. Literature [17] addresses the governance of accounting information in corporate enterprises, proposing a response based on the design of high standard objectives, and re-examining the historical accounting information data with high standard requirements to realize a new evolution of accounting research.

In this paper, an enterprise accounting intelligent platform is designed for the defects of the traditional accounting process, and the intelligent application direction is conceived from the aspects of full-scene account reporting, budget control, intelligent bill filling and automatic accounting. It proposes an OCR-based intelligent accounting reporting method, which carries out image rotation or image deformation of the original bill voucher image through the perspective transformation of image processing, corrects the skewed image therein, and extracts the key pixel points using binarization. Then the character recognition is completed by combining HOG features with SVM classification to realize the automatic filling of reports. For the financial calculation scenario, the enterprise financial process is simplified based on the process reengineering method, and the financial calculation is reintegrated by means of mathematical modeling. Finally, the production and sale of cosmetic lotion of a cosmetic company is used as a case study to develop the application of intelligent accounting, and the role of the use of intelligent platforms in corporate finance is explored through regression analysis.

2. CONSTRUCTION OF ENTERPRISE ACCOUNTING INTELLIGENCE PLATFORM

2.1. OBJECTIVE DESIGN OF ENTERPRISE ACCOUNTING INTELLIGENCE PLATFORMS

Relying on the financial sharing platform to build electronic image module and mobile application reimbursement module and other sub-systems, to realize the intelligent filling of the billing business, automatic identification and verification of invoices, automatic and intelligent system audit, real-time automatic generation of

vouchers, real-time analysis of the report push. Promote the quality of financial work, efficiency and power of change, so that the existing accounting staff can be liberated from the heavy and boring and low-value affairs, and focus on the creation of high value, to truly realize the transition from basic accounting to management accounting.

2.2. FUNCTIONAL FRAMEWORK OF INTELLIGENT ACCOUNTING PLATFORM

2.2.1. FULL SCENARIO REPORTING

The functional framework includes the setting of reporting matters for prior application, material procurement, functional expenses, monopoly law enforcement funds, financial expenses, employee remuneration, tax and fee payment, R&D expenditures, capital operations, asset operations and other operations. The automatic accounting generation in the whole scenario is shown in Figure 1. Matching document templates for different business matters, realizing online filling by employees, online approval by management and document status tracking. Support write-off of pending accounts, receivables and payables.

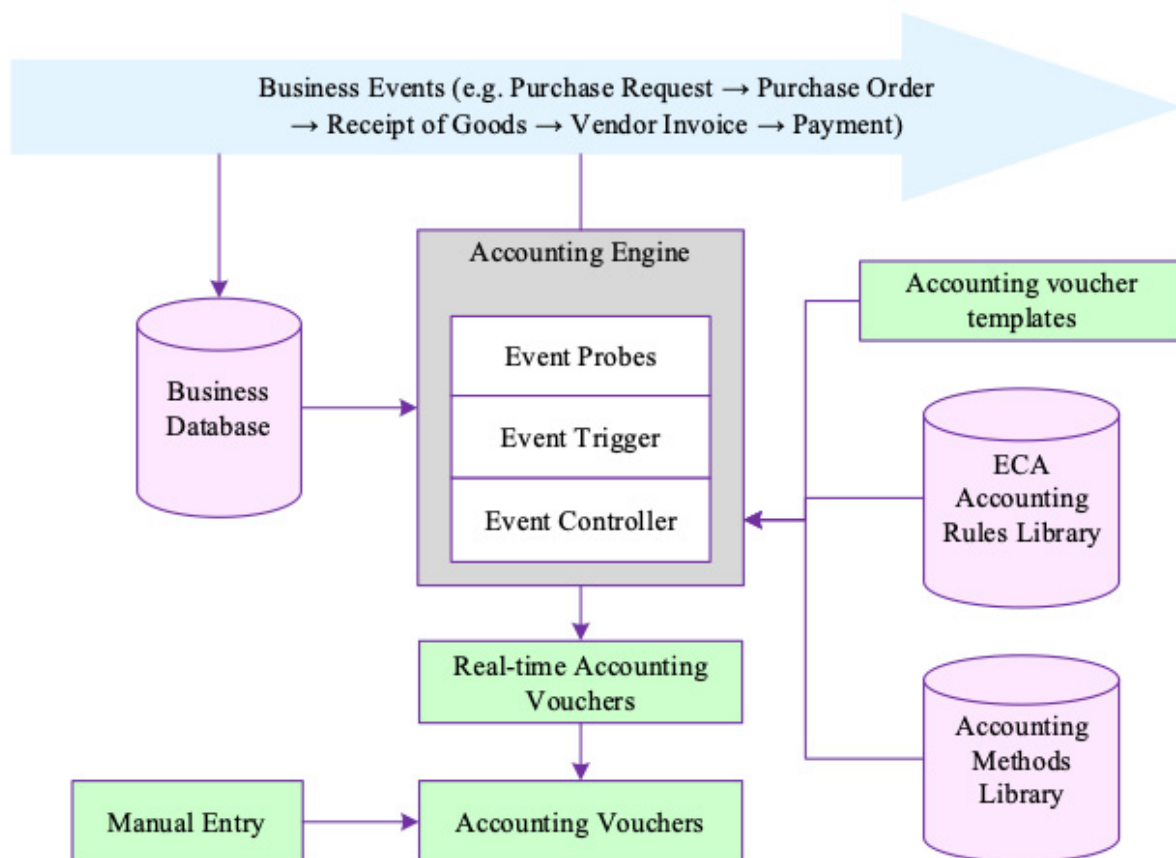


Figure 1. Automatic report formation under the full view

2.2.2. BUDGETARY CONTROL

The intelligent accounting platform is docked to the comprehensive budget management system, and through system interaction, the budget data validated by the comprehensive budget module is synchronized to the intelligent accounting platform for the process control of freezing, occupying and releasing the budget. The budget control process is shown in Figure 2. The intelligent accounting platform regularly writes back the budget execution figures to the comprehensive budget module as the basic data for the budget execution statement.

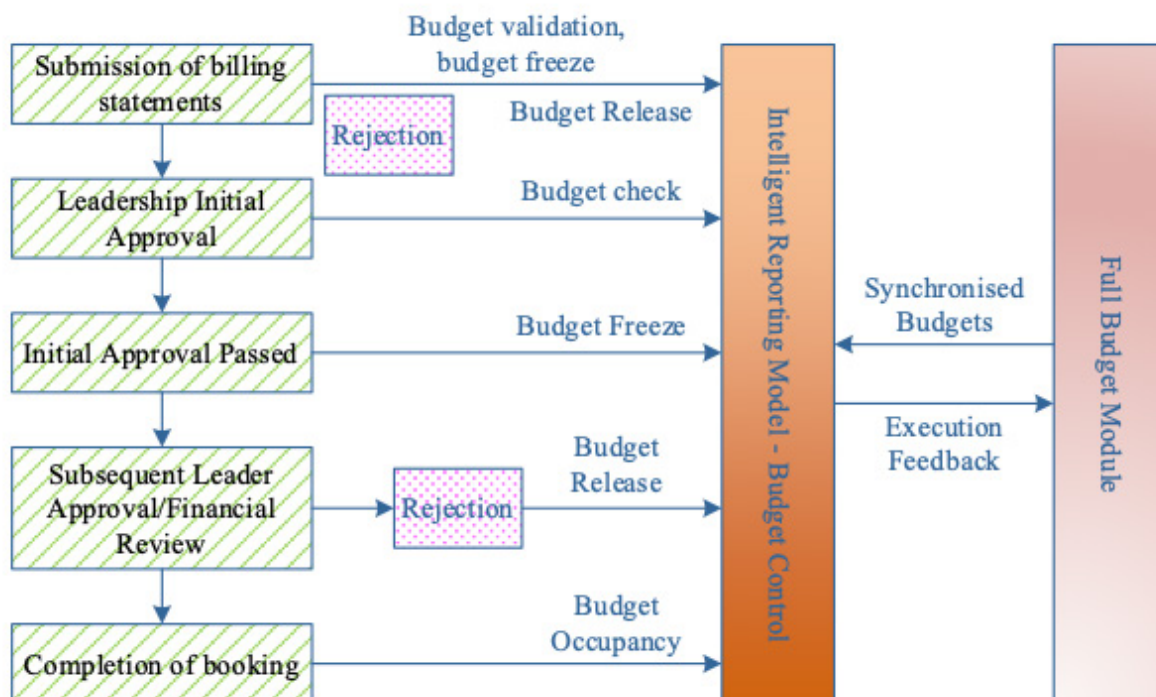


Figure 2. Budget control process

Intelligent accounting platform is docked to the shared operation module, which pushes the approved accounting documents to the shared operation task pool for auditing and sends back the auditing status of the documents. Intelligent accounting platform connects to the fund management module, synchronizes the fund budget to automatically generate the fund plan, and updates the execution of the fund plan according to the execution of the fund budget. Synchronize the information of the reporting documents with the bank water for automatic matching, and send back the bank water information to the reporting documents.

2.2.3. INTELLIGENT BILLING AND AUTOMATED ACCOUNTING

It supports extracting information from invoices, contracts, customers, etc. and automatically filling in relevant fields, automatically calculating tax deductible amount, and automatically filling in payee bank account information. According to the standard

business matters corresponding to the accounting standards, automatically generate accounting vouchers. At the same time, it interfaces with internal and external systems, receives or pushes out information, and generates corresponding accounting documents according to the received information or checks the information in the relevant systems in the accounting documents to realize information sharing.

3. INTELLIGENT REPORT PRODUCTION AND FINANCIAL CALCULATION

3.1. OCR-BASED INTELLIGENT ACCOUNT REPORTING

3.1.1. BILLING IMAGE PROCESSING

1. Perspective transformation and image normalization

The use of high-flying cameras or mobile devices for the original certificate image information acquisition, the need to extract the original certificate from the captured image, in the process of using image processing perspective transformation for the original certificate image image rotation or image deformation. Perspective transformation, also known as projection transformation, refers to the use of perspective center, the target point, the image point of the conditions of the three points of the co-linear, according to the law of perspective rotation so that the perspective surface and the axis of rotation of the perspective at a certain angle, destroying the original projected beam of light, but still be able to maintain the projection geometry on the surface of the projected surface of the unchanged transformations.

The essence of perspective transformation is to project an image onto a new plane, and the mutual transformation between the original image P and the new image P' requires a perspective transformation matrix T , which is realized by equation (1):

$$\begin{bmatrix} x' & y' & z' \end{bmatrix} = \begin{bmatrix} u & v & z \end{bmatrix} * T \quad (1)$$

Where (u, v) is the pixel coordinate of the original image P , after perspective transformation, the corresponding image P' coordinate is $(x = x'/z', y' = y'/z')$. The transformation formula for the perspective transformation matrix T is as follows:

$$T = \begin{bmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{bmatrix} = \begin{bmatrix} T_1 & T_2 \\ T_3 & a_{33} \end{bmatrix} \quad (2)$$

Wherein, $T_1 = \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix}$ is a linear transformation of the scanned image information, and $T_2 = [a_{13} \ a_{23}]$ produces a perspective transformation. $T_3 = [a_{31} \ a_{32}]$ represents the recognized image translation.

2. Image rotation

Image rotation processing that is the process of image tilt correction, the phenomenon of image tilt refers to the operation of the actual business process, due to reimbursement claims processing business personnel are not familiar with high-fidelity camera and other hardware equipment, there is a scanning process of the original voucher paper inverted, that is, rotated 180°, in this case, the scanning of the image needs to be flipped after the processing. Taking the VAT invoice as an example, the VAT invoice will be stamped with a red seal in the middle of the invoice right above the invoice, and the position of the red seal of the invoice can be detected through this mark to determine whether there is an inversion of the VAT invoice in the process of scanning the invoice.

3. Image binarization

Through the above series of image transformation operations, in order to really extract a correctly placed original certificate image, and has been normalized to the pixel size of 1200 * 700, the next thing to do is to do further image processing for the original certificate image, highlighting the characteristics of the image and reduce other interference. The first step is to binarize the original certificate image.

Binary image of each pixel value are black or white, will be defined as 0 for black, 255 defined as white, binary map is non-black or white image, and will be converted to a binary map of an image we call the process of image binarization. The role of image binarization is to distinguish the background of the image from the target, the background mentioned here is the part of the image other than the specific target to be obtained. The maximum inter-class variance binarization algorithm is introduced next.

The maximum interclass variance formula is shown in equation (3)

$$\sigma_B^2 = P_1 (m_1 - m_G)^2 + P_2 (m_2 - m_G)^2 \quad (3)$$

Where σ_B^2 denotes the inter-class variance, P_1 denotes the probability of a pixel being classified as a target image, P_2 denotes the probability of an image being classified as a background image, m_1 denotes the average gray level of a pixel being classified as a target image, m_G denotes the average gray level of all pixels, and m_2 denotes the average gray level of a pixel being classified as a background image. So in the process of binarization of the image, traverse the 256 pixel values and find a

pixel value which gives maximum inter class variance, then this pixel value is considered to be the appropriate threshold value and process the image with this appropriate threshold value and finally get the binarized image.

3.1.2. BILLING CHARACTER RECOGNITION

In the natural scenario of expense reimbursement, the characters to be recognized include the name of the purchaser and seller, invoice number, invoice code and taxpayer identification number in the VAT invoice or the type of medical insurance and social security number in the medical fee invoice, which contains both character recognition and text recognition. Recognition methods for character recognition.

HOG, short for Histogram of Orientation Gradient. HOG is an image feature that is very commonly used in the field of computer vision and pattern recognition to describe the local texture of an image [18]. HOG features combined with SVM are widely used in the field of image recognition, and here this method is also applicable to character recognition. The processing flow of HOG+SVM method is shown in Figure 3.

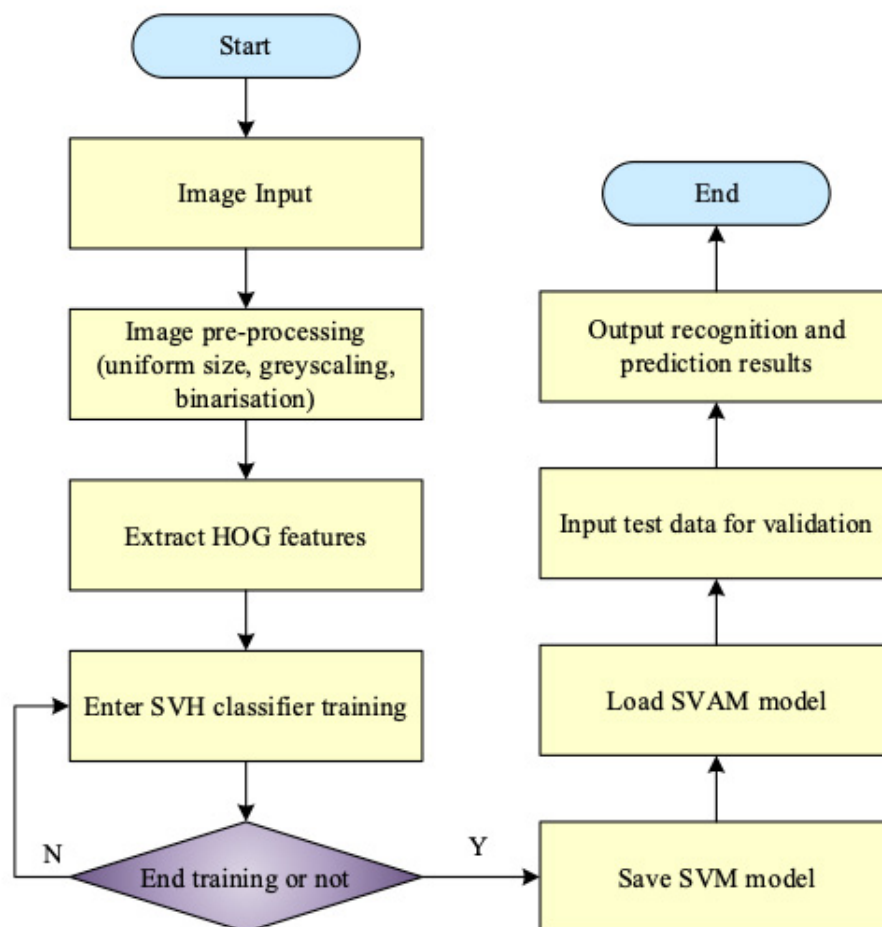


Figure 3. The HOG+SVM method processing process

The specific implementation steps of HOG+SVM algorithm are as follows:

1. After grayscaling and normalizing the collected original voucher image, as an input to the algorithm, calculate the directional gradient through the gradient operator and get the gradient information of the image, the gradient formula is as follows:

$$G_x(x, y) = H(x + 1, y) - H(x - 1, y) \quad (4)$$

$$G_y(x, y) = H(x, y + 1) - H(x, y - 1) \quad (5)$$

In Eq. $G_x(x, y)$ and $G_y(x, y)$ represent the horizontal and vertical gradients of (x, y) the pixel point in the input image, respectively, and $H(x, y)$ denotes the pixel value of the pixel point, then the magnitude and direction of the gradient at that point is:

$$G(x, y) = \sqrt{G_x(x, y)^2 + G_y(x, y)^2} \quad (6)$$

$$\alpha(x, y) = \tan^{-1} \left(\frac{G_y(x, y)}{G_x(x, y)} \right) \quad (7)$$

2. After completing the above steps, the next step is to segment the sample image into cells containing a number of pixels, for example, segmented into units of size 3*3, divide the gradient direction sub-evenly into 9 intervals, and in each cell perform interval histogram statistics of the gradients of all the pixels in the 9 directions, to obtain a 9-dimensional feature vector.
3. Combine individual cell units into large, spatially connected intervals. The feature vectors of all cells in an interval are concatenated and normalized to obtain the HOG features of the interval.
4. HOG feature extraction is accomplished by concatenating all the blocks that have completed normalization.
5. Using the extracted features and the pre-completed classification labels, SVM classifier training is performed. Input the character to be recognized, first perform HOG feature extraction, and then complete the character recognition by the classifier trained in the above steps.

3.2. FINANCIAL CALCULATIONS BASED ON PROCESS RE-ENGINEERING

Typical features of accounting process reengineering can be summarized as integration of financial business processes, decision making by employees, natural shaping, and process diversification [19]. Performing work in the smartest state, reducing checks and controls, reducing tradeoffs and coordination, providing a single point of contact, centralization and decentralization coexist, etc. In this paper, the typical features applied to financial processes are selected based on the difference

between process reengineering and financial process reengineering, and financial calculations are reintegrated by means of mathematical modeling.

The following assumptions can be made about sequential and parallel systems:

1. Sequential system. Total work tasks are divided among sequenced m treasurers, each of whom processes one job. All tasks are processed in the same order $1, 2, \dots, m$. There exists between personnel J and $J - 1$ that there are enough tasks waiting to be processed by personnel J . Each personnel processes one job at a time.
2. Parallel system. Parallel processing mode has personnel with the same function, and all the tasks required for the job can be accomplished one after the other in the hands of any one of the personnel, with no interruptions or change times between tasks. The total processing time of a task in the hands of each personnel is and its mean value is:

$$\bar{S}' = \sum_{j=1}^m \bar{S}_j \quad (8)$$

S_{VC} for $C_s^2 \cdot \sum_{j=1}^m \bar{f}_j^2 \cdot C_{s_j}^2$, among others:

$$f_j = \bar{S}_j / S' \quad (9)$$

The processing efficiency of the sequence processing model is:

$$TH^{(S)} = 1 / \max_j \bar{S}_j \quad (10)$$

In contrast, the processing efficiency of the parallel processing model is:

$$TH^{(P)} = n / S' \quad (11)$$

Notice that if $n \geq n^t = \sum_{j=1}^m \bar{S}_j / \max_j \bar{S}_j$ & $n^t < m$ then there is $TH^{(S)} \geq TH^{(P)}$

unless the sequential system is balanced (has an average business processing time) and so $\bar{S}_j = \bar{S}' / m$, $J = 1, \dots, m$. That is, the parallel processing mode can require only a small investment. In order to make the resource requirements of the two modes the same. In order to make the resource requirements of the two systems identical, it will be assumed that the sequential systems are balanced in terms of average processing time, so $\bar{S}_j = \bar{S} = \bar{S}' / m$, $J = 1, \dots, m$. Following this, we have $f_j = 1/m$,

$C_s^{2'} = \sum_{j=1}^m C_{s_j}^2 / m^2$. For simplicity, it will also be assumed for most comparisons that

the sequential systems are identical in terms of the Scv of the modal processing operation times, i.e., $C_{s_j}^2 = C_s^2, J = 1, \dots, m$.

Assume that the mean task arrival interval is $1/\lambda$ and Scv is C_s^2 and that the task intervals are independent. The utilization rate of each personnel is $p = \lambda \bar{S}$.

In a sequential system, it is assumed that jobs are processed in FCFS order, whereas in a parallel system there are more ways to carry out control. There are two options to consider:

1. Random assignment. Arrival tasks are randomly assigned to parallel personnel with a probability of assignment to a particular personnel of $1/m$. Thus, the Scv of the arrival interval on that personnel is $1 - 1/m + C_s^2 m$.
2. Cyclic assignment. Arrival tasks are assigned mechanically, with the first task going to person 1, the second to person 2, and so on. The Scv of the arrival interval on a particular person is C_s^2/m .
3. Single-team assignment. Instead of assigning tasks to a parallel person as soon as they arrive, tasks are first organized into a single queue and then assigned from that queue to the person who will be idle.

A common performance metric for comparing the two patterns is the total average captain. Viewing the patterns as special open business processing units, the performance metric for the sequential pattern is made to be $\bar{l}^{(n)}$, and the performance metrics for the parallel system, randomized allocation, and round-robin allocation are made to be $\bar{l}^{(p)}$ and $\bar{l}^{(c)}$.

The interaction between employees and leaders and finance in the new process is no longer face-to-face, but through the system as an interface. There is no longer the phenomenon that the work of leaders is interrupted, saving a lot of labor costs. The efficiency of the financial entry staff is also greatly improved after the reengineering, a large number of review work is replaced by the system simulation verification, financial staff only need to pay attention to the authenticity of the bills, business compliance can be. Due to the organic docking between the reimbursement system and the Internet banking system, the workload of the cashier has also greatly decreased, and through batch import, a cashier can complete the work of multiple cashiers previously. Due to the transparency of the whole process of the system, the information communication cost of each link has been effectively controlled. From employees to leaders to finance, you can dynamically monitor the process and status of each relevant document.

4. EXAMPLES OF ENTERPRISE INTELLIGENT ACCOUNTING APPLICATIONS

The case study is based on the production and sale of general cosmetic lotions by a cosmetic company. For the sake of simplicity, certain conditions have been set for this case.

First, considering that a real multi-firm value chain can eventually be transformed into the simplest model of supplier, manufacturer, and seller, the value chain of this cosmetic company (denoted by M) consists of only upstream material suppliers (denoted by S) and downstream sellers (denoted by D).

Second, the value chain within enterprise M is composed of a number of value activities such as design and development, material procurement, production and processing, sales and delivery, and after-sales service, while design and development and after-sales service are not considered for the time being because they are not representative.

Thirdly, the operation and management costs incurred within the enterprise for daily operation and management are not very relevant to the research purpose of this paper, so they are not considered as the research object.

Fourthly, this chemical pastoral company assumes that there is only one production workshop which only produces two kinds of cosmetic emulsions T1 and T2, and the production process of this product is five specific operations: oil phase preparation, water phase preparation, emulsification and cooling, aging, and filling; the outputs of oil phase preparation and water phase preparation are the inputs of emulsification and cooling; the outputs of emulsion and cooling are the inputs of aging and filling; the outputs of filling are the final products. The output of the filling operation is the final product, and different products A and B are obtained according to the different amounts of raw materials added, heating and cooling time in each process.

4.1. INTERNAL COST ACCOUNTING

Resource consumption for the month is charged separately to each resource account, i.e., the various resources consumed during the month are charged separately to each resource account. The calculation of material costs for Company M is shown in Table 1. The content costing of material costs for the two products, T1 and T2, totals \$1,008,300. Since specific products directly consume specific materials, they can be charged to each product cost account according to the product's quota consumption value, and the difference in material costs over the quota is charged to manufacturing overhead.

Table 1. M company's material cost calculation (Yuan)

Resource project		Materials cost			Total
		Oil phase	Water phase	Packaging	
Production cost	T1	267200	201400	11500	480100
	T2	298300	195600	10200	504100
Manufacturing cost		13900	10200	-	24100
Total		579400	407200	21700	1008300

4.2. INTER-ENTERPRISE COSTING

After the above-mentioned resource analysis and cost collection, it is the specific accounting of inter-enterprise costs. First of all, we take the fees collected in all primary assembly points as transaction costs, and the fees collected in all secondary assembly points as relationship costs, and calculate the human, financial and material resources that occur between S-M and M-D in the transaction costs and relationship costs, respectively, and the inter-enterprise cost accounting is shown in Table 2. Among them, the final accounting results of transaction cost and relationship cost were 89,353.5 yuan and 216,848.5 yuan respectively.

Table 2. Acquisition cost accounting

Project	Transaction cost (Yuan)					
	HR primary assembly point		FR primary assembly point		MR primary assembly point	
	S-M	M-D	S-M	M-D	S-M	M-D
Direct account	0.0	0.0	27614.0	27635.0	0.0	0.0
Mixed transfer	4852.4	6354.2	9215.4	2854.3	3685.7	7142.5
Subtotal	4852.4	6354.2	36829.4	30489.3	3685.7	7142.5
Amount to	11206.6		67318.7		10828.2	
Total	89353.5					
Project	Relationship cost (Yuan)					
	HR primary assembly point		FR primary assembly point		MR primary assembly point	
	S-M	M-D	S-M	M-D	S-M	M-D
Direct account	44123.5	37481.5	15428.3	97541.2	8248.4	14025.6
Mixed transfer	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal	44123.5	37481.5	15428.3	97541.2	8248.4	14025.6
Amount to	81605		112969.5		22274	
Total	216848.5					

5. RESEARCH ON THE IMPACT OF INTELLIGENT PLATFORMS ON BUSINESS ACCOUNTING

5.1. RESEARCH HYPOTHESIS AND VARIABLE SETTING

The theory of operational accounting points out that the degree of refinement of accounting work will directly affect the operational efficiency of enterprises. The impact of the intelligent platform on accounting work and operational accounting performance response, decision support, real-time control features have many similarities, the application of the intelligent platform in the accounting confirmation process can make the confirmation of income and expense accounting data more real and reliable, in order to improve the operational efficiency of the income and expense confirmation process at the same time also reduces the cost of the enterprise, for the managers to make decisions to provide more accurate and effective support for the financial data so as to Enhance the efficiency of the enterprise.

In this paper, the sample data is selected from the data of listed companies in the computer, communication and other electronic equipment manufacturing industry that have introduced intelligent platforms in their accounting work between 2012 and 2022, and the data is obtained from the database of GuotaiAn. First of all, this paper will empirically explore the effectiveness of the practical application of intelligent platform in accounting work. Measuring the enhancement of corporate efficiency should not only consider the changes in revenue, but also need to consider the changes in total assets, the use of revenue and asset rationing relationship reflects the efficiency of the enterprise's use of assets, and better reflect the actual operating efficiency of the enterprise, so this paper will be the total asset turnover as a measure of the effectiveness of the application of the intelligent platform in the accounting work.

The representation and definition of each variable are shown in Table 3. By collecting the data of listed companies in the computer, communication and other electronic equipment manufacturing industry that use the intelligent platform in accounting work from 2012 to 2022, and after processing the sample data by deleting the missing values outliers as well as up and down indenting by 1.5%, 152 compliant sample data are obtained.

Table 3. The representation and definition of each variable

Variable type	Variable name	Variable symbol	Variable specification
Explained variable	Total asset turnover	TAT	Use total asset turnover rate as a measure of the effectiveness of block chain technology in accounting work
Interpretation variable	Use smart platforms	Smart-plat	The sample enterprise used the year of the block chain technology in accounting accounting to be 1, and did not use the block chain technology year for 0
Control variable	Total asset profit rate	ROA	The total net profit of the enterprise is the ratio of the total total assets of the enterprise
	Company size	Size	The average total assets of the year
	Asset ratio	ALR	The annual report lists the ratio of total liabilities to assets
	Current liability ratio	CAR	The annual current liabilities account for the total amount of liabilities

5.2. STATISTICAL EMPIRICAL ANALYSIS

The correlation analysis was done by analyzing the explained variables, explanatory variables as well as control variables and making initial judgment on the research hypotheses. Table 4 gives the correlation analysis of the main variables. According to the table, it can be seen that whether or not to adopt the smart platform dummy variable in accounting work has a significant positive correlation with the total asset turnover ratio (0.257), and the total asset turnover ratio has a positive and

significant correlation with the company's size, the asset liability ratio and the current liability ratio, but the correlation with the profitability of the total asset ratio is insignificant, which indicates that the profitability level of the enterprise may not be a representative of the enterprise's operational efficiency, on the contrary, it may be that the profitability level of the enterprise may not represent the operational efficiency of the enterprise. Intelligent platform dummy variable indicators have a more significant effect on the total asset turnover ratio.

Table 4 Correlation analysis of major variables

TAT	Smart-plat	ROA	ALR	CAR	Size	
TAT	1					
Smart-plat	0.257***	1				
ROA	0.0274	0.00124	1			
ALR	0.325***	-0.0543	0.152*	1		
CAR	0.192**	0.206**	-0.0132	-0.254***	1	
Size	0.223***	0.158*	-0.114	0.0325	0.178**	1

The above study shows the positive correlation of the dummy variable of intelligent platform on the total asset turnover ratio, on the basis of which we will carry out multiple regression analysis on the related variables, and the multiple regression results of the main variables are given in Table 5. As can be seen through the multiple regression results, the regression results of the intelligent platform dummy variable as an explanatory variable are significant, while the regression results of the three control variables, namely company size, gearing ratio, and current liabilities ratio, are also more significant, with 95% confidence intervals of [0.14852,0.30819], [0.16751,1.27943], [0.02417,- 0.02252]. It shows that to some extent the initial experimental hypotheses can be verified, but the variable of net profitability of total assets is not significant, which matches the results of the previous correlation analysis. The profitability level of the sample enterprises did not significantly affect the total asset turnover ratio of the enterprises, from which it can also be seen that the profitability level of an enterprise can not be a single indicator to measure the level of operation of the enterprise. The total asset turnover ratio, as a measure of the effectiveness of the application of the intelligent platform in accounting, is significantly affected by the dummy variable of the intelligent platform, which shows that after the introduction of the intelligent platform technology in accounting, its technological advantages have brought about a positive impact on the accounting work of the enterprise, and brought about a substantial increase in the efficiency of the enterprise. The positive regression results of the gearing ratio variable reflect that although more capital utilization will bring certain debt-servicing pressure and debt risk to the enterprise, it is able to utilize the utilized capital to improve the operating efficiency of

the enterprise, and the production scale benefit brought by the larger company size can also significantly improve the asset turnover rate.

Table 5. Multivariate regression of major variables

Source	SS	Df	MS	Number of obs		152
				F(5, 142)		10.56
Model	9.45217	6	1.93582	Prob > F		0
Residual	26.1247	141	0.163574	R-squared		0.2574
Total	36.21457	143	0.235841	Adj R-squared		0.2415
				Root MSE		0.43153
TAT	Coef.	Std.Err	t	P> t	[95%Conf.	Interval]
Smart-plat	0.23161	0.05582	3.27745	0.00421	0.09421	0.34829
ROA	0.60507	0.38991	1.69422	0.10514	-0.13486	1.31163
ALR	0.17127	0.02043	5.24553	-0.07268	0.14852	0.30819
CAR	0.68195	0.2884	2.59546	0.04716	0.16751	1.27943
Size	5E-05	-0.05145	2.01994	0.05924	0.02417	-0.02252
_cons	-0.28104	0.24317	-0.95824	0.35691	-0.75004	0.24245

6. CONCLUSION

In this paper, by building an intelligent platform for enterprise accounting and designing the corresponding functional framework, we propose an intelligent reporting method based on OCR and a financial calculation based on process reengineering. Company M is selected as an accounting example, and the impact of the intelligent platform on accounting is analyzed by regression method. The research conclusions are as follows:

1. The adoption of intelligent platform dummy variables in accounting work has a significant positive correlation (0.257) with the total asset turnover rate, while the total asset turnover rate and so on also have a positive and significant correlation, indicating that the level of corporate profitability may not be representative of the operational efficiency of the enterprise, on the contrary, the intelligent platform dummy variable indicators of the total asset turnover rate has a more significant impact.
2. Intelligent platform dummy variable as an explanatory variable its regression results are significant, but the total assets net profit margin variable is not significant, which matches the results of the previous correlation analysis.

3. The positive regression results of the gearing ratio variable reflect that more funds are occupied, which will bring certain debt-servicing pressure as well as debt risk to the enterprise, but it can utilize the occupied funds to improve the operating efficiency of the enterprise.

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/03/

STUDY ON THE INFLUENCING FACTORS AND IMPROVING COUNTERMEASURES OF REGIONAL FINANCIAL SERVICE FUNCTION - TAKE CORPORATE LOANS AS AN EXAMPLE

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ABSTRACT

Focusing on regional financial services, this paper analyzes the variables affecting non-financial businesses getting loans through the region economic services function, and then proposes countermeasures to improve it. The DPC algorithm is applied to the financial analysis in this paper because of its fast speed and high accuracy. The AD-DPC approach is suggested in this study as a solution to the issue that the computation of local density relies on the choice of the truncation length parameter d_c and the clustering sites must be manually chosen. This strategy lessens the subjectivity and volatility that the fictitious label d_c brings. For the DPC algorithm by using a one-step assignment strategy, i.e., assigning the labels of clustering centers to all non-clustering centroids at one time, such a strategy is poorly fault-tolerant, this paper proposes the DAS-DPC algorithm on the basis of AD-DPC. Through experiments, ADAS-DPC is optimal for ARI metrics in the dataset. Among them, the ARI indexes of ADAS-DPC algorithm are 0.832, 0.895, 0.768 and 0.757 in the datasets Iris, Wine, Seed and Sonar. It shows that the ADAS-DPC algorithm can not only handle the datasets with complex shapes, large density differences between clusters and tightly connected clusters, but also improve the clustering performance of the algorithm for high-dimensional data.

KEYWORDS

Regional financial services; corporate lending; DPC algorithm; AD-DPC algorithm; DAS-DPC algorithm

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1. INTRODUCTION

The primary engine of economic growth is finance, and the "vitality", "stability", "prosperity" and "strength" of finance determine the "vitality", "stability", "prosperity" and "strength" of the economy. Determines the "vitality", "stability", "prosperity", and "strength" of the economy, pointing up the crucial role that money plays in economic growth [1-3]. The most potent indicator of increased financial competitiveness is the improvement in the capacity of financial services to contribute to the actual economy, the development of inclusive finance, or the promotion of an equitable growth of the capital market [4]. Regional financial competitiveness, on the other hand, is the expression of financial competitiveness at the regional level, as well as the relative advantage and comprehensive ability of a region in competition with other regions through the process of absorption, control, utilization, ownership and allocation of financial resources [5-6]. Therefore, the level of a region's financial competitiveness directly determines whether the region's financial resources are effectively allocated, it ultimately has an impact on the area's capacity to deliver financial goods to the actual economy, thereby affecting the overall national economic and social development [7-9].

The literature [10] specifically analyzes the causes of regional financial differences and the impact of diffusion methods on regional financial development differences, and finds that financial liberalization has a key impact on the unbalanced development of regional finance, and this unbalance leads to the emergence of administrative power inequality, which makes financial development differences more serious, and a vicious circle is thus formed, and the differences gradually expand. The literature [11] argues that credibility in the financial market has an important influence on the transaction behavior of borrowers and lenders, just as appearance has a positive effect on a person's employment, good credibility has a positive effect on access to loans, and good credit and high market recognition make it easier to obtain loans. The literature [12] suggests that blockchain technology can be applied to supply chain finance projects, which is expected to accelerate the speed of capital operation in the whole supply chain platform, but it is still in the exploration stage. According to the literature [13], while increasing financial growth scale does not significantly affect the outcomes, improving financial growth structure and efficiency are advantageous to enhancing regional innovation potential. The literature [14] found through the study of Internet finance that the relationship between traditional finance and Internet finance is one of competition and integration, and the competitiveness of Internet finance is increasing. By studying the synergy between market-oriented financial competitiveness and government-oriented financial stability, the literature [15] found that there is a high correlation between financial competitiveness and financial stability, and the dispersion of their synergistic effects and economic development are strongly correlated.

The DPC clustering algorithm is known for its simplicity and efficiency, but there are some drawbacks. To address the problem that the calculation of local density depends on the selection of the truncation distance parameter d_c and the clustering centers

need to be selected manually, this paper proposes an adaptive local density and clustering center density peaking algorithm (AD-DPC). The algorithm finds the optimal number of nearest neighbors k through the concepts of "forward neighbors" and "reverse neighbors", and proposes a k adjacent neighbor fuzzy kernel to determine the regional density. This approach reduces the subjectivity and instability caused by artificially specified d_c . In this paper, based on the multiplication of local density and relative offset distance, a new core point evaluation method is proposed, through which core points can be effectively screened. For the DPC algorithm by using a one-step assignment strategy, i.e., assigning the labels of clustering centers to all non-clustering centroids at one time, such a strategy is poorly fault-tolerant, this paper proposes an adaptive multi-step assignment strategy for density peak clustering algorithm (ADAS-DPC) on the basis of AD-DPC. The three primary steps of the suggested method are as follows: the first step employs a particular strategy to locate edge points and high-density points. In the second step, the core point labels are assigned by propagating the assignment strategy. In the third step, a checking mechanism is introduced to check whether the labels of the edge points are optimal. Finally, the ADAS-DPC algorithm is applied to the analysis of factors influencing the function of regional financial services.

2. FINANCIAL ANALYSIS MODEL BASED ON IMPROVED DPC ALGORITHM

2.1. ADAPTIVE DENSITY PEAK CLUSTERING ALGORITHM

In the DPC algorithm, if the truncation distance is not chosen properly, that could have a significant impact on how the regional density of points is calculated and ultimately result in a reduction in the clustering effect, while in this section, an improved local density calculation will be proposed without artificially coming to set the truncation distance. Based on the data provided by its nearby samples, the regional density of a site is precisely determined.

2.1.1. IMPROVED LOCAL DENSITY CALCULATION

This section suggests using a fuzzy kernel to estimate local density as a better method of doing so. The idea of k nearest neighbor and k nearest neighbor will be introduced by the suggested fuzzy kernel in this section in order to take the local data structure into account while determining the densities. As described by the proposed fuzzy kernel:

$$\rho_i = \max \left\{ 1 - \frac{1}{k} \left(\sum_{j \in \text{knn}(x_i)} d(x_i, x_j) \right), 0 \right\} \quad (1)$$

where $knn(x_i)$ is the group of close neighbors of point x_i . It's described as:

$$knn(x_i) = \left\{ x_j \mid d(x_i, x_j) \leq d(x_i, x_k) \right\} \quad (2)$$

where $d(x_i, x_j)$ is the Euclidean distance among x_i and x_j and x_k is the k th nearest neighbor of x_i . The information on the local density dispersion from nearby samples is combined in the enhanced local density expression. As a result, the fuzzy kernel can effectively extract the local density distribution. The focus on neighbor relationships is appropriate for sets of data with an uneven density dispersion and subpar DPC performance.

2.1.2. FINDING THE OPTIMAL NEIGHBORHOOD SIZE

In the previous section, a way to calculate the local density using k nearest neighbor was proposed, where the parameter k still needs to be set artificially, which also interrupts and destroys the continuous operation of the algorithm to some extent. In this section, the optimal k value is determined by calculation, so that the whole algorithm does not depend on the parameter.

In the present study, we suggest a flexible method for finding the optimal k value. Firstly, by setting the k value initially to 1, the nearest neighbor point of each point is found by definition 1, and then the number of times each point is considered as a neighbor point by other points, i.e., the reverse neighbor proposed by definition 2, is calculated to help iterative finding. Then the optimal k value is finally found by increasing in steps of 1.

The Euclidean distance among two data points x_i and x_j of dimension n is represented by $Dis(x_i, x_j)$. x_i and x_j fit to the set D , x_j is the k th neighbor of x_i , and is sorted by distance from x_i , from smallest to largest.

Definition 1 Positive neighbors and the positive neighbors of point x_i are represented by set $nbr(x_i)$:

$$nbr(x_i) = \left\{ x_m \mid Dis(x_i, x_m) < Dis(x_i, x_j) \right\} \quad (3)$$

Definition 2 Reverse neighbor, the reverse neighbor point of any point x_i is represented by the set $rnbr(x_i)$, which needs to satisfy equation (4), i.e., a point x_n in the forward neighbor of point x_i . If the forward neighbor point of x_n contains point x_i , then x_n is said to be a reverse neighbor. $rnbr(x_i)$ is used to denote the set of reverse neighbor points of point x_i :

$$rnbr(x_i) = \left\{ x_n \mid x_i \in nbr(x_n) \wedge x_n \in nbr(x_i) \right\} \quad (4)$$

The optimal k value size can be obtained as follows: as the k value increases from 1 and in increments of 1, each point x_i in the set acquires at least one reverse neighbor point, but when all points do not acquire a reverse neighbor point, The k value is regarded as the ideal k value. The termination condition for the optimal k value is expressed using equation (5):

$$T(x_i) = \begin{cases} \left| rnbr(x_i) \right|_k - \left| rnbr(x_i) \right|_{k-1} & k > 1 \\ \left| rnbr(x_i) \right|_k & k = 1 \end{cases} \quad (5)$$

Where, k starts from 1 with a step size of 1 and sets the upper search limit $l(l = \text{int}(\sqrt{n}))$. $\left| rnbr(x_i) \right|$ indicates the number of elements of the set of $rnbr(x_i)$. Combining with equation (1), the local density can be obtained.

2.1.3. ADAPTIVE DETERMINATION OF CLUSTERING CENTERS

The DPC algorithm requires visual inspection of the decision diagram to manually set the clustering centers. This human selection approach is unreliable when dealing with complex decision graphs. In order to select the appropriate core points, this section will design a new scoring formula to evaluate each point and then check whether it can be considered as a clustering center based on the threshold value. In this paper, the improved local density and relative offset distance will be used to identify the clustering centers. Then a new scoring method is proposed for scoring all points to determine the clustering centers by scoring, see Equation (6).

$$Pscore_i = \left(\frac{\rho_i \delta_i}{\max(\rho) \max(\delta)} \right)^2 \quad (6)$$

Using the assessment score values $Pscore_i$, each point in the data set is sorted. Higher score values will be assigned to points that have elevated local density and high comparative offset distances, and then the scores are sorted in descending order from highest to lowest. In order to determine the candidate clustering centers a threshold value is needed, by which the clustering centers can be determined adaptively.

For the proposed $Pscore_i$ design algorithm finds the threshold value. As shown in Figure 1, the values of $Pscore_i$ for most of the data points are concentrated in a lower region, while the values of $Pscore_i$ for only a few points are concentrated in a higher region. The non-clustering center point of $Pscore_i$ decreases almost linearly and slowly. From the critical point $Pscore_i$ value to the non-clustered centroid $Pscore_i$ value, there is a leap gap. The core points are filtered by finding this gap. Firstly, this subsection defines equation (7) to describe the $Pscore$ absolute

difference of adjacent consecutive points, and then calculates the mean value of $DPscore$ by equation (8).

$$DPscore_i = abs(Pscore_i - Pscore_{i+1}) \quad (7)$$

$$\overline{DPscore} = \sum_{i \in D} \frac{DPscore_i}{|D| - 1} \quad (8)$$

In Figure 1(a), the solid blue circles represent the core points and the hollow blue circles represent the non-core, and from Figure 1(b) the vertical coordinates are the scoring values and the horizontal coordinates are the point numbers. We can see that the points behind the core points $DPscore$ are very small. This feature can be used to determine the candidate core points.

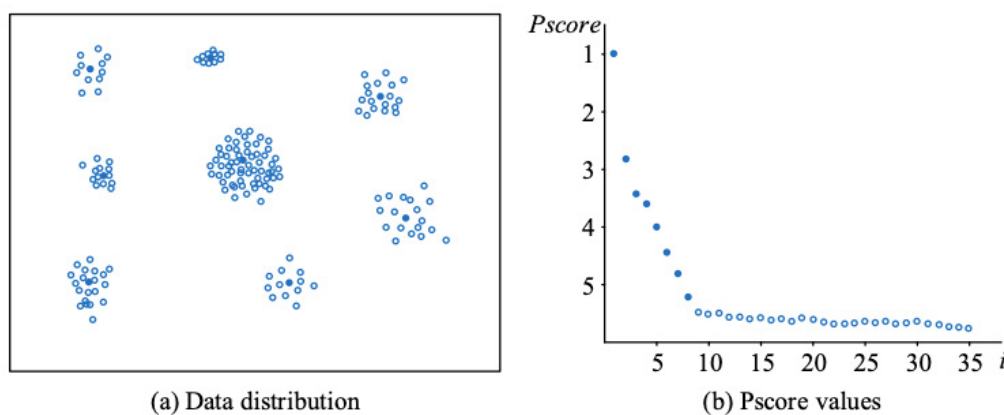


Figure 1. Data distribution and value ranking chart

When there are multiple candidate centers in a high-density region, they are usually very close to each other. Therefore, it is necessary to determine whether these candidate centers can be identified as the final independent clustering centers. Therefore, to determine each candidate point's k closest neighbor, the candidate cores are adjusted. If, for a point x_i in the candidate set, a k nearest neighbor x_j is found and x_j is also a candidate core, then the values of the Pscore of the two points are compared and the one having the larger Pscore value is kept and the smaller one is removed from the candidate core set. The final actual clustering centers are determined from the candidate set using a fine-tuning process.

2.2. ADAPTIVE MULTI-STEP ALLOCATION STRATEGY DENSITY PEAK CLUSTERING ALGORITHM

Although the AD-DPC algorithm proposed above solves the two problems that the local density calculation in the DPC algorithm depends on the truncation distance and requires human experience to select the clustering centers based on the decision map. When the data set is vast, there are many noisy points, and the area of overlap is complicated, the accuracy index still deteriorates. To address this problem, the

adaptive multi-step assignment strategy density peak clustering algorithm, referred to as the ADAS-DPC algorithm, will be proposed on the basis of the AD-DPC algorithm.

2.2.1. NON-CORE POINT DIVISION

The main purpose of this step is to make an initial distinction between non-core, and to first perform a round of division of non-core points by the formula designed in this subsection. This division is not a division of non-core point categories, but a round of data points based on the distribution in the decision diagram. For this purpose, three types of points are divided: cluster centers, high-density points, and edge points. While the density near edge points differs significantly from that of their neighbors, it is similar to that of the high-density points and their neighbors. Depending on how effectively the clustering algorithm interprets the clustering structure, edge point detection accuracy can vary. The sites with substantial density values created by eliminating edge points are the clustering backbones. Each core should roughly preserve the cluster's form and be separated from the others:

$$\text{Avg}(\rho) = \frac{1}{n} \sum_{i=1}^n \rho_i \quad (9)$$

where n is the number of points.

Edge points are points surrounding the backbone cluster, so these points have different characteristics from those in the high-density cluster. To express this concept, edge points are points $(\rho_i < \text{Avg}(\rho))$ whose local density is lower than the average local density, and their relative offset distance values are lower than the variance $(\delta_i < \text{Var}(\delta))$ of the relative offset distance values of all points, and the effect of setting $\text{Var}(\delta)$ is to exclude individual points with abnormal values, see Equation (10):

$$\text{Var}(\delta) = \frac{1}{n} \sum_{i=1}^n (\delta_i - \bar{\delta})^2 \quad (10)$$

Figure 2 shows the distribution of data points in the decision diagram, with the horizontal coordinates representing the local density and the vertical coordinates representing the relative offset distance. The blue and orange colors represent the core points, the black circles represent the high density points, and the black diamonds represent the edge points. This figure clearly shows the distribution of core, high-density, and edge points in the decision diagram. divides the diagram into two parts, left and right, with core and high-density points on the right side of the diagram and edge points on the left side of the diagram.

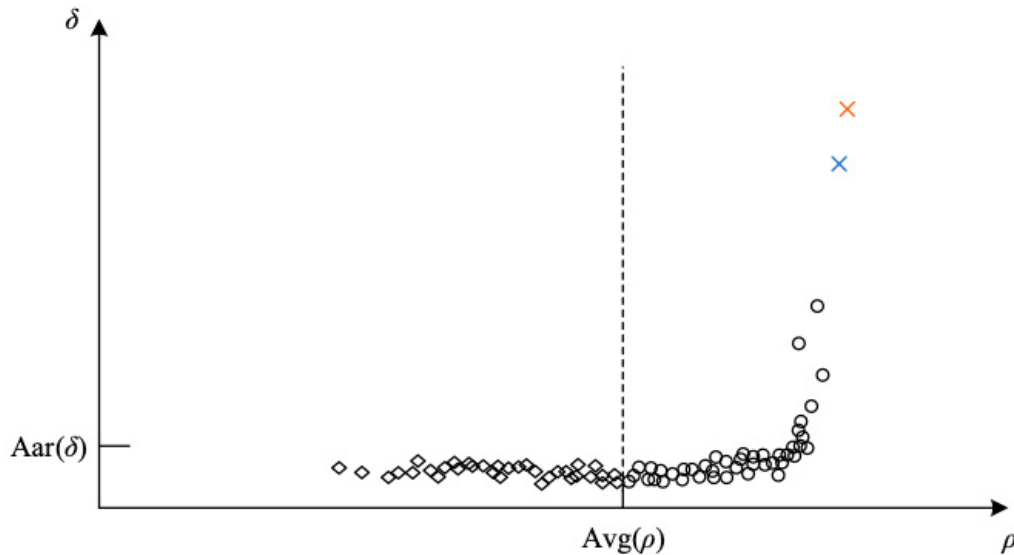


Figure 2. Distribution of data points in the decision diagram

2.2.2. LABEL ASSIGNMENT

This subsection aims to assign clustering labels to non-clustering centroids by three sub-steps: (1) Core points are assigned to high-density points. (2) High-density points are assigned to high-density points. (3) High-density points are assigned to edge points.

The cluster centers will each be given a different label, after which the tags of the comment cluster centers will be discovered by searching for the cluster centers' mutually dense nearest neighbors. The marks with all these assigned labels will then be used as starting points, and each nearest neighbor will then be found dynamically. This concept is expressed by equation (11), where $Label(x_i)$ denotes the label of x_i .

$$Label(x_i) = \begin{cases} Label(x_j) & x_i \in rnbr(x_j) \\ 0 & \end{cases} \quad (11)$$

Figure 3 illustrates the specifics of the suggested label assignment technique for arbitrary data. Figure 3(a) highlights that the clustering centers have been identified using the AD-DPC algorithm proposed in this paper. The proposed approach in this chapter is then used to identify high-density points and border points, with high-density points highlighted by hollow black circles and black hollow diamonds indicating edge points. The tags of a cluster centers are transmitted to their dense neighbors, as shown in Figure 3(b). The left cluster's trunk points are depicted in this figure as blue, as well as the right cluster's trunk points as orange.

The second stage in this work tries to transmit the clustering tags to the edges by assigning the tags of the closest trunk points in order to decrease computation time.

Equation (12) is used to determine the total of each edge point's distances from all of its backbones' nearest neighbors for this purpose:

$$\text{SumDis}(x_b, M^c) = \frac{1}{k} \sum_{x_i \in \text{nbr}(x_b, M^c)} \|x_b - x_i\|^2 \quad (12)$$

where x_b is an edge point, M^c is a collection of dense nodes from the c rd trunk, and $\|x_b - x_i\|^2$ depicts the distance in Euclidean terms between the two spots. $\text{SumDis}(x_b, M^c)$ is the average of all the distances between x_b and the closest neighbors of M^c in k . The edge point x_b will obtain the trunk label with the smallest distance from itself. The purpose of using the exponential function in Eq. (13) is to magnify the gap and avoid the inability to distinguish the size due to insufficient number of calculated bits when the distances are extremely close:

$$\text{Label}(x_b) = \underset{c \in C}{\text{argmin}} e^{\text{SumDis}(x_b, M^c)} \quad (13)$$

where C is the total number of detected trunks. This method is repeated until cluster labels have been assigned to each edge point. The proposed method's assignment of the labels to edge points x_b is depicted in Figure 3(c). The figure demonstrates that point x_b has been given by the blue label using the method described in this study because the average amount of the distances added by the blue labels is less than the average value of the distances added by the orange labels.

Figure 3(d) shows the edge point rechecking mechanism, which starts to execute after the labels of all edge points have been assigned, to detect whether the edge point label assignment is reasonable.

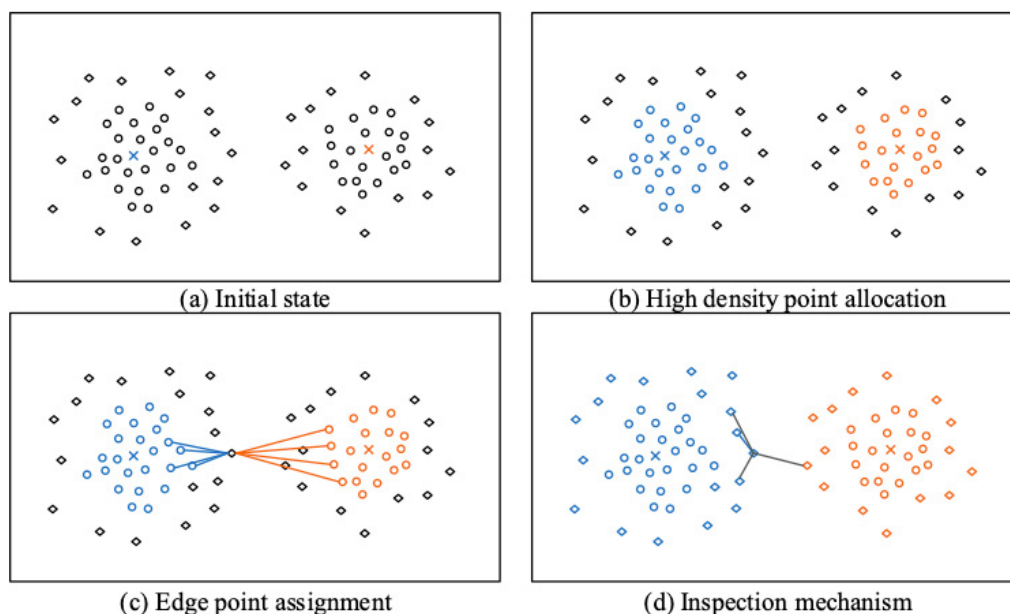


Figure 3. Example of a multi-step allocation strategy

2.3. PERFORMANCE ANALYSIS OF THE ALGORITHM

To verify the effectiveness of the algorithm, comparative experiments are conducted using UCI datasets, which contain a wide variety of sizes and types. Some of these datasets also have clusters of various complex shapes, and the data distribution of the specific UCI datasets is exposed in Table 1. It is visible from the table that these seven UCI datasets basically cover a wide variety of datasets (size, complexity and data characteristics). The performance and robustness of the algorithm can be detected by such a variety of types of data with complex distribution. This section tests the performance of the ADAS-DPC, AD-DPC, and DPC algorithms by using the evaluation metrics FMI and ARI, showing the best values for each test dataset.

Table 1. UCI data set

Data set	Number of data	Dimensionality	Number of classes
Inis	150	4	3
Wine	178	13	3
Seed	210	7	3
Sonar	208	60	2
Ecoli	336	8	8
WDBC	569	30	2
Balance	625	4	3

Figure 4 shows the results of FMI for the clustering algorithm on the seven datasets. From the overall results the ADAS-DPC algorithm has the highest FMI metrics in the datasets. Among them, in the datasets Iris, Wine, Seed, Sonar, and WDBC, the FMI values of ADAS-DPC are all over 0.8, which shows that the ADAS-DPC algorithm is effective for the improvement of the AD-DPC algorithm proposed in this paper, especially when facing the datasets with larger dimensionality, ADAS-DPC has a certain degree of improvement compared with the algorithms participating in the comparison experiments. Degree of improvement.

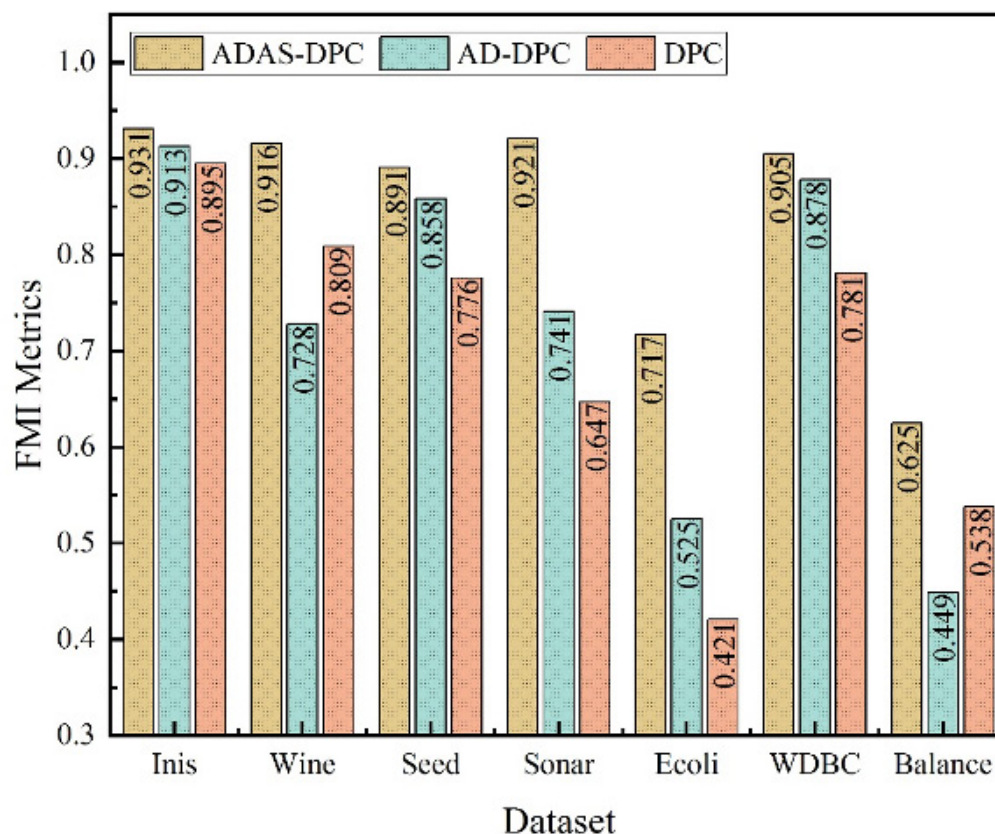


Figure 4 Experimental results of FMI in UCI dataset

Figure 5 shows the results of the clustering algorithm for the ARI metrics in the seven datasets. The overall results show that ADAS-DPC has the best ARI metrics in the datasets. Among them, in the datasets Iris, Wine, Seed, and Sonar, the ARI metrics of the ADAS-DPC algorithm are 0.832, 0.895, 0.768, and 0.757, which shows that the ADAS-DPC algorithm is effective for the improvement of the AD-DPC algorithm proposed in this paper. In the Ecoli, WDBC, and Balance datasets, although ADAS-DPC achieves the optimum, the ARI metrics are too low, indicating that it is difficult for these eight algorithms to deal with these three datasets effectively.

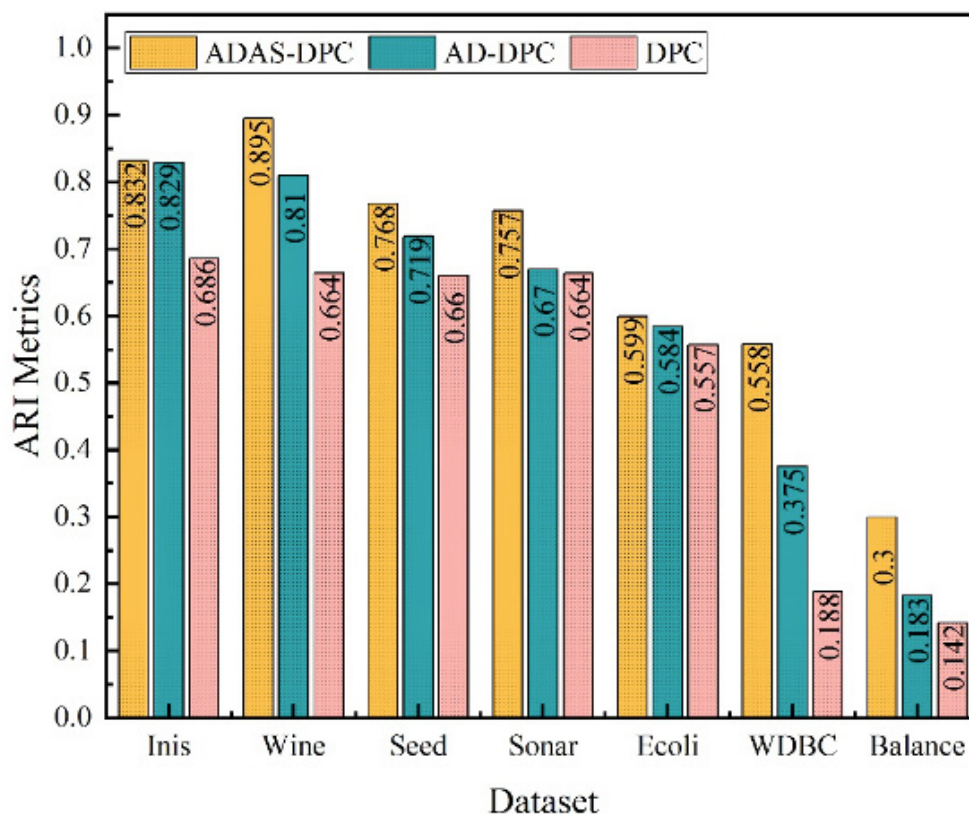


Figure 5. ARI in the UCI dataset Experimental results

3. STUDY ON THE IMPACT FACTORS OF REGIONAL FINANCIAL SERVICES FUNCTION

3.1. RESEARCH PROGRAM

3.1.1. RESEARCH HYPOTHESIS

As Internet finance and the actual economy grow, so do the funding options available to businesses. However, whether it is a bank or other financing platform, they all play the role of intermediaries for enterprise financing, collecting and lending funds from multiple and scattered sources. Consequently, it may be said that one of the key variables affecting how much money is lent out is the number of deposits. The reserve minimum ratio stated by the bank's governor indirectly influences the total quantity of loans in alongside the total number of deposits. Based on this, the following hypotheses are put out in this article, which takes into account non-financial company deposits, household deposits, and the required reserve ratio as variables affecting the lending amount provided by non-financial corporations and institutions.

Hypothesis 1: The volume of loans made by non-financial institutions and corporations has a positive correlation with the deposits made by households and

non-financial businesses. The ratio of reserve requirements to loans made to non-financial institutions and corporations has a negative relationship with both variables.

Hypothesis 2: Loans to non-financial institutions and firms and loans to households have a favorable correlation.

Hypothesis 3: The number of lending to non-financial businesses and institutions is inversely connected with the reduction of loss-making businesses.

Hypothesis 4: Index of consumer prices Loans made to organizations and businesses that are not in the financial sector have a negative correlation with the CPI. Negative correlation exists between the quantity of loans placed by non-financial firms and organizations and the Shanghai Interbank Offered Rate (SHIBOR).

3.1.2. RESEARCH METHODOLOGY

This study expanded the research area of the number of loans positioned by non-financial businesses to the research topic of the number of loans positioned by non-financial businesses and institutional groups by using the number of loans positioned by non-financial businesses and governmental groups as the predictor variables. Table 2 displays the variables.

Table 2. Selection of variables

Variable Code	Variable name
Y	Amount of loans to non-financial enterprises and institutions
X1	Deposits in non-financial enterprises
X2	Household deposit
X3	Household loan
X4	Reduction rate of loss-making enterprises
X5	CPI
X6	SHIBOR rate
X7	Deposit reserve ratio

3.1.3. DATA SOURCES

Based on the proposed research question, this paper chooses the following variables for the period of 2017 to 2021 in Hunan Province: non-financial corporate and institutional loan placement, non-financial corporate deposits, household deposits, household loans, loss-making enterprises reduction rate, CPI, SHIBOR 1-month interest rate, and deposit reserve ratio. Based on the numerous interest rate

term varieties published by SHIBOR, this paper selects the interest rate term variety for SHIBOR term variety with the 1-month interest rate from January 2017 to December 2021 as the choice of interest rate term variety. Since the 1-month SHIBOR rate changes every few trading days with the market and for the convenience of data selection, this paper selects the official January SHIBOR rate on the first trading day of each month as the 1-month SHIBOR rate data. Regarding the data itself, in order to further investigate the effect that outside influences of non-financial enterprise loans on enterprise loans, this paper selects data of loan placement of non-financial businesses and related groups in Hunan Province over the last five years with the variables of non-financial entrepreneurship deposits and household deposits.

3.2. ECONOMETRIC TESTS OF FACTORS INFLUENCING CORPORATE LENDING

The results of the ADAS-DPC algorithm test were obtained using the amount of loans to non-financial businesses and organizations as the variable that is dependent and variables like funds to non-financial businesses and funds to households as separate variables. The information is shown in Table 3.

Table 3's results make it clear that X1 is unimportant and X7 has a positive correlation with Y, which is inconsistent with the hypothesis. As a result, the variables are examined for multicollinearity, which can produce unimportant variables and the incorrect sign of the coefficient of regression.

Table 3. ADAS-DPC estimation results

Variables	coefficient	Standard deviation	T-value	P-value
C	-1.305	2.344	-553	558
X1	116	90	1.660	112
X2	281	57	3.765	-12
X3	1.005	92	11.237	3
X4	-3.194	8.344	-3.790	-1
X5	-1.016	4.636	-2.180	22
X6	-2.954	9.178	-3.228	14
X7	2.579	1.150	2.230	26

Table 4 displays the straightforward correlation coefficient matrix. Variable X7 exhibits strong multicollinearity amongst the variables since it is substantially linked with variables X2, X3, and X4 in a two-by-two fashion. Therefore, despite the fact that the number of loans placed and the X7 deposit reserve ratio are theoretically

negatively connected, as the deposit reserve ratio rises, banks have comparatively less money to use for lending.

Table 4. Simple correlation coefficient matrix

	X1	X2	X3	X4	X5	X6	X7
X1	1.000	587	576	-314	-75	109	-367
X2	587	1.000	993	-870	225	-507	-928
X3	576	993	1.000	-825	251	-550	-945
X4	-314	-870	-825	1.000	-439	658	861
X5	-75	225	251	-439	1.000	-334	-330
X6	109	-507	-550	658	-334	1.000	703
X7	-367	-928	-945	861	-330	703	1.000

On the basis of this, after deleting the variable for the X7 deposit reserve percentage, the ADAS-DPC estimation was re-run to obtain Table 5. For the original hypothesis H_0 : , given the significance level , $F(6, 53)=6.48$, $F=211>6.48$ in the table, the original hypothesis H_0 should be rejected, demonstrating the significance of the regression equation. Also, it can be inferred that the factors X1, X2, X3, X4, X5, and X6 are significant at the $\alpha=5\%$ significance threshold from the p-values in Table 5 that are less than 0.05, showing that the regress of the chosen explanatory factors with the explanatory variables is significant. Among them, non-financial corporations and organizations are positively correlated with non-financial corporate deposits, household deposits and household loans, CPI and SHIBOR 1-month interest rate are inversely connected with the rate of loss-making businesses.

Table 5. ADAS-DPC estimation consequences

Variables	Coefficient	Standard deviation	T-value	P-value
C	3.479	9.815	3.559	12
X1	252	75	3.493	15
X2	214	86	3.134	-9
X3	896	75	11.578	-7
X4	-3.712	8.33	-4.478	-5
X5	-1.46	4.357	-3.35	13
X6	-1.88	8.096	-2.341	26

This led to an analysis of the interconnections between the variables, which is depicted in Table 6. The regression results of the explanatory variables X2 and X3 passed the test statistics in Table 4 of the estimation findings, and there is a strong

correlation between X4, X2, and X3. In order to make the data smoother and to eliminate the problems of multicollinearity and heteroskedasticity of the model, the results of ADAS-DPC estimation after taking logarithms for Y, X1, X2, and X3 are shown in Table 7, and the variables are significant after taking logarithms for the variables of interest.

Table 6. Simple correlation coefficient matrix

	X1	X2	X3	X4	X5	X6
X1	1.000	594	583	-306	-66	100
X2	594	1.000	999	-868	228	-531
X3	583	999	1.000	-858	242	-557
X4	-306	-868	-858	1.000	-415	666
X5	-66	228	242	-415	1.000	-363
X6	100	-531	-557	666	-363	1.000

Table 7. ADAS-DPC estimation results after logarithm

Variables	Coefficient	Standard deviation	T-value	P-value
C	3.060	1.069	2.877	15
LN X1	93	45	2.212	43
LN X2	3.187	88	3.617	9
LN X3	413	43	9.834	-11
X4	-140	40	-4.229	7
X5	-628	212	-3.029	1
X6	-806	364	-2.126	31

A unique technique for determining whether macroeconomic, monetary, and financial information series are stable and exhibit specific statistical properties is the root unit test of stability. Unit root tests can be performed in a number of ways, including the ADF test, PP test, DF test, KPSS test, ERSPO test, and NP test, among others. ADF test is primarily utilized in this paper, as shown as Figure 6.

ADF statistics for $\ln Y$, $\ln X1$, $\ln X2$, $\ln X3$, $X4$, $X5$, and $X6$ were all above the critical values with confidence levels of 1%, 5%, and 10%. This indicates that at levels of significance of 1%, 5%, and 10%, $\ln Y$, $\ln X1$, $\ln X2$, $\ln X3$, $X4$, $X5$, and $X6$ are non-stationary sequence. From this, the ADF test then is completed to evaluate the first-order distinctions $D(\ln Y)$, $D(\ln X1)$, $D(\ln X2)$, $D(\ln X3)$, $D(X4)$, $D(X5)$, and $D(X6)$ of $\ln Y$, $\ln X1$, $\ln X2$, $\ln X3$, $X4$, $X5$, and $X6$, and the findings demonstrate that the ADF

statistical data are all smaller than the significance level with levels of confidence of 1%, 5%, and 10%, which demonstrates that $\ln Y$, $\ln X1$, $\ln X2$, $\ln X3$, $X4$, $X5$, and $X6$ of the first-order difference series are all smooth series. The single integer series $\ln Y$, $\ln X1$, $\ln X2$, $\ln X3$, $X4$, $X5$, and $X6$ are all first-order ones.

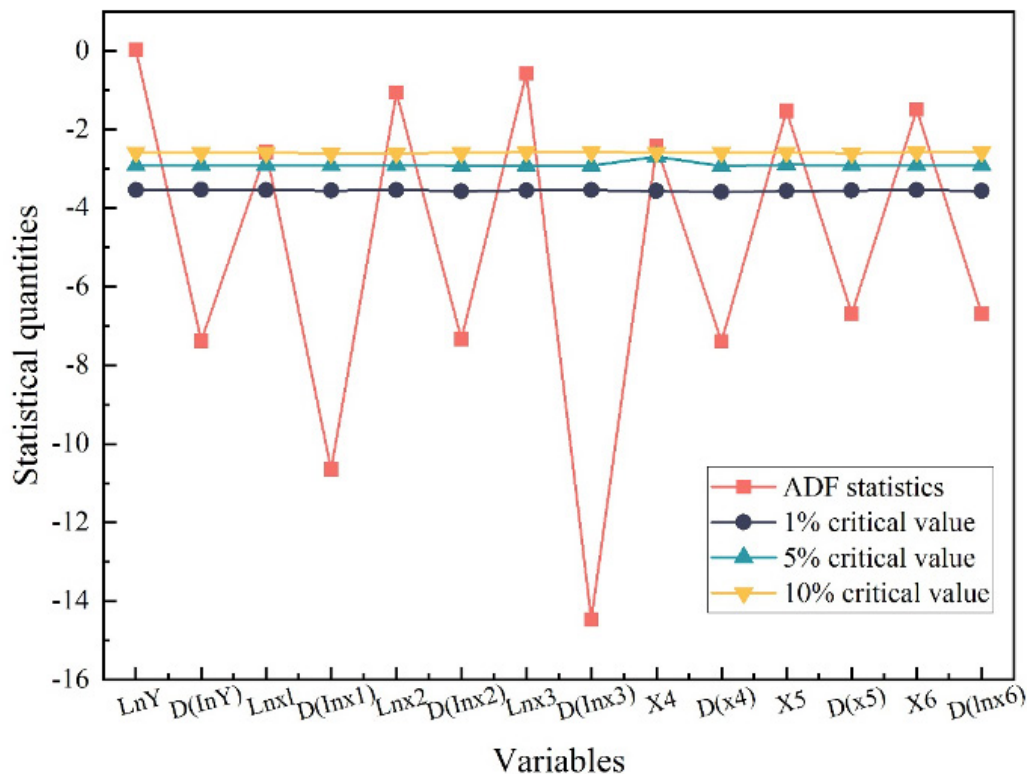


Figure 6. Stationarity test results of variables

4. SUGGESTIONS FOR COUNTERMEASURES

1. Accelerate the progress of financial sector integration and create a healthy ecosystem for regional financial markets

A strong credit system, financial guarantee system, and supervision system make up the bulk of a favorable financial market ecological environment. It is urgent to create a new and effective regional financial guarantee system and credit system, enhance the credit guarantee system, and reform the regulatory system in order to effectively contribute to the enhancement of the loan volume of non-financial enterprises and encourage the financing of small and medium-sized enterprises. At the moment, many studies pointed out that the guarantee system as well as credit system to be enhanced for the loans of small and medium-sized enterprises is one of the major reasons for financing difficulties.

2. Optimize loan structure and improve policy benefits

Based on an analysis of the existing situation of the country's macroeconomic system, China has continued to pursue a cautious monetary policy in recent times,

providing some support and vigor to the actual economy in order to revive the market. At the microeconomic level, the main types of loans are concentrated in the real economy, and it is necessary to actively optimize the structure of loan investment, so as to more effectively encourage the growth of the actual economy and maximize the advantages. On the other hand, the promotion of preferential policies should be improved, and special online and offline policy consultation and direct services divided by industry or enterprise nature should be set up, so that the benefit of the policy can be effectively improved and enterprises eligible for preferential policies can be precisely benefited, and the problem of information asymmetry can be further alleviated.

3. Accelerate the creation of the financial digital economy.

With the policy-oriented construction of the digital economy of regional finance, first of all, online and offline financing should promote the sharing of information and the interconnection of financial institutions, so as to further improve the efficiency of resource allocation of financial services. Nowadays, the majority of non-financial enterprise loans and financial originates from bank loans. But, as Internet finance has developed and associated laws and regulations have been introduced, financing sources outside of banks have also become more prevalent. Online and offline financing methods each tend to diversify, but the effective and sufficient links between financial institutions and financial institutions, online financial institutions and Internet financing platforms have not been obtained, resulting in a greater cost of finding effective information, which to a certain extent affects the amount of non-financial enterprise loan placement, thus accelerating the construction of the digital economy of finance.

4. An innovative financial services system is reviving the local financial services industry.

The real economy benefits from finance. As China continues to attach importance to innovation, while innovating, the financial service system is also in urgent need of innovation, so as to effectively build a financial support innovation economic system. From the service territory of regional finance, a strong regional financial service system may be established to generate green finance by innovating the financial service mechanisms in accordance with various regional features and inadequacies. From the regional finance's service objectives, it encourages the productive fusion of finance + agricultural, finance + research and technology, finance + pension and other sectors, thereby fostering industrial transformation and upgrading.

5. CONCLUSION

DPC has been widely used in image recognition, marketing, bioinformatics and financial analysis due to its speed and accuracy, the DPC algorithm is frequently used in the financial analysis, marketing, bioinformatics, and image recognition industries. For the large scale of financial service information and complex overlapping regions,

which can seriously affect the clustering algorithm's ability to segmentation, this paper proposes the density peak clustering algorithm with adaptive multi-step assignment strategy (ADAS-DPC). Comparative experiments are conducted using the UCI dataset, and the overall results show that ADAS-DPC is optimal for both FMI metrics and ARI metrics in the dataset, indicating that the ADAS-DPC algorithm is effective for the improvement of the AD-DPC algorithm proposed in this paper. Finally, we use the algorithm to analyze the influence factors of regional financial service function by using enterprise loans as an example to get the following conclusions:

1. Deposits of non-financial corporations and households are positively correlated with loans to non-financial corporations and organizations

Deposits can basically be split into two categories, one is the deposits available for lending by commercial banks and the other is the legal deposit reserve. An increase in the directness of deposits of non-financial corporations and households will have an immediate impact on commercial banks' total deposits, which will be transmitted to the amount of loans placed by non-financial corporations. There is a positive correlation between non-financial deposit and household loans, according to the regression assessment of these variables with other independent factors on the loan placing of non-financial firms and organizations.

2. Positive change of household loans on the volume of loans to non-financial enterprises and institutional groups

Residential leverage will, to a certain extent, cause the income benefit to outweigh the crowding out impact of residential leverage on consumption growth, thus to a certain extent, it is not conducive to amplify consumer demand, but as far as enterprises are concerned, residential leveraging will amplify consumer spending power, boost loans to non-financial businesses and the amount of financial investments made by businesses, whereas residential leveraging and loan growth both increase debt risk.

3. The change in the amount of loans to non-financial firms and organizations is inversely correlated with the decline in the number of loss-making enterprises, CPI, and SHIBOR 1-month rate of interest.

According to the stationary behavior unit root test and integration test, the rate of rise in loans to non-financial firms declines when the SHIBOR interest rate rises. The loss-making business reduction rate gauge, which is calculated based on all of the businesses in the area, provides insight into the industry's overall development environment and trend. The majority of area businesses attain profitability, and the business environment is favorable, according to a greater percentage of loss-making business reduction.

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STRATEGIES FOR IMPROVING THE DETECTION ACCURACY OF COMPUTERIZED MACHINE VISION CONSIDERING SPATIAL APPLICATIONS

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ABSTRACT

In this paper, strategies in image preprocessing, hardware composition and detection methods are considered to improve computerized machine vision detection accuracy. First, image preprocessing and image enhancement are performed to improve the quality of the input image. Second, the hardware composition of the computer vision online inspection system is optimized by focusing on the light source selection and the performance of the image acquisition card in spatial applications. Combined with spatial application calculations, methods such as frequency domain method and Canny operator are used in order to improve the accuracy of machine vision detection. Finally, in the same test environment, the machine vision detection requires only 400MB and the detection accuracy ranges from 85.13% to 99.42%. With these comprehensive strategies, this paper provides a comprehensive and effective approach for computerized machine vision detection in spatial applications to improve detection accuracy and meet demanding application scenarios.

KEYWORDS

Image preprocessing; machine vision detection; hardware composition; frequency domain method; Canny operator

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1. INTRODUCTION

With the continuous progress of science and technology, computerized testing has developed rapidly, and the categories of computerized products are getting richer and richer, and the quality requirements for testing are getting higher and higher [1]. In machine management, the accuracy of the detection results is very critical [2]. Due to the influence of factors such as the failure of traditional detection equipment or operational errors in the detection process, the detection results have some errors [3]. The spatial environment has a serious impact on the results of computer testing, which not only causes economic benefit loss to the relevant enterprises, but also seriously affects the competition of the computer industry in the international arena [4]. At present, most of the computer testing relies on manual to detect and identify the fault point, however, the manual detection method has limited detection accuracy, detection speed is not high, the test results are easy to be affected by the subjective factors of manual, high labor costs [5]. Thus making the computer in operation there are potential quality hazards, which directly leads to the inefficiency of machine vision inspection, reducing the competitiveness of the computer industry, and ultimately may face the end of being eliminated from the market [6]. Therefore, how to carry out rapid and effective detection of computers to improve the detection accuracy is an urgent problem to be solved.

Although the existing computerized detection methods have achieved some success in various aspects, the influence of spatial environmental factors has not been considered. In this paper, the input image is optimized and its quality is enhanced through computer image preprocessing. Various components required to construct an online workpiece inspection system for computer vision, especially in spatial applications, light sources adapted to the spatial environment are considered to improve the clarity and contrast of the workpiece. In the frequency-domain method, the fluctuation characteristics specific to spatial applications are emphasized to better adapt to the spatial environment. The application of Canny operator further improves the sensitivity to edges and enhances the detection effect. The accuracy enhancement strategy includes optimizing the preprocessing process, choosing a hardware composition adapted to the spatial environment, adjusting the light source, and improving the spatial application calculation method.

2. LITERATURE REVIEW

Sangirardi, M et al. showed that detecting the onset of structural damage and its gradual evolution is essential for the assessment and maintenance of the built environment, and in their study presented the application of a computer vision based structural health monitoring methodology for shaking table investigations [7]. Liu, G et al. addressed the fact that traffic management systems can capture large amounts of video data and use video processing techniques to detect and monitor traffic accidents. The collected data is traditionally forwarded to a traffic management center for in-depth analysis, which can exacerbate the problem of network paths to the traffic

management center. In the study, it is pointed out to utilize edge computing to equip edge nodes close to the camera with computational resources [8]. Wu, Z et al. proposed a computer vision based weed detection method, which explores the solution to the weed detection problem in terms of both traditional image processing and deep learning. Various weed detection methods in recent years were summarized, the advantages and disadvantages were analyzed, and relevant plant leaves, weed datasets, and weeding machines were introduced [9]. Li, Z et al. proposed a static software defect detection system design based on big data technology, which aimed to optimize the design of the traditional system. By predicting potentially defective program modules, the system design improves the hardware and software structure and achieves efficient allocation of testing resources, thus improving the quality of software products [10]. Lee, H et al. proposed a feature descriptor-based computer vision method for detecting rail corrugations to achieve automatic differentiation between corrugated and normal surfaces. The authors extracted seven features and combined them into a feature vector for constructing a support vector machine. The results show that the method is more effective than References in the recognition of corrugated images [11].

Qiao, W et al. redesigned the structure of DenseNet and improved it by adding the Expected Maximum Attention (EMA) module after the last pooling layer. The EMA module plays a significant role in bridge damage feature extraction. In addition, a loss function considering pixel connectivity is used in the paper, which shows good results in reducing the breakpoints of fracture prediction as well as improving the accuracy of fracture prediction, and the application in computer vision inspection helps to improve the accuracy and precision of bridge damage [12]. Shi, H et al. worked on the quality of steel wire ropes in lifting equipment, and used an industrial video camera to acquire infrared images of steel wire ropes. The wire rope contour was extracted by Canny edge detection and the diameter of the wire rope was corrected by one-dimensional measurements and directional fitting. The combination of computer vision inspection is expected to play an important role in improving the accuracy and efficiency of wire rope quality inspection [13]. Ljubovic, V et al. introduced a novel approach to source code repository construction by storing each editing event in the program source as a new commit, resulting in an ultra-fine-grained source code repository. Machine learning techniques were applied to detect suspicious behavior, thus significantly improving the performance of traditional plagiarism detection tools [14]. Roy, S. D et al. used a variety of feature extractors, including texture features such as SIFT, SURF, and ORB, as well as statistical features such as Haralick texture features, to form a dataset containing 782 features. Then, by stacking these features using multiple machine learning classifiers and using Pearson's correlation coefficient for feature selection, a dataset containing four features was finally generated for classification. This study combined the advantages of computer vision and machine learning to achieve good performance in feature extraction and classification tasks [15]. Huang, H et al. utilized a combination of computer vision, machine learning, and edge computing to provide an efficient and accurate solution for the citrus detection task. To

facilitate the deployment of the model, a pruning approach was used to reduce the computational effort and parameters of the model [16].

3. COMPUTERIZED IMAGE PREPROCESSING

3.1. PRETREATMENT PROCESS

Considering the conditions of spatial factors, when computer detection is carried out with the help of computer vision technology, it is necessary to pay attention to the image pre-processing technology, which is closely related to the subsequent image processing and analysis [17]. Figure 1 shows the image preprocessing process, to first extract the relevant information data of the image, and then effectively integrate the image preprocessing technology and template technology, thus reducing the technical difficulty of the actual monitoring. Based on the actual technical requirements, during the implementation of image pre-processing, the efficiency of the use of images should be improved. After completing the pre-visualization process, carry out the two-dimensional numerical execution of the marginalization extraction operation, effectively input the whole frame of image data, extract the image edges, and clarify the key nodes of the processing technology, so as to make it meet the stability requirements. In addition, in the course of practice, the previsualization processing should be performed several times.

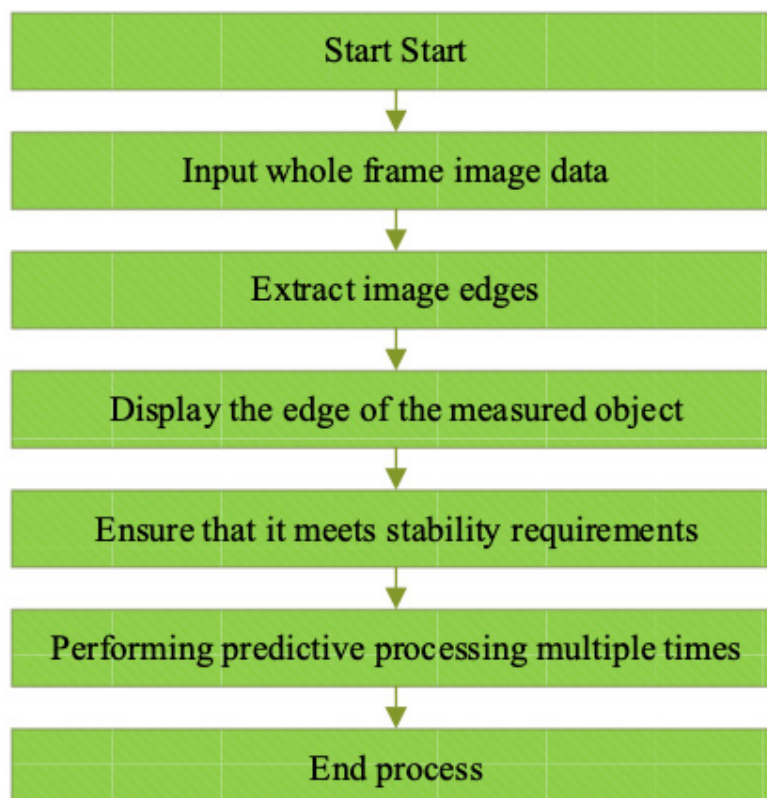


Figure 1. Image preprocessing process

3.2. IMAGE ENHANCEMENT

Image enhancement techniques are spatial domain processing method and frequency domain processing method, the spatial domain processing method mainly focuses on direct operations on image pixels in the spatial domain [18]. In this paper image enhancement technique using spatial domain method is described by the following equation:

$$g(x, y) = f(x, y) \cdot h(x, y) \quad (1)$$

Where $f(x, y)$ is the image before processing, $g(x, y)$ denotes the image after processing and $h(x, y)$ is the spatial operation function. The frequency domain processing method of image enhancement is to process the transformed values of an image in some transform domain, usually the frequency domain, by performing some kind of operation on the transformed values of the image and then transforming back to the spatial domain. It is an indirect processing method with the following process:

1. First input the original image $f(x, y)$ for positive transformation.
2. After the positive transformation, $F(\mu, \nu)$ is obtained, which is corrected to obtain $H(\mu, \nu)$.
3. After transforming $G(\mu, \nu)$, inverse transform is performed and the enhanced image $g(x, y)$ is output.

The above mathematical description is as follows:

$$F(\mu, \nu) = T\{f(x, y)\} \quad (2)$$

$$G(\mu, \nu) = H(\mu, \nu) \cdot F(\mu, \nu) \quad (3)$$

$$g(x, y) = T^{-1}\{G(\mu, \nu)\} \quad (4)$$

Where $T\{\}$ denotes some frequency domain positive transform, $T^{-1}\{\}$ denotes the inverse transform of that frequency domain transform $F(\mu, \nu)$ is the result of the $g(x, y)$ frequency domain positive transform of the original image, $H(\mu, \nu)$ is the number of positives in the frequency domain $G(\mu, \nu)$ is the result of the correction, and $g(x, y)$ is the result of the $G(\mu, \nu)$ inverse transform, which is the enhanced image.

4. HARDWARE COMPOSITION OF COMPUTERIZED MACHINE VISION ONLINE INSPECTION SYSTEM

4.1. COMPOSITION OF COMPUTER VISION ONLINE WORKPIECE INSPECTION SYSTEM

Computer vision online workpiece inspection system belongs to the application of computer vision system in detecting parts, and the system is required to be able to accurately observe the target and make effective decisions on which parts can pass the inspection and which need to be discarded [19-20]. The computer vision online workpiece inspection system is shown in Fig. 2, which should include several parts such as light source, optical system, CCD camera, image acquisition card, image processing module and fast and accurate actuator.

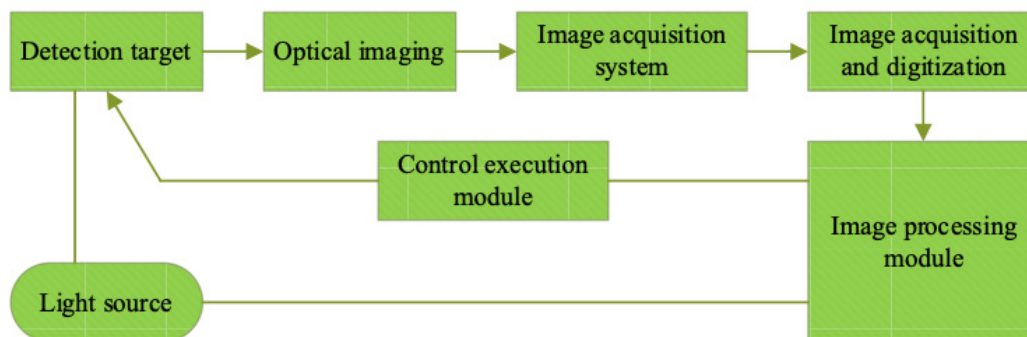


Figure 2. Structure of computer vision on-line workpiece inspection system

4.2. DETECTION LIGHT SOURCE SELECTION CONSIDERING SPATIAL APPLICATIONS

In computer vision application systems, a good light source and illumination scheme is often the key to the success or failure of the whole system, and plays a very important role [21]. The cooperation of light source and illumination scheme should highlight the amount of object features as much as possible, in the part of the object that needs to be detected, and those unimportant parts should be as much as possible to produce a clear difference between the parts to increase the contrast. It should also ensure that the overall brightness is sufficient, and changes in the position of the object should not affect the quality of the image. Transmitted light and reflected light are generally used in vision inspection applications. For the reflected light situation should fully consider the relative position of the light source and optical lens, the texture of the object surface, the geometry of the object and other elements. The choice of light source equipment must be consistent with the desired geometry, illumination brightness, uniformity, the spectral characteristics of the light emitted must also meet the actual requirements, but also consider the luminous efficiency and service life of the light source. In short, different forms of light sources should be

selected and designed according to the actual task in order to achieve the best state of object imaging.

Table 1 shows the classification of commonly used light sources. LED light source has the advantages of free shape, long service life, fast response speed, as well as free choice of color and low comprehensive running cost, which makes it the most suitable dedicated light source for computer vision inspection system applications.

Table 1. Classification of common light sources

	Complex design	Service life	Temperature effect	Degree of stability	Costs	Luminance
Fuorescent tube	Lower	General	General	Differ from	Lower	Lower
Halogen lamp + fiber optic conduit	General	Differ from	Differ from	General	Above average	Above average
LED light source	Above average	Good	Lower	Good	General	General

Space due to some of the measured object surface reflection phenomenon is very serious, you can use diffuse reflection light illumination method for illumination. Both to avoid the appearance of reflections, but also to facilitate the subsequent various image processing algorithms. Lambert's law states that the effect of diffuse reflection is related to the orientation of the surface with respect to the light source, that is:

$$I_d = I_p \cdot K_d \cdot \cos \theta \quad (5)$$

Where I_d is the brightness of a point on a visible surface caused by diffuse reflection. I_p is the brightness caused by incident light from a point source. K_d is the diffuse reflection coefficient, which takes values between 0 and 1 and varies with the material of the object. Is the angle of incidence between the visible surface in the direction normal to N and the point light source in the direction L , which should be between 0° and 90° .

4.3. IMAGE ACQUISITION CARD

At present, there are many types of image acquisition cards, according to different classification methods, there are black and white image and color image acquisition cards, analog and digital signal acquisition cards, composite signals and RGB component signal input acquisition cards. Figure 3 for the image acquisition card structure framework, image acquisition card generally has the following functional modules:

1. Image signal reception and A/D conversion module, responsible for image signal amplification and digitization.

2. Camera control input and output interfaces, mainly responsible for coordinating the camera for synchronization or to achieve asynchronous reset photo, timed photo and so on.
3. Bus interface, responsible for high-speed output of digital data through the computer's internal bus, generally PCI interface, the transmission rate can be as high as 130Mbps, fully capable of high-precision image transmission in real time, and occupies less CPU time.
4. Display module, responsible for high-quality image display in real time.
5. Communication interface, responsible for communication.

When selecting the image acquisition card, the main consideration should be the functional requirements of the system, the image acquisition accuracy and the matching of the output signal with the camera and other factors.

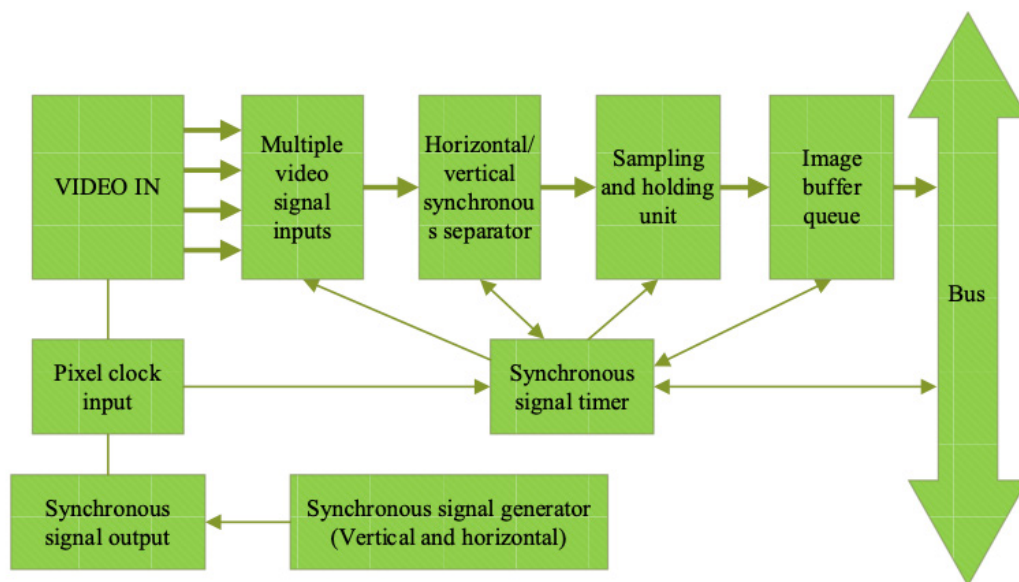


Figure 3. Acquisition card structure framework

5. CALCULATION PROCESS OF MACHINE VISION INSPECTION METHOD

5.1. IMAGE SEGMENTATION

In computers, including the four primary colors cyan, magenta, yellow and black, which are used in the usual space, the accuracy detection algorithm is based on black in order to calculate the distance between each monochrome color to the black baseline [22]. Therefore, it is necessary to convert the acquired RGB mode image to CMYK model, and the conversion is shown in Eq:

$$\begin{bmatrix} C \\ M \\ Y \end{bmatrix} = \begin{bmatrix} 1 \\ 1 \\ 1 \end{bmatrix} - \begin{bmatrix} R \\ G \\ B \end{bmatrix} \quad (6)$$

In the RGB to CMYK conversion formula, the black color separation (K) is calculated from red (R), green (G) and blue (B). Specifically, the value of the black color separation is:

$$K = \min(C, M, Y) \quad (7)$$

5.2. SPATIAL FILTERING CALCULATIONS

Spatial filters can be subdivided into linear and nonlinear filters depending on whether the processing is linear in the image system [23]. A linear spatial filter is at any point (x, y) in the image, and the sum of the product of the coefficients of this type of filter and the corresponding pixel values of the region scanned by the mask is the filter response $g(x, y)$ at that point.

Nonlinear spatial filtering is the same as linear spatial filtering in that it scans the image to be processed with a pre-defined mask, but it cannot be used directly with the filter coefficients, and the product and sum of the corresponding pixel values of the area city scanned by the mask to obtain the response value at this point. Nonlinear spatial filters include median filters, statistical ordering filters, and so on. The median filter can protect the edge pixel points of the image, and has a low degree of smoothing and blurring compared with the linear spatial filter of the same size. The nonlinear spatial filter filtering mechanism is to replace the pixel value at the origin with the maximum value pixel, or the minimum value pixel after sorting the pixel points in the neighborhood.

5.2.1. FREQUENCY DOMAIN METHOD

An ideal low-pass filter will pass all frequencies without attenuation in a circle centered at the origin and radiused at D_0 . The functional expression is given in equation (8):

$$H(u, v) = \begin{cases} 1 & D(u, v) \leq D_0 \\ 0 & D(u, v) > D_0 \end{cases} \quad (8)$$

where D_0 is the cutoff frequency, i.e:

$$D(u, v) = [(u - P/2)^2 + (v - Q/2)^2]^{1/2} \quad (9)$$

Where P, Q is the size of the image to fill the image with complementary zeros.

5.2.2. ANNY OPERATORS

Canny operator algorithm has low error rate, no pseudo response and can detect real edges when dealing with edge detection of images. Firstly, the smoothing filter of the image to be processed is carried out, here the smoothing filter is a Gaussian filter and the gradient is calculated, and the intensity and direction of the edge pixel points are estimated using the obtained gradient size and direction. Then the non-maximum value suppression method is used for edge refinement, and the edge direction of the center point of the neighborhood is quantized into horizontal, vertical, and two diagonal directions, and the image edge direction is determined by the edge normal direction. Finally, to reduce the detection of pseudo edge points, the sub-detection of the true edge of the image, using the lagged intrusion value method, that is, in the range of Min value to take out the high value and low Que value, and set the ratio of 2:1 or 3:1.

The image to be processed is $f_s(x, y)$ and the Gaussian function is $G(x, y)$, then it can be expressed as:

$$G(x, y) = e^{-\frac{x^2 + y^2}{2\delta^2}} \quad (10)$$

Where δ is the standard deviation.

After performing Gaussian filtering the image is $f_s(x, y)$ which can be expressed as:

$$f_s(x, y) = G(x, y) * f(x, y) \quad (11)$$

5.3. DETECTION PROCESS

Based on the above, the software detection process is shown in Fig. 2, where the user can specify the model to be used in image processing by selecting the model, involving different algorithms or techniques. Subsequently, in the image enhancement stage, the visual quality of the image can be improved to make it more suitable for analysis for spatial applications. Next, in the image feature extraction stage, meaningful features are involved to be extracted from the image that are essential for improving the accuracy of computerized machine vision detection for spatial applications. In the import modeling computation step, a machine learning model is introduced for image processing. In addition, the user can ensure effective communication between the image processing device and the computer by connecting the computer. For the wide only image set to be detected, it may refer to a wide set of images prepared to be detected. Subsequently, image acquisition and image acquisition involves acquiring image data by means of a camera, a scanner, and the like. In a filtering and noise reduction step, noise is removed from the image by using filtering techniques to improve the image quality. Next, image segmentation and edge extraction involves segmenting the image into different regions and detecting edges of objects in the image. The image preprocessing stage may then

include further enhancement and preparation of the image to ensure adaptation to subsequent analysis needs. Upon completion of the image processing, the user may be given the option to display the data to view the processed image or data and store it for future reference by saving the data. Finally, an exit option is used to end the image processing program or system. The entire process also includes a computerized accuracy check, which is used to assess the accuracy of the computer algorithms during processing.

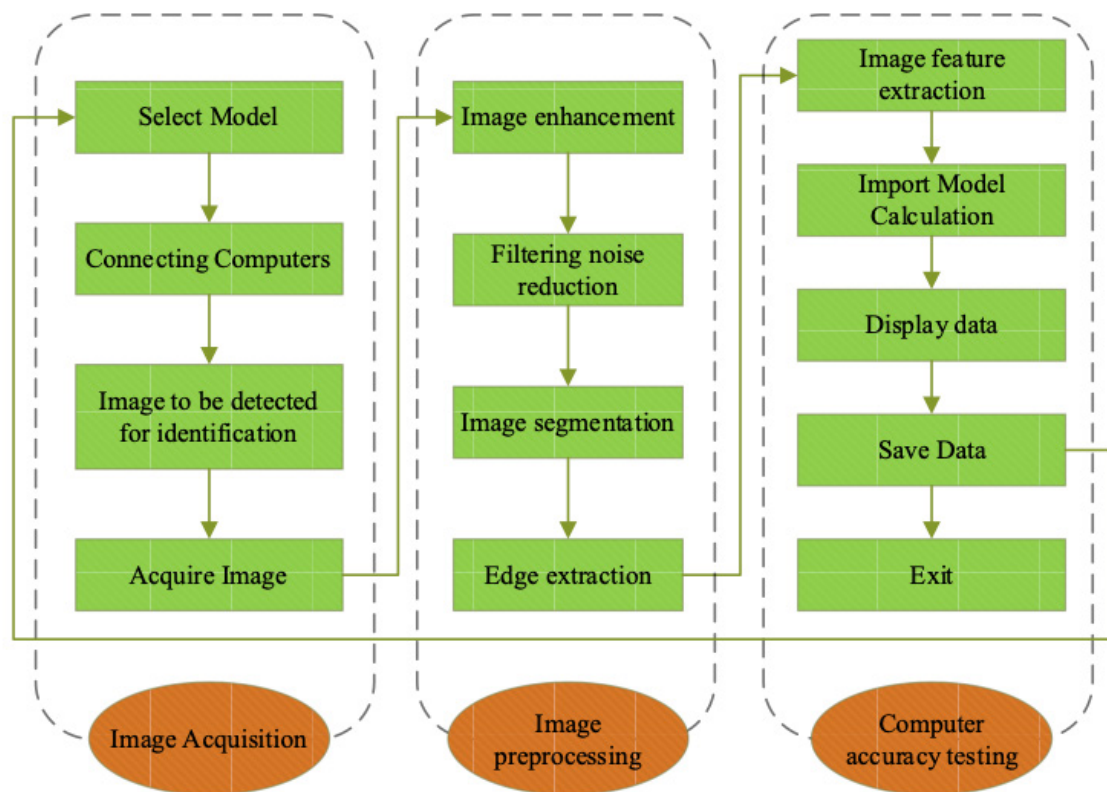


Figure 4. Software testing process

6. DETECTION ACCURACY IMPROVEMENT STRATEGY ANALYSIS

6.1. DETECTION ERRORS

In order to evaluate the performance of the proposed machine vision inspection enhancement strategy on different inspection samples, the variation of the detection error is first analyzed and Table 2 shows the variation of the detection error. The detection error varies between samples, but generally stays at a low level. The error ranges from 1.4% to 3.4%, which indicates that the proposed strategy can achieve accurate detection in most cases. There are some differences between the actual data and the test data, and the errors are mainly due to the deviation between these two. However, this deviation is relatively small in most cases. In summary, the proposed strategy for improving the accuracy of machine vision detection shows high

accuracy under multiple detection samples, and the error is kept within a reasonable range, which helps to improve the performance of computerized machine vision in spatial applications.

Table 2. Detection errors

Test sample	Actual data	Test data	Error
10	102.5	100.2	2.3
20	98.7	97.1	1.6
30	115.2	118.6	3.4
40	92.8	94.3	1.5
50	105.6	103.8	1.8
60	99.3	97.9	1.4
70	110.7	112.2	1.5
80	97.6	99.0	1.4
90	103.8	102.2	1.6
100	112.1	110.5	1.6

6.2. COMPARATIVE VALIDATION

In order to examine the accuracy of computerized machine vision data detection in spatial application scenarios, four different methods are compared, namely the proposed strategy, deep learning, artificial intelligence, and virtual reality. The performance of these methods in dealing with complex spatial data is evaluated and compared by analyzing 20 different detections. Figure 5 shows a comparison of the detection accuracy of the different methods, and the accuracy of the proposed computerized machine data detection for considering spatial applications ranges from 85.13% to 99.42%, which shows an extremely high detection accuracy. In particular, 99.42 is achieved in the number of detections 8, and on 97.54% for the number of detections at 7. The proposed strategy demonstrates significant high accuracy. The accuracy of deep learning ranges from 62.84% to 89.01%. Deep learning performed poorly on most data points compared to the proposed strategy, but reached 89.01% at 15 times. As well as performing better on 16 times at 88.99%. The accuracy of Artificial Intelligence ranges from 60.26% to 89.17%. Similar to Deep Learning, Artificial Intelligence lagged behind the proposed strategy on most data points, but had a high performance on 89.17% at the 3rd time and 87.24% at the 12th time. The accuracy of Virtual Reality ranges from 50.97% to 79.84%, which is the lowest of the four methods. This indicates that virtual reality faces some challenges in terms of detection accuracy in cases where spatial applications are considered.

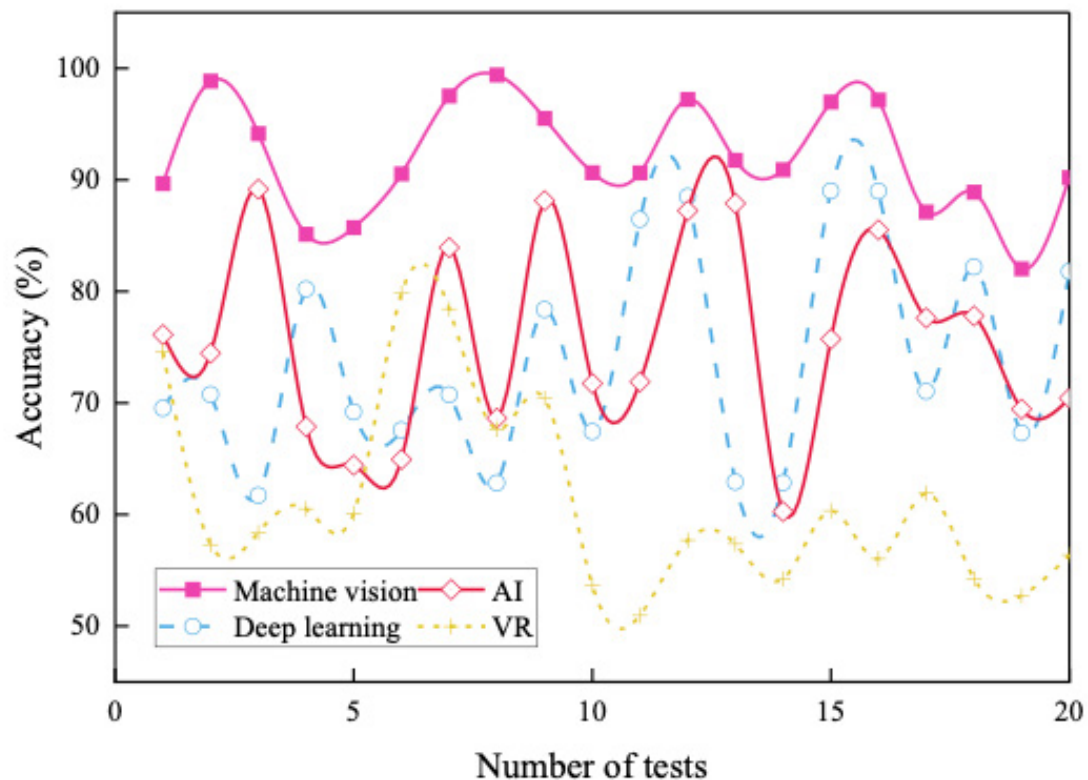


Figure 5. Comparison of detection accuracy

6.3. ALGORITHM PERFORMANCE VALIDATION

In this paper, a series of identical run time points, from 1 to 10 seconds, were chosen to ensure a fair comparison. The computerized machine vision detection algorithm and the traditional AI method were run separately and the CPU utilization at each time point was recorded. Figure 6 shows the results of the algorithm performance test, where the traditional AI method typically has higher resource consumption than the machine vision detection algorithm for the same run time. For example, the traditional AI method consumes 500 MB of memory in 10 seconds, while the machine vision detection only requires 400 MB. Secondly, the traditional AI method also typically exhibits higher CPU utilization. The resource consumption of both methods tends to increase linearly as the runtime increases, but the traditional AI method increases at a faster rate. Within 10 seconds, the CPU utilization of the traditional AI method reaches 50%, while the machine vision detection algorithm uses only 40%. In addition to this, the CPU utilization of both methods also shows a linear growth trend, but the CPU utilization of machine vision detection grows at a slower rate. For computerized machine vision inspection accuracy improvement strategies for spatial applications, there is a need to weigh performance requirements and resource availability. If computing resources are limited, algorithms or hardware need to be optimized to reduce the growth rate of CPU usage to ensure system stability and performance.

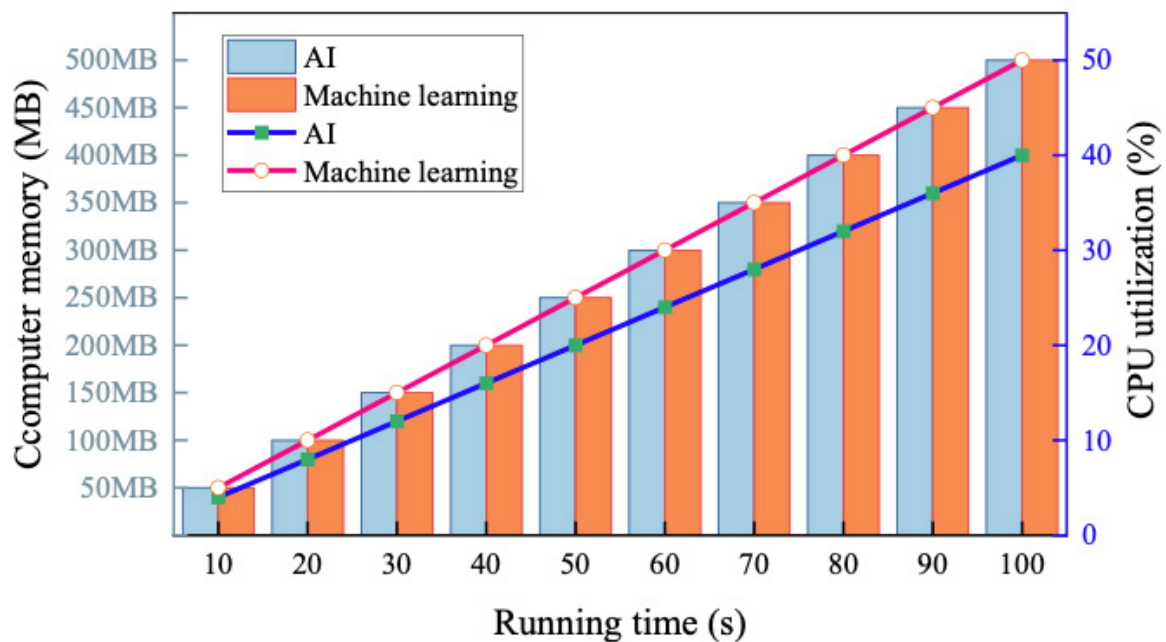


Figure 6. Algorithm performance verification

6.4. COMPARISON OF THE AMOUNT OF DETECTION ERRORS

In spatial applications, the performance of computerized machine vision detection systems is critical and is directly related to the successful execution of the task and the safety of the system. By comparing the detection quantities of machine learning, artificial intelligence and virtual reality on different error types, key performance bottlenecks can be identified and effective strategies can be developed for improving the detection accuracy of the system. Table 3 shows the comparison of the amount of errors detected by different methods, with machine learning detecting 25, AI 16, and virtual reality 22. Robotic arm damage, as a high-frequency error type, requires focusing on optimizing the algorithm, especially in machine learning for performance improvement. For this problem, the introduction of more sophisticated feature extraction and fusion methods can be considered to enhance the accurate detection of the state of the robotic arm. Inclement weather or poor lighting conditions are a prominent challenge, corresponding to a number of detections of 23, 15, and 20, respectively. In this regard, adaptation to inclement weather and lighting conditions should be optimized to ensure the reliability of the system in complex environments. By taking these error types into account, a comprehensive enhancement strategy including improving algorithm robustness, enhancing adaptation to specific environments, and optimizing the quality of simulation of computer environments is developed to improve the accuracy of computerized machine vision detection for spatial applications.

Table 3. Comparison of error amount detected by different methods

Error type	Detection quantity comparison		
	Machine learning	Artificial intelligence	Virtual reality
	19	8	12
Packet loss or error in data transmission	22	12	18
Low battery	8	4	6
Mechanical arm failure	25	16	22
Image distortion or artifact	8	7	6
Positioning deviation	19	10	14
Algorithm execution error	11	6	9
Bad weather or poor light conditions	23	15	20
Dangerous object intrusion	6	2	4

7. CONCLUSION

The computerized machine vision inspection accuracy enhancement strategy considering spatial applications proposed in this paper provides a reliable inspection solution for spatial applications, and the conclusions are as follows:

1. The machine vision detection accuracy proposed in this paper for spatial applications ranges from 85.13% to 99.42% while maintaining a low error range of 1.4% to 3.4%. The proposed strategy performs better compared to deep learning and traditional AI.
2. In terms of resource consumption, the traditional AI method consumes 500MB of memory in 0 seconds, while machine vision detection only requires 400MB, making the machine vision detection algorithm more efficient.
3. By comparing the amount of detection errors, the number of machine learning detection is 25, artificial intelligence is 16, and virtual reality is 22. It reflects the reliability and efficiency of the proposed method, which provides a strong support for the development of machine vision detection systems in spatial applications.

In conclusion, it is proved that the proposed method is not only better than the traditional method in terms of accuracy, but also more efficient in terms of resource

consumption, which provides a strong support for the development of machine vision detection systems in future space applications.

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DIGITAL SIGNAL PROCESSING ORIENTED ELECTRONIC COMMUNICATION ENGINEERING APPLICATIONS AND PRACTICES

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ABSTRACT

This paper first describes the applications of digital signal processors in software radio, speech compression coding, modems and GPS systems, demonstrating the versatility of digital signal processors in practical communication systems. Next, digital signal processing oriented electronic communication practices are presented in the system design section to design high performance communication systems for specific communication needs and environmental conditions. The digital signal processing platform used in the platform architecture is optimized for signal processing and data transmission. The BER is 0.008% when the signal-to-noise ratio is -10 dB. The time complexity of digital signal processing is 7.2 ms when the number of communication nodes is 1000. It shows that digital signal processing oriented electronic communication engineering is important for improving the performance, reliability and efficiency of communication systems.

KEYWORDS

Digital signal processing; speech compression; GPS system; electronic communication; signal-to-noise ratio

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1. INTRODUCTION

The research on the application and practice of electronic communication engineering oriented to digital signal processing is at the forefront of the current scientific and technological development, integrating the latest achievements of electronic engineering, communication technology and computer science [1]. With the rapid development of digital technology, digital signal processing has become the core technology in the field of electronic communication, which plays a key role in many aspects such as speech, image processing, wireless communication and data compression [2]. The rapid progress in this field, especially the breakthroughs in mobile communication, satellite communication and network technology, has brought revolutionary changes to electronic communication engineering [3]. The high efficiency, flexibility and powerful functions of digital signal processing technology provide the possibility of processing a large number of complex communication signals, and at the same time bring new challenges, such as the need for high-speed signal processing, signal quality assurance and the implementation of complex algorithms [4]. Therefore, studying the application and practice of digital signal processing in electronic communication engineering is not only crucial for the development of the theory, but also has a far-reaching impact on practical engineering applications [5]. With the rise of the Internet of Things, smart devices and 5G communication technology, the research and exploration of this field will be more urgent, foreshadowing the future development direction and application prospects of communication technology [6].

The density matrix of subsystems in reacting complexes is discussed by Nalewajski, R. F and is used to describe the entanglement phenomena occurring in donor-acceptor systems including molecular fragmentation and electronic communication [7]. Han, D et al. activated the molybdenum disulphide MoS₂ by doping it with palladium and achieved a phase transition to the stable 1T phase. The study was also verified using Raman spectroscopy. The prepared Bi/Pd-MoS₂ catalysts exhibited excellent electrochemical hydrogen precipitation performance in acidic medium [8]. Toyoshima, M discussed the concept of utilizing smaller and less power consuming on-board devices for broadband and high capacity communications. This technique can provide more efficient communication in space communication and has a wide range of applications [9]. Zhang, L et al. proposed that conventional wireless communication usually requires digital-to-analog conversion and frequency mixing to transmit digital information to different users at different locations. However, spatio-temporal coded digital metasurfaces can encode spatio-temporal coding matrices over multiple channels and directly transmit digital information to multiple users at the same time without the need for complex processing [10]. Tan, M. et al. introduced an optical signal processing technique that achieves extremely high performance, including high bandwidth and low energy consumption. This optical signal processor can process 17 Terabits/s of data, is capable of processing 400,000 video signals simultaneously, and performs 34 different image processing functions such as object edge detection, edge enhancement, and motion blur processing [11]. He, X et al. stated that although power

electronics and communication electronics are often regarded as two different branches of the electrical engineering field. However, both are based on electromagnetic theory. In addition, electricity is considered as the most common material-based information carrier. Therefore, power electronics and communication electronics can be considered together to find new applications and approaches [12]. Huang, C et al. proposed a new approach to construct highly parallel, ultrafast neural networks using photonic devices to process optical signals in the analog domain, thus reducing the need for digital signal processing circuits. A silicon photonic electronic neural network was reported for solving the fiber nonlinearity compensation problem in submarine fiber optic transmission systems [13]. Niu, Z et al. described the architecture of this communication system using the microwave band to provide multiple signal carriers that are converted to 220GHz channels, thus reducing the need for high sampling rate analog-to-digital converters. The system consists of a set of 220 GHz solid-state transceivers including two signal carriers and two basebands to support 4 GSPS analog-to-digital converters. A 16QAM modulation is used [14].

Digital signal processors are used to process and optimize signals to improve the performance of communication systems. This paper firstly describes the application of digital signal processor in communication engineering to realize flexible radio communication systems through digital signal processing so that they can adapt to different communication standards and spectrum requirements. The application of digital signal processing in voice coding can help to achieve efficient data compression and transmission in order to deliver high quality voice communication with limited bandwidth. Modems are key components in communication systems and digital signal processing helps to improve the performance of modems to ensure reliable data transmission. In digital signal processing oriented electronic communication practices, system design and platform architecture are carried out to ensure effective application of digital signal processing in practical communication engineering.

2. APPLICATION OF DIGITAL SIGNAL PROCESSOR IN COMMUNICATION ENGINEERING

2.1. APPLICATIONS IN SOFTWARE RADIO

The application of software radio in communication, especially in the 3rd generation mobile communication has become more and more the focus of research. Digital signal processor hardware technology and its algorithms are precisely the key to the realization of software radio, software radio system flexibility openness and tolerance and other characteristics, mainly through the signal processor as the center of the general hardware platform and software to achieve [15-16]. Figure 1 shows the software radio system framework, mainly to complete the radio station internal data processing modulation and demodulation and coding and decoding work. Due to the radio internal data flow, filtering frequency conversion and other processing operations

more often, must use high-speed real-time parallel digital signal processor module, or special integrated circuits in order to meet the requirements. To complete such a difficult task, must require hardware processing speed increases, chip capacity expansion, while requiring algorithms for the processor optimization and improvement.

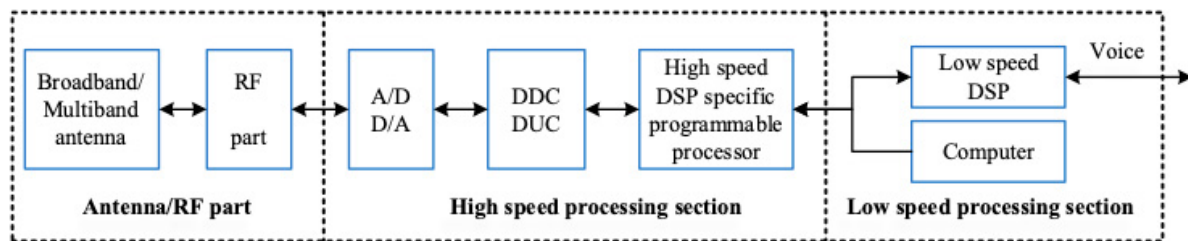


Figure 1. Software radio system

2.2. APPLICATIONS IN SPEECH COMPRESSION CODING

2.2.1. PRINCIPLES OF COMPOSITION

The purpose of speech data compression is to be able to obtain high quality speech effects at the lowest possible transmission rate. That is, it is desired that the speech signal can be transmitted in a channel with a more observable bandwidth with little or as little degradation in the quality of the speech as possible [17]. Speech coding systems early used waveform coding methods, also called waveform coding which essentially follows the Nyquist sampling theorem, adaptive ability to synthesize better speech quality [18]. But the coding rate is high, the coding efficiency is very low and parametric coding is different from waveform coding efficient coding method, is the mechanism of speech generation is mainly on the extracted speech signal characteristics of the parameters of the coding, can achieve a very low coding rate. But can only achieve the effect of synthesized speech, voice quality is not as good as waveform coding for voice processing, the higher the compression rate, the more complex the coding algorithm, real-time compression is not possible to use logic circuits to achieve, but also will not be used to achieve a large volume of slow and high-cost microcomputer. The digital signal processor is a suitable choice, Figure 2 for the composition of the principle of speech coding, the use of DSP to develop embedded voice coding and decoding system, it is one of the popularity of the current research. In the network conference voice communication monitoring systems and other areas are important components, the use of digital signal processors not only for the application of voice compression algorithms provide a broad prospect, and make the system design becomes simple reliability is also greatly improved.

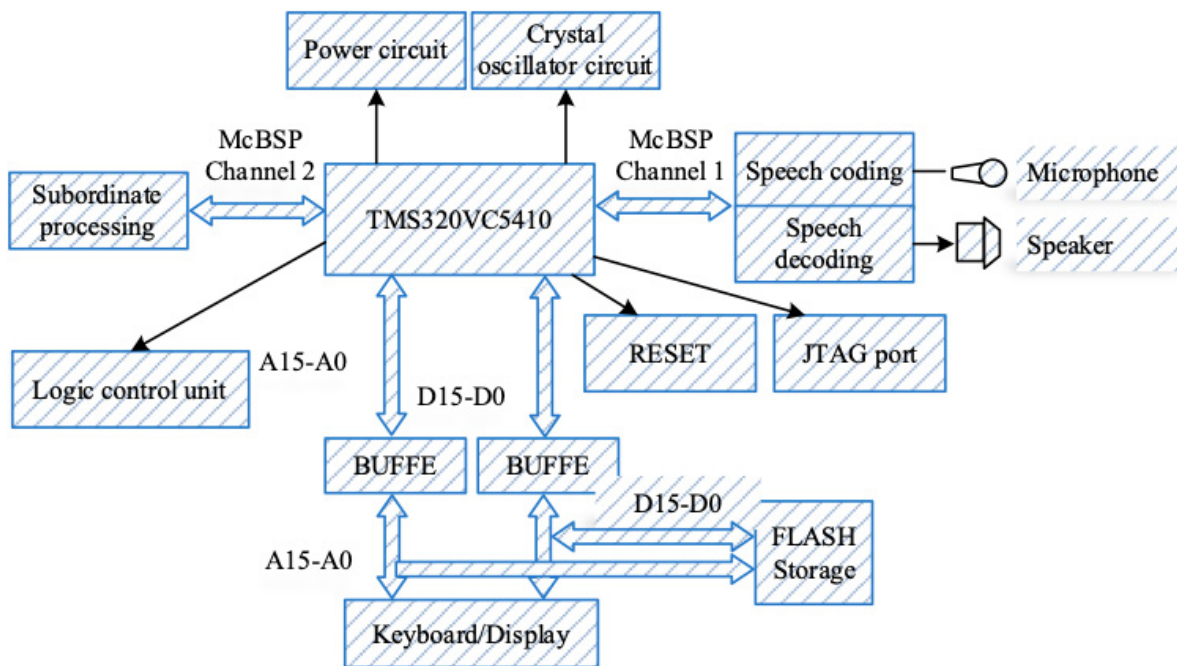


Figure 2. Components of speech coding

2.2.2. SIGNAL OPERATING MODES

There are four modes of operation during communication, including:

1. The default mode after power-up or reset is the single-frequency signal mode, with a default value of zero in the frequency control word register [19]. The default value after power-up or reset defines a safe no-output state that produces a 0 Hz, 0 phase output signal. The default zero amplitude setup mode outputs from both the I and O digital-to-analog converters are DC, with an amplitude corresponding to a medium output current. The user must program some or all of the 28 registers to obtain the desired output signal. The value of the frequency control word is determined by the following equation:

$$FTW = (DOF * 2N) / * SYSCLK \quad (1)$$

Where N is the phase accumulator, in this case 48 bits, the frequency is expressed in Hz, and the frequency control word, FTW, is a decimal number. Once a decimal number has been calculated, it must be rounded to the nearest whole number and then converted to binary format. The basic sine wave DAC output frequency ranges from DC to 1/2 system clock. The phase is continuous as the frequency changes, meaning that the new frequency uses the last, phase of the old frequency as the starting phase.

2. When the frequency shift keying mode is selected, the output frequency of the DDS is the value of frequency control word register 1 or frequency control word register 2. The selection of the frequency register is controlled by the logic level terminal PIN29. When logic is low on PIN29, select F1, frequency control word

- 1, and when logic is high, select F2 frequency control word 2. Frequency changes are phase-continuous and almost instantaneous.
3. CHIRP mode is also known as pulse FM. Pulse FM can be used with any sweep, but most Chirp systems use a linear FM sweep. This is a spread spectrum modulation that allows for processing gain. The user-definable frequency range FTW1~FTW2, duration, frequency resolution, and sweep direction can be internally generated linear, monitored and managed by the electric frequency manager, or externally programmed to generate a nonlinear sweep. 3GN00LD can be pulsed or continuous wave. Non-linear sweeping is achieved by varying the time step slope counter, and the frequency step delta frequency word to produce different slopes. delta frequency control word is a binary complement, positive or negative, which defines the direction of the CHIRP mode sweep. If the DELTA frequency control word is negative, the highest bit goes high. If the DELTA frequency control word is negative, the highest bit is a high level, the frequency is scanned from FTW1 to the negative direction, and the frequency is decreasing.

2.3. APPLICATIONS IN MODEMS

In a modem, a digital signal processor is used to perform tasks such as modulation and demodulation, adaptive equalization, and echo cancellation. Figure 3 shows the operating principle of the demodulator, TMS320C25 has a large storage space and rich internal resources, so it can support a variety of standard algorithms in the classic modem, synchronization and timing is the use of the phase discriminator road filter voltage-controlled oscillator and other components of the phase-locked loop. The DS has a very high precision internal programmable timer sound quite interface circuit TLC32044c, and the rate can be fine-tuned with the program 14-bit A/D and D/A converter. Therefore, the above mentioned by the DSP and other devices constitute the modulation and demodulation scheme, all operations, including timing and synchronization can be achieved with software.

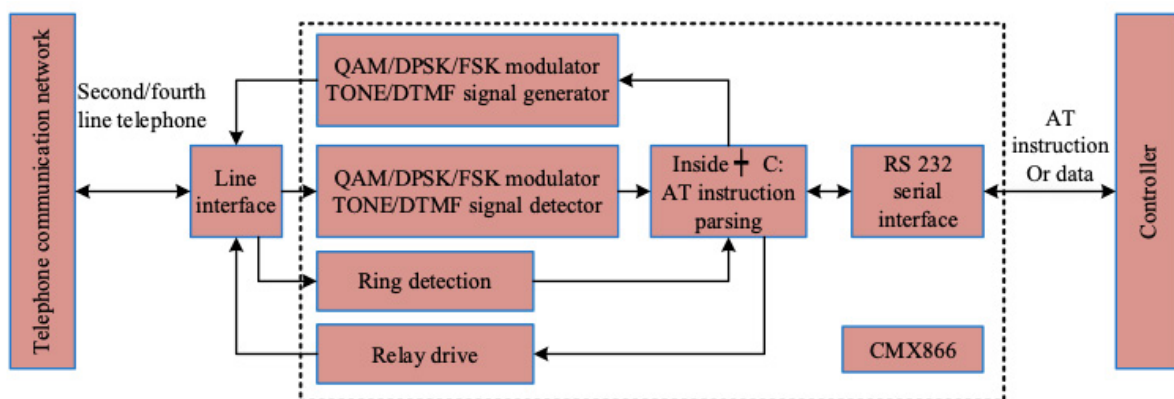


Figure 3. Working principle of demodulator

2.4. APPLICATION IN GPS SYSTEMS

GPS is a non-self-contained navigation and positioning system developed by the U.S. based on the reception of navigation satellite signals, and this system provides accurate and continuous two-dimensional position and velocity information to global users with appropriate receiving equipment [20]. Widely used in various military and economic fields, along with the promotion and popularization of GPS technology in various fields of application, the miniaturization of the receiver intelligent and meet the user needs of the algorithm research are very necessary [21]. Global positioning system is mainly composed of two parts, the satellite constellation monitoring network and user receiving equipment by the receiving equipment is different. Mainly includes the GPS receiver and its antenna processing transmission 3 output, and a power supply in GPS applications often need to reprocess the data collected by the GPS receiver, or the use of GPS receivers to provide certain information for the development of a certain industry within the DSP, small size, high speed, low power consumption and high reliability characteristics. Suitable for real-time processing of highly complex GPS signals, with its composition with the OEM board GPS information system, not only well meet the GPS signal processing in real time and high complexity, and in the DSP's powerful data processing capabilities of the system can also be further functionality to expand the clock stops, thereby terminating the clock pulse sent to the frequency accumulator. The result is to stop sweeping, so that the output frequency is maintained at the frequency of the hold terminal is valid. After the holdover is released, the clock is restored and the sweep continues. In the hold state, the user can change the value of the register, however, the slope counter must be the original slope to resume work until the count is zero, to load the new slope count initial value.

Phase shift keying means fast switching between two pre-set 14-bit phase shifts, and this switching affects both of the AD9852's 2 converters. The logic state at the BPSK end selects the phase shift, and when it is low, phase 1 is selected, and when it is high, phase 2 is selected. If more phase shifts are required, monotonic mode should be selected, and the phase register should be programmed with either a serial or high-speed parallel bus.

3. DIGITAL SIGNAL PROCESSING ORIENTED ELECTRONIC COMMUNICATION PRACTICES

3.1. SYSTEM DESIGN

The hardware circuit is mainly composed of two parts: the transmitter side and the receiver side. The transmitter side is mainly composed of power supply module, temperature acquisition circuit, microcontroller, wireless transmission module, reset circuit, clock circuit, etc. The transmitter side is mainly to realize that the real-time temperature value is converted into a digital signal to be sent to the microcontroller,

and then the serial port of the microcontroller is transported to the wireless signal transceiver module to be sent to the receiver side of the system. The receiving end is shown in Figure 4. To have a power supply module, microcontroller, reset circuit, keyboard circuit, clock circuit, buzzer alarm, wireless receiver module and LCD module and other components. Converted to digital signals, transmitted to the microcontroller, after processing by the microcontroller, the data will be sent to the LCD display module to display the measured value of the sampling end and the buzzer alarm module for over-limit alarm.

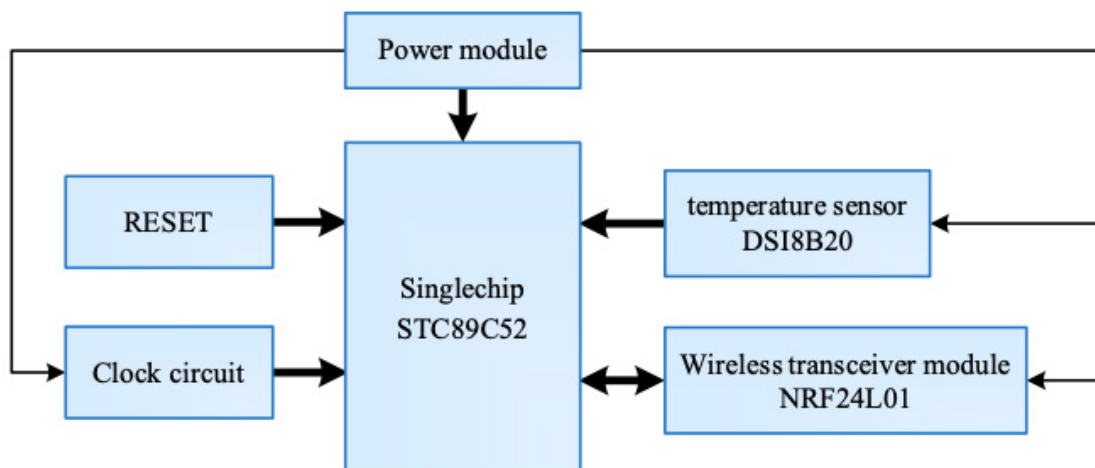


Figure 4. Receiver side

3.2. PLATFORM STRUCTURE

In order to establish the digital signal processing system of electronic information engineering integrated practice platform, Figure 5 shows the DSP processor as the core signal processing unit, integrated man-machine dialogue operation and computer control of the signal processing platform [22-23]. The whole system is mainly composed of two parts: computer and DSP processor. Among them, the DSP processor mainly consists of three parts: memory, interface and real-time channel, which accepts the operation control of the computer and real-time completion of different tasks such as storage, processing and transmission of signal data. Computer to electronic information engineering comprehensive practice, the application of signal processing system, DSP processor to send back the data for further processing. For example, digital analysis, waveform display and so on, at the same time, also control the specific operation of the DSP processor. In this way, through the flexible software loading of digital signals, you can realize the content of different integrated practice of electronic information engineering. The basic principles of modulation and demodulation of the amplitude of the system.

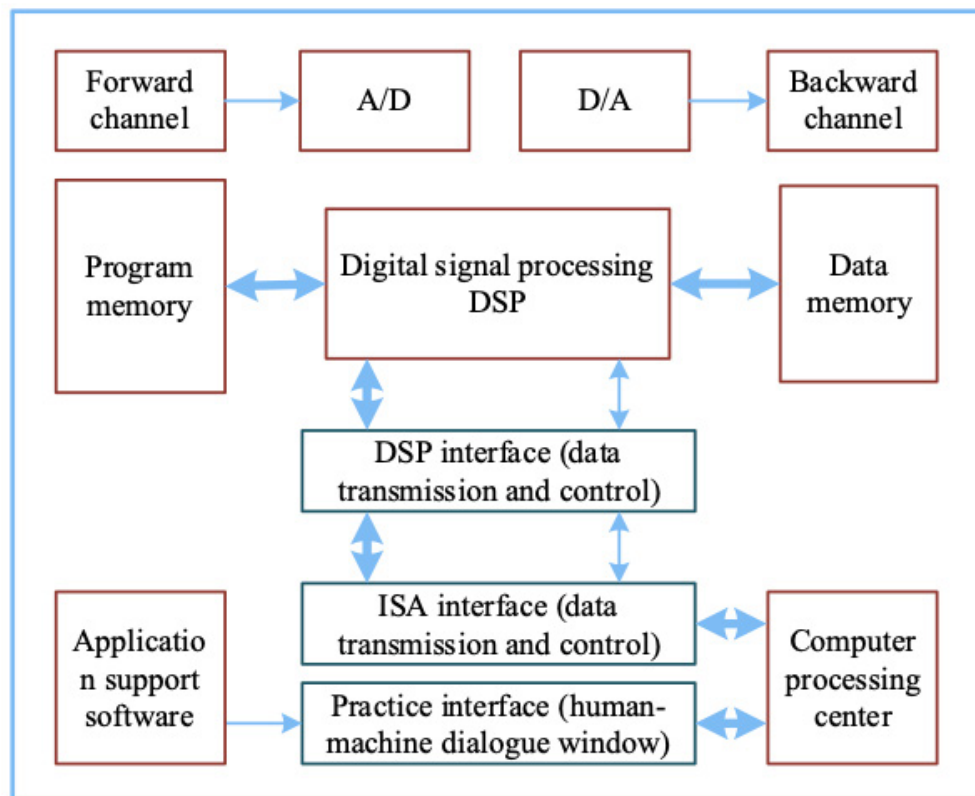


Figure 5. DSP signal processing unit

On the basis of the above system design, the basic principle of modulation and demodulation of the system amplitude is shown in Fig. 6. Amplitude keying uses the amplitude change of the carrier wave to transmit digital information while its frequency and initial phase remain constant. In 2ASK, the amplitude of the carrier wave has only two states of change, corresponding to the binary information 0 or 1.

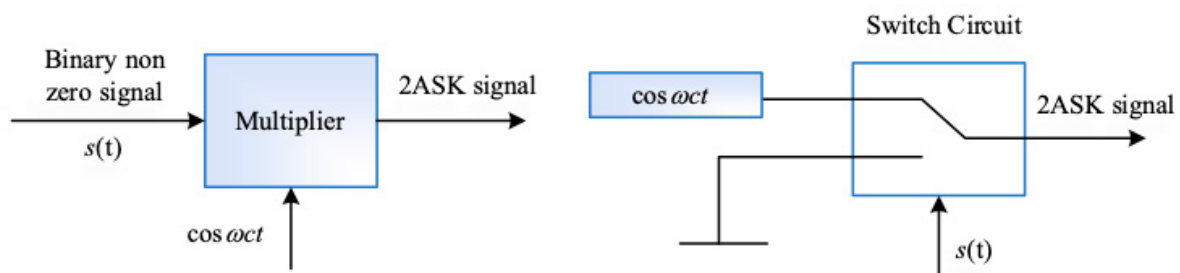


Figure 6. Modulation and demodulation of amplitude control

A common and simplest form of binary amplitude keying is called on-off keying. Its expression is:

$$e_{ook}(t) = \begin{cases} cA \cos w_c t \\ 0 \end{cases} \quad (2)$$

$$e_{2ASK}(t) = s(t)\cos \omega_c t$$

The general expression for a 2ASK signal is $s(t) = \sum_n a_n g(t - nT_S)$.

In this case, there are usually two types of binary amplitude keying signals generated, the analog modulation method and the keying method, and the corresponding modulators are shown in Fig. 7. Fig. 7(a) shows the general analog amplitude modulation method, which is implemented with a multiplier. Fig. 7(b) is a digital keying method in which the switching circuit is controlled by $s(t)$. The digital keying method is used in this paper.

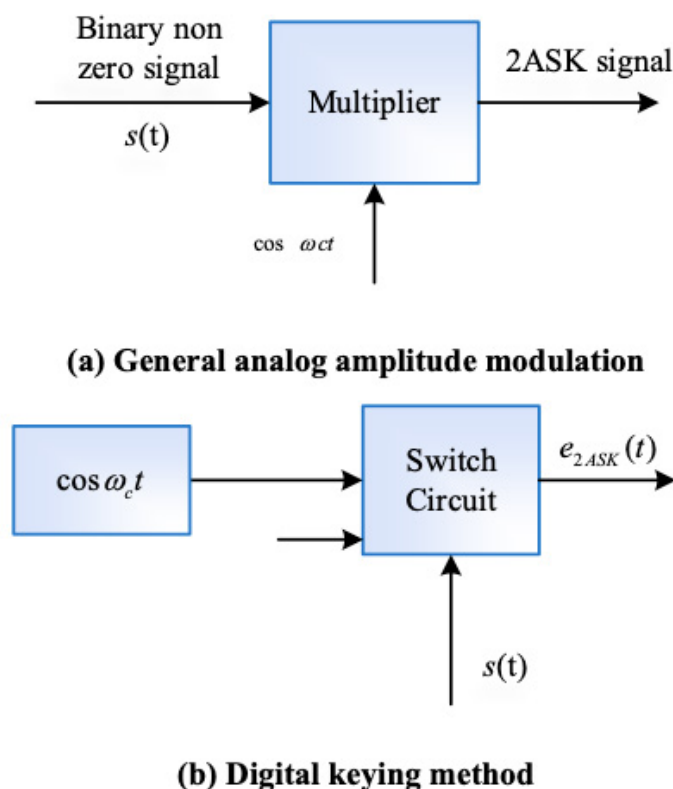


Figure 7. Signal modulator principle

As with the demodulation method for AM signals, there are two basic demodulation methods for ASK/OOK signals, the incoherent demodulation envelope detection method and the coherent demodulation synchronization detection method, and the corresponding block diagram of the receiving system composition is shown in Fig. 8. Compared with the receiving system for analog signals, a sampling judge box is added here, which is necessary to improve the receiving performance of digital signals, and coherent demodulation is used in this paper.

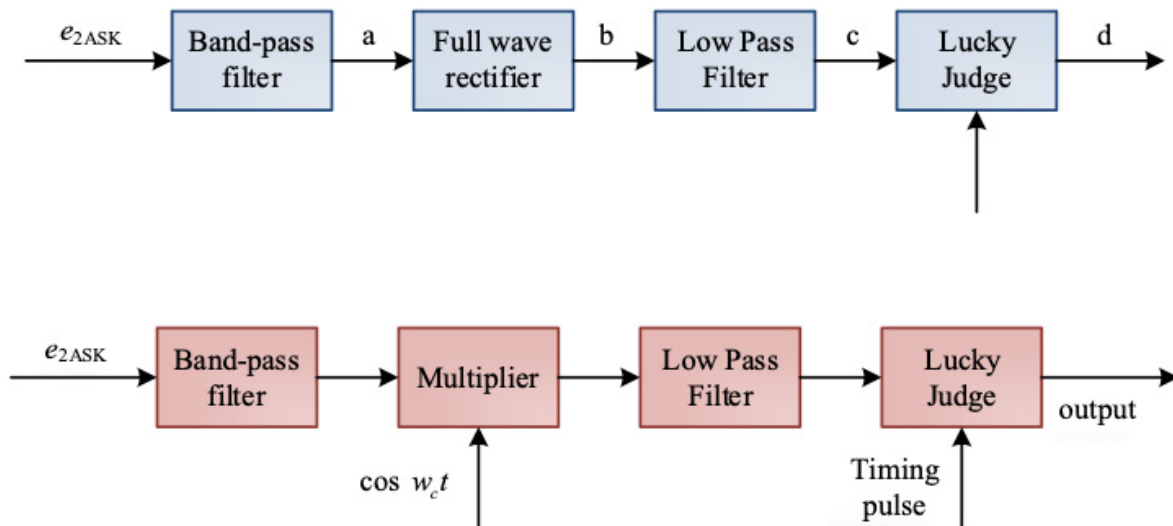


Figure 8. Signal Receiving System Component Box

4. ELECTRONIC COMMUNICATION VERIFICATION FOR DIGITAL SIGNAL PROCESSING

4.1. PERFORMANCE METRICS VALIDATION

In this paper, in the Malthb environment, the communication node information transmission collision avoidance simulation analysis, without considering the control, check redundancy and other data, according to epcglobal company, the proposed coding standard, by the number of communication node labels from 0 to increase to 2200, randomly formed 95-bit information code. Figure 9 shows the results of time complexity analysis, when the number of communication node labels is 0, the time complexity of digital signal processing is 2.5 ms, fiber optic communication is 4.6 ms, and digital technology is 4.9 ms. digital signal processing performs best. As the number of communication node tags increases, the time complexity of all three methods gradually increases. The time complexity of digital signal processing grows relatively slowly, and fiber optic communication and digitization techniques grow faster. The time complexity for the number of communication nodes is 1000 is 7.2 ms for digital signal processing, 14.2 ms for fiber optic communication and 14.89 ms for digitization techniques. Digital signal processing performs the best at this point.

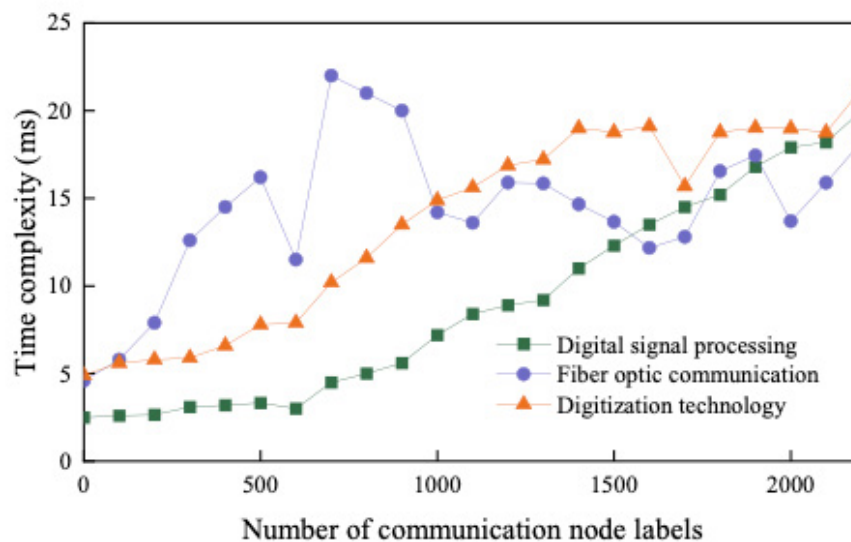


Figure 9. Results of time complexity analysis

The selection of the best communication method for different SNR conditions depends on the specific application requirements and resource budget. Table 1 shows the results of signal-to-noise ratio comparison of different methods, and in all three methods, the performance improves as the signal-to-noise ratio increases. At low signal-to-noise ratios of -10 dB to 0 dB, digital signal processing performs the best and its performance is higher than the other two methods, and digital signal processing can process signals more efficiently under low signal-to-noise ratio conditions. At high signal-to-noise ratios of 35 dB to 40 dB, the performance gap between the three methods becomes smaller, but digital signal processing is still slightly ahead. At low signal-to-noise ratios, the performance gap between digital signal processing and the other two methods is larger, especially at -10 dB signal-to-noise ratio. It indicates that digital signal processing is the best choice for working at low signal-to-noise ratios because it performs best under these conditions.

Table 1. Comparison results of signal-to-noise ratio of different methods

Signal-to-Noise Ratio	Digital signal processing	Fiber optic communications	Digitization technology
-10	2.1	3.9	4.2
-5	2.3	4.1	4.5
0	2.6	4.4	4.8
5	2.9	4.7	5.2
10	3.2	5.0	5.5
15	3.6	5.3	5.9
20	3.9	5.6	6.2
25	4.2	5.9	6.6
30	4.5	6.2	6.9
35	4.8	6.5	7.3
40	5.1	6.8	7.6

4.2. ALGORITHM EFFICIENCY ANALYSIS

Table 2 shows the efficiency comparison of the three algorithms, where the resource consumption of the digital signal processing method gradually increases from 15% to 38% in the same time. It shows that digital signal processing requires less computational and storage resources to handle the communication task and the resource consumption gradually increases with time. The resource consumption of fiber optic communication methods gradually increases over the same period of time, from 30% to 55%. Although the resource consumption of fiber optic communication is higher than that of digital signal processing, it starts taking more resources at an earlier time. The resource consumption of digitization techniques approach increases from 25% to 46% in the same time period. Although the resource consumption of digitization techniques is between digital signal processing and fibre optic communications, it started to take up more resources at an earlier time.

Table 2. Efficiency of three algorithms

Signal-to-Noise Ratio	Digital signal processing	Fiber optic communications	Digitization technology
-10	2.1	3.9	4.2
-5	2.3	4.1	4.5
0	2.6	4.4	4.8
5	2.9	4.7	5.2
10	3.2	5.0	5.5
15	3.6	5.3	5.9
20	3.9	5.6	6.2
25	4.2	5.9	6.6
30	4.5	6.2	6.9
35	4.8	6.5	7.3
40	5.1	6.8	7.6

4.3. SYSTEM STABILITY AND RELIABILITY TESTING

In terms of system availability, all three methods have very high availability, above 98%. In terms of BER testing, the average BER of all three methods is very low, ranging from 1×10^{-6} to 9×10^{-7} respectively. The pass rates were also high, all above 98%, indicating that these methods performed well in data transmission. The immunity test shows that the digital signal processing techniques have good immunity to interference. The immunity test shows that the digital signal processing has good immunity to interference with a high level of immunity to interference and resistance to multipath interference.

Table 3 System stability and reliability results

Test Items	Indicator	Digital Signal Processing	Fiber Optic Communication	Digitization Technology
System Availability (%)	Mean Time Between Failures (MTBF)	1500h	2000h	1800h
	Mean Time to Repair (MTTR)	30h	40h	35h
	System Availability (MTBF / (MTBF + MTTR))	97.4%	98.0%	98.0%
Bit Error Rate Test	Average Bit Error Rate (BER)	1×10^{-6}	8×10^{-7}	9×10^{-7}
	Maximum Bit Error Rate (BER)	1×10^{-5}	7×10^{-6}	8×10^{-6}
	Bit Error Rate Test Pass Rate (%)	98.7%	99.2%	99.1%
Anti-jamming Test	Immunity Level (dB)	75 dB	78 dB	76 dB
	Anti-Multipath Interference Performance (dB)	80 dB	82 dB	81 dB
	Phase noise immunity (dBc/Hz)	-110 dBc/Hz	-112 dBc/Hz	-111 dBc/Hz
Data Loss Rate Test	Frequency Shift Resistance (Hz)	1 kHz	800 Hz	900 Hz
	Average Data Loss Rate (%)	0.8%	0.6%	0.7%
	Maximum Data Loss Rate (%)	2.1%	1.8%	2.0%
	Data Loss Pass Rate (%)	96.2%	97.3%	96.9%

4.4. ENVIRONMENTAL AND DISTURBANCE TESTING

In the application and practice of electronic communication engineering, the testing of environmental and interference factors is crucial and significantly affects the performance and reliability of communication systems. Table 4 shows the results of the interference immunity test, on a high-speed moving vehicle, the signal interference strength is -18 dB, the signal-to-noise ratio is 20 dB, and the BER is 0.015%. This indicates that on mobile vehicles, the communication system can maintain better performance at higher speeds with high signal quality and low BER. In mountainous and forested areas, the signal interference strength is -28 dB, the signal-to-noise ratio is 11 dB, and the BER is 0.05%. This indicates that in complex terrain such as mountainous areas and forests, the communication system may face higher interference with slightly poorer signal quality and slightly higher BER. Over the airplane, the signal interference strength is -12 dB, the signal-to-noise ratio is 22 dB, and the BER is 0.008%. This indicates that at high altitude and in flight, the communication system performs well with high signal quality and very low BER. It is possible to determine the performance of the communication system under different environmental conditions and to be able to take appropriate measures to cope with signal interference and improve the stability and reliability of the system.

Table 4. Anti-interference test results

Test Scene	Signal Interference Strength (dB)	Signal-to-noise ratio (dB)	BER (%)
Indoor environment	-20	15	0.02
Outdoor urban environment	-15	18	0.01
Around tall buildings	-25	12	0.03
On high speed moving vehicles	-18	20	15
Open rural areas	-30	10	0.04
Inside industrial plants	-22	14	25
Mountain woodlands	-28	11	0.05
Coastal areas	-16	19	12
Over airplanes	-12	22	8
Inside subway tunnels	-32	8	0.06

5. CONCLUSION

This paper explores several aspects of digital signal processing oriented electronic communication engineering applications and practices, performance evaluation in different communication scenarios, signal-to-noise ratio comparisons, resource consumption analysis, and system stability and reliability testing. Digital signal processing performs best in most scenarios, with a slower growth in time complexity, and especially excels when the number of communication nodes is 1000. The time complexity of digital signal processing is only 2.5 ms at 0 number of communication node labels, compared to 4.6 ms for fiber optic communication and 4.9 ms for digital technology. Digital signal processing not only excels in performance, but also has a significant advantage in speed and efficiency when dealing with communication tasks. When the signal-to-noise ratio is as low as -10 dB, digital signal processing shows a significant performance advantage over fiber optic communication and digitization techniques. This suggests that digital signal processing is the optimal communications processing method when operating at low signal-to-noise ratios because of the ability to demonstrate superior performance under these harsh conditions.

6. DISCUSSION

With advances in digital signal processing technology, communications systems will be able to provide higher data transmission speeds and greater capacity, enabling rapid transmission and real-time processing of data-intensive applications such as high-definition video, virtual reality, and augmented reality. Digital signal processing will also play a key role in improving the reliability of communication systems by providing more stable communication connections through digital signal processing technologies that can better cope with signal interference, noise and other communication barriers. Future digital signal processors will be more energy efficient while providing higher performance. This is critical for applications such as mobile devices, IoT devices and drones that need to operate for long periods of time. As communication networks expand, security and privacy protection will become critical issues. Digital signal processing can be used to encrypt, decrypt and identify security breaches to ensure secure communications.

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USING PEST ANALYSIS TO EXPLORE THE IMPACT AND MECHANISM OF CHINESE AND AMERICAN BREEDING PATENTS ON THE DEVELOPMENT OF AGRICULTURAL SCIENCE AND TECHNOLOGY

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ABSTRACT

In recent years, PEST analysis and its application in decision-making has become a hot topic, and this paper proposes a new model of PEST analysis based on neutral cognitive map static analysis. The proposed framework consists of five activities, identifying PEST factors and sub-factors, modeling the interrelationships among PEST factors, calculating centrality measures, categorizing the factors, and ranking the factors. The results show that the impact factor of the US breeding patent on the development of agricultural science and technology has reached the level of interrelationship, and the uncertainty is included in the analysis. Using this model to analyze the impact of U.S.-China breeding patents on the development of agricultural science and technology, we ranked the factors according to their interrelationships and incorporated uncertainty into the analysis. The results showed that the impact factor of U.S. breeding patents on the development of agricultural science and technology reached 0.70, and the index of the Gross Agricultural Product (GAP) caused by patents was greater than 100. The quantitative analysis of the impact of Sino-US cooperation in agricultural science and technology using PEST analysis has scientifically and accurately grasped the quantitative law of Sino-US agricultural science and technology cooperation.

KEYWORDS

Agricultural science and technology; Breeding patents; PEST analysis; Neutral cognitive map; Breeding technology

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1. INTRODUCTION

For thousands of years, the development of agricultural science and technology has contributed to the growth of human population and the expansion of social complexity [1]. In fact, the ability to meet the basic needs of the world's food supply and to gradually improve the quality of life of the rich people in the employment of fewer and fewer people is mainly due to the development of agricultural science and technology. At present, in the context of economic globalization and rapid development of science and technology, it is important to explore the impact and mechanism of the Chinese and U.S. patents in the area of agricultural science and technology development [2]. Currently, in the context of economic globalization and rapid development of science and technology, it is of great significance to investigate the impact and mechanism of Sino-US breeding patents on agricultural science and technology development [2]. As the world's two largest economies, the progress of China and the United States in the field of agricultural science and technology has a far-reaching impact on the global food security and sustainable agricultural development [3]. The new technologies created by China and the United States in the field of agriculture can significantly increase the world's agricultural production and maintain the sustainability of the world's agricultural development. The promotion of new disease-resistant hybrid varieties, the reduction of the use of pesticides, the scientific prevention and control of biological pests, the improvement of cultivation technology of agricultural products, etc. agricultural science and technology can increase the production of agricultural products, and promote agricultural development. Intellectual property management is not only related to the incentive mechanism of technological innovation, but also affects the competitive pattern of the global agricultural market [4]. In addition, with the global climate change and population growth brought about by the pressure of food supply, improve crop yield and adaptability has become an urgent need, which is the core goal of the innovation of breeding technology [5]. Therefore, an in-depth understanding of the development of the U.S. and Chinese breeding patent situation, the differences in patent policy and its impact on the development of their respective and global agricultural science and technology. Therefore, in-depth understanding of the development of Chinese and American breeding patents, patent policy differences and their impact on the development of their respective and global agricultural science and technology is the key to grasp the pulse of the global agricultural science and technology development, guide the future development of agricultural policy and promote international cooperation.

This paper utilizes PEST analysis to systematically analyze the impact and mechanism of agricultural science and technology development, and comprehensively assesses the factors from political, economic, social and technological dimensions, so as to provide powerful strategic support for promoting the healthy development of agricultural science and technology and global agricultural cooperation. In order to reduce the dependence between the influencing factors, this paper employs the NCM to model the integrated structure of the sub-factors of

PESTEL, and to stratify and refine the impact of agricultural science and technology through the measurement of the influencing factors. In order to reduce the dependence between the influencing factors, this paper adopts NCM to model the comprehensive structure of PESTEL sub-factors, and to refine the influence of agricultural science and technology by stratifying the influence of the influencing factors through the measurement of the influencing factors. In the exploration and analysis, the performance of Sino-US breeding patents in different PEST dimensions and the role of breeding patents on the development of agricultural science and technology are used to validate the reasonableness of the methodology of this paper, so as to comprehensively and systematically sort out the history of the cooperation between China and the United States in agricultural science and technology and to summarize the basic mode of the cooperation in agricultural science and technology between China and the United States. We quantitatively analyze the influence of Sino-US agricultural science and technology cooperation.

2. LITERATURE REVIEW

Zhang, F et al. elaborated the mechanism of agricultural science and technology innovation to promote the green development of agriculture through spatial spillover from the perspective of multi-dimensional approach, from the perspective of factor spillover path and product spillover path, and measured the level of China's agricultural green development by using grey correlation analysis and analyzed the spatial and temporal evolution of the green development of China's agriculture [6]. Wang, Y proposed a program design for the intelligent platform of agricultural science and technology park, and listed the basic content of the construction of the intelligent park. The proposed intelligent platform program design applies new ICT technologies such as 5G, artificial intelligence, cloud computing, Internet of Things, mobile Internet, etc., and solves the problems faced by traditional agricultural science and technology parks for a long time such as lack of experience in service, poor integrated security, low operational efficiency, high management cost, and difficult business innovation [7]. Mahapatra, B. used autoregressive distributed lag combined with F-test and investigated the impact of agricultural credit on total cereal, grain and rice production using ARDL regression modeling framework. The empirical results of bounded F-test showed that there was a statistically significant relationship between agricultural credit and total cereal, millet and rice production at 1% level, which verified the long-run equilibrium relationship in the model [8]. Wang, Z designed a set of agricultural digital greenhouse system based on ZigBee wireless sensor network technology. At the same time, in the corresponding data acquisition and processing problems, this paper adopts the PID controller under the particle filtering optimization technology to optimize the error of the corresponding data acquisition system, eliminate the corresponding noise and interference, so as to ensure the stability and effectiveness of the corresponding data acquisition system in the digital greenhouse, reduce the power consumption of the whole system, and ensure the stable transmission of data[9].

Aragie, E applied economic modeling in economics to assess the relative efficiency of alternative investment choices for agricultural performance and household welfare. To explain the linkages, as well as the direct and indirect impacts of alternative public expenditure policies, the study used a general equilibrium model of Ethiopia calibrated according to a well-decomposed socio-accounting matrix representing the structure of the economy in the year 2010 [10]. Gurnovich, T. The innovation and investment processes in the agricultural economy were studied by using system analysis methods taking into account the manifestations of the trend of digitization of the agro-industry. Structural changes and imbalances in the process of investment and innovation in the agricultural sector of the economy were revealed. Statistical and economathematical methods were used to forecast the development of agricultural production [11]. Habtewold, The impact of climate-smart agricultural technology on multidimensional poverty of rural households in Ethiopia was used by T. To estimate the impact of the mentioned technology, propensity score matching and endogenous switching regression methods were used. The increase in income/consumption by increasing the returns to production reduces the technology-induced multidimensional poverty. This impact is transmitted more through the non-food expenditure pathway. Finally, the impact of technology adoption on the Finally, the impact of technology adoption on multidimensional poverty reduction has also been revealed [12]. Treurniet, M. used exogenous variation in the probability of a baseline survey to estimate the impact of a baseline survey on the adoption by subsistence farmers of a new agricultural technology that improves food security, and found that acceptance of the survey had a large and statistically significant impact [13].

3. CONSTRUCTING AN IMPACT MECHANISM FOR AGRICULTURAL SCIENCE AND TECHNOLOGY DEVELOPMENT BASED ON PEST ANALYSIS

3.1. PEST ANALYTICAL FRAMEWORK

PEST analysis is used to assess these four external factors related to the business situation, when including environmental and legal factors, it is called PESTEL, i.e., the analysis of political, economic, socio-cultural, technological, environmental, and legal factors [14]. In the use of PEST analysis to explore the impact and mechanism of the influence of the Chinese and American breeding patents on the development of agricultural science and technology, PEST analysis framework provides a comprehensive method to examine the various external environmental factors. The PEST analysis framework is shown in Figure 1, and the framework includes four main dimensions: political, economic, social, and technological. The PEST analysis framework is shown in Fig. 1, which includes four main dimensions: political, economic, social and technological. This will help identify opportunities and challenges, provide decision support for policy makers and the industry, and promote the healthy and sustainable development of agricultural science and technology.

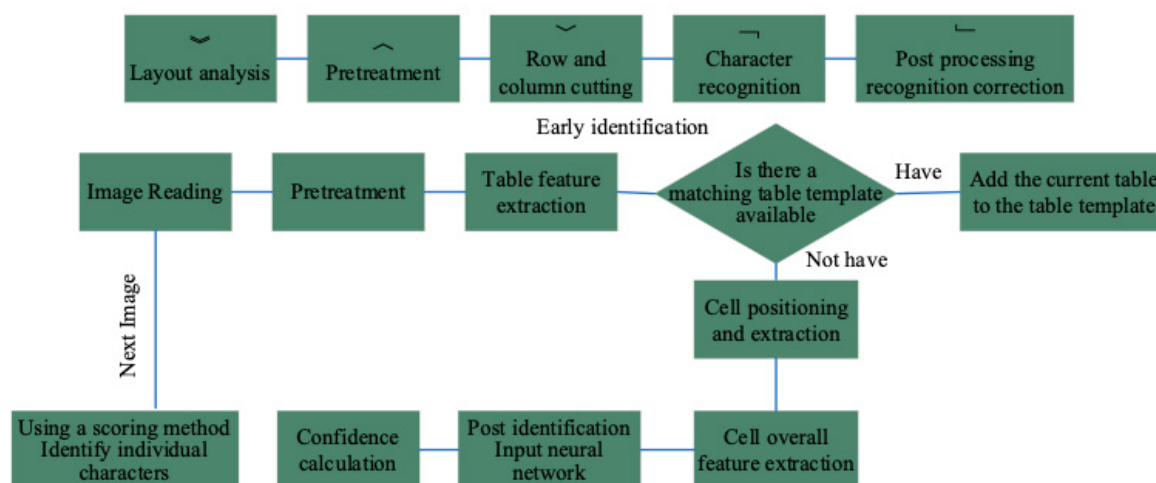


Figure 1. PEST analysis framework

3.2. IMPACT OF U.S.-CHINA BREEDING PATENTS ON AGRICULTURAL SCIENCE AND TECHNOLOGY DEVELOPMENT

3.2.1. POLITICAL FACTORS

The governments of China and the United States influence the protection and application of breeding patents through the formulation of relevant policies and legal frameworks. Intellectual property laws, the duration of patent protection, and the regulation and restriction of biotechnology all have a direct impact on the development and application of breeding technologies [15-16]. trade agreements and diplomatic relations between China and the United States also have an impact on breeding patents. the provisions of trade agreements on agricultural products and biotechnology affect technology exchanges and market access. The level of government funding and support for research in agricultural science and technology has a significant impact on the innovation and application of breeding patents, and government-sponsored research programs may drive the development of new varieties and technological innovations. government public policies, including attitudes toward genetically modified products and consumer right-to-know policies, may also affect the market acceptance and application of breeding patents. In some cases, breeding technologies and patents are also linked to national security and food safety policies, and breeding technologies that improve crop yields and resilience may be considered part of a national food safety strategy.

3.2.2. ECONOMIC FACTORS

The development of breeding patents requires significant R&D investment, and the rate of development of new technologies and varieties is determined by the investment made by companies and research institutions in the U.S. and China. the

patent system provides a level of protection that encourages such investment in the hope of obtaining a return on that investment through exclusivity during the term of the patent. the holder of a patented technology can gain a competitive advantage in the marketplace, influencing the price of seed and the planting choices of farmers. at the same time, a market with a high degree of patent concentration can lead to market monopolization and affect fair competition. At the same time, markets with high patent concentration can lead to market monopolization and affect fair competition in the marketplace. patent protection for breeding technologies also plays an important role in international trade. the entry of patented products for export is affected by differing IPR protection laws and market access rules in different countries, which has a direct impact on the competitiveness of the U.S. and China in the global marketplace for agricultural products. patented technologies for breeding affect the cost and efficiency of agricultural production. New breeding technologies can improve crop yields and resistance to pests and diseases, reduce the cost of agricultural production, and increase farmers' income [17].

3.2.3. SOCIAL FACTORS

Public attitudes towards breeding technologies, especially transgenic technologies, have a direct impact on the market acceptance of breeding patents, and societal concerns about food safety and environmental impacts may lead to boycotts or restrictions on certain breeding technologies, thus affecting the commercialization of these technologies. The degree of societal awareness of intellectual property rights (IPRs) protection, especially in the agricultural sector, has a significant impact on the filing and enforcement of breeding patents [18]. In societies with strong awareness of intellectual property protection, patents are likely to be better defended, thus stimulating more innovation and investment. breeding patents, especially those involving gene editing and transgenic technologies, often lead to moral and ethical debates in society, which may influence the formulation of governmental policies, and consequently, the development and application of breeding technologies. the degree of importance that societies attach to education and training in agricultural science and technology determines the training of human resources in the field of agricultural science and technology. The level of social emphasis on education and training in agricultural science and technology determines the cultivation of human resources and dissemination of technology in the field of agricultural science and technology, and a high level of scientific education and technical training can accelerate the progress of agricultural science and technology by facilitating the understanding and application of breeding technology. changes in consumer demand for food products, such as the preference for organic and non-GMO products, can affect the commercial prospects of patents on breeding technology, and the market demand for crops with specific characteristics, such as higher nutritional value and better taste, can also drive breeding technology. Market demand for specific crop characteristics, such as higher nutritional value and better taste, will also drive the direction of breeding technology.

3.2.4. TECHNICAL FACTORS

The existence of breeding patents encourages technological innovation, particularly in areas such as gene editing and transgenic technologies, and patent protection provides inventors with a window of time to recoup their R&D investment, thereby stimulating additional R&D activities and innovation attempts. patenting standards and specifications for breeding technologies differ in the U.S. and China, affecting the direction of the technologies and the scope of their application. the technical standards in the patenting and approval process determine which innovations can be protected and disseminated. Breeding patents affect the accessibility and diffusion of technologies, and the licensing of patented technologies determines how easily they can be applied and under what conditions they can be used by other researchers and developers. the patent system facilitates technology transfer and international cooperation to a certain extent. Through patent licensing and cooperative agreements, advanced breeding technologies can cross national boundaries and contribute to the development of global agricultural science and technology [19].The development of breeding technologies has a direct impact on the efficiency and sustainability of agricultural production.For example, new drought- or disease-resistant varieties can increase crop yields and reduce the reliance on chemical fertilizers and pesticides, thus contributing to the sustainable development of agriculture.

4. MODELING OF INFLUENCING FACTORS

4.1. DATA ACQUISITION

PEST analysis is a premise analysis whose main function is to identify the environment in which a company or project operates and to provide data and information to enable the organization to anticipate new situations and circumstances [20], Figure 2 shows the process of data collection for agro-technology influencing factors.

Political factors include government regulation of business, commercial law, labor legislation, tax legislation, legislation in the field of import and export regulation, competition protection, consumer protection, and environmental protection laws. It can be expressed as $GSI = G/T$, $TRI = A/T$, $IPPI = P/TP$, where GS is the government support index, G is the financial support for agricultural science and technology from government agricultural policy, and T is the total agricultural science and technology development budget. TRI is the trade relationship index, A is the volume of agricultural trade between China and the U.S., and T is the total volume of agricultural trade. $IPPI$ is the intellectual property protection index, P is the number of patents on breeding, and TP is the total number of patents on agricultural science and technology.

Economic factors include E i.e. inflation, GDP , interest rate, exchange rate, unemployment etc. as well as ratio, intensity and type of contest between small, medium and large enterprises, private and state owned property etc. denoted as $AIG = I/GDP$, $PVR = (P_{\max} - P_{\min})/P_{\text{avg}}$, $RDEP = R \& D/TA$. Where AI is agricultural investment as a percentage of GDP , I is investment in the agricultural sector, and GDP is the GDP to the overall state of the country's economy. PVR is the price volatility of agricultural products, P_{\max} is the highest point of the price of key agricultural products, P_{\min} is the lowest point of the price of key agricultural products, P_{avg} is the average price. $RDEP$ is the ratio of agricultural research and development expenditures, $R \& D$ is the expenditures on agricultural research and development, TA is the total agricultural expenditures.

Socio-cultural factors s cover demographic trends including age, sex, number of people, natural growth rate, birth rate, death rate, population migration, educational level and social groups in the population, cultural beliefs and values, and people's individual needs. i.e., $PGR = (Pend - Pstart)/Pstart$, $CSI = CC/TCC$, and $REI = ER/TR$. where PGR is the Population Growth Rate, $Pend$ is the end of the year population, and $Pstart$ is the beginning of the year. CSI is the Consumer Concern Index, which is the score of the survey on consumer concern about the quality and sustainability of agricultural products, and the total survey score. CC is Consumer Concern Survey Score on Quality and Sustainability of Agricultural Products, TCC is Total Survey Score. REI is Rural Education Level, ER is Percentage of Educated Population in Rural Areas, TR is Total Population.

The analysis of technological factors covers innovation and creativity, technology transfer, availability and access to patents, attitudes of researchers toward copyright, and availability and access to the services of research institutes, which can be denoted as $ATI = NP/TP$, $DAI = DA/TA$, and $ICPI = CRC/TRC$, where ATI is the Agricultural Technological Innovation Index, NP is the number of new patents in the field of agriculture, and TP is the total number of patents. DAI is the Digital Agriculture Adoption Rate, DA is the number of agricultural operators that have adopted digital technologies, and TA is the total number of agricultural operators; $ICPI$ is the index of cross-country scientific research cooperation, CRC is the number of joint research projects between China and the U.S. in the field of agricultural science and technology, and TRC is the total number of research projects.

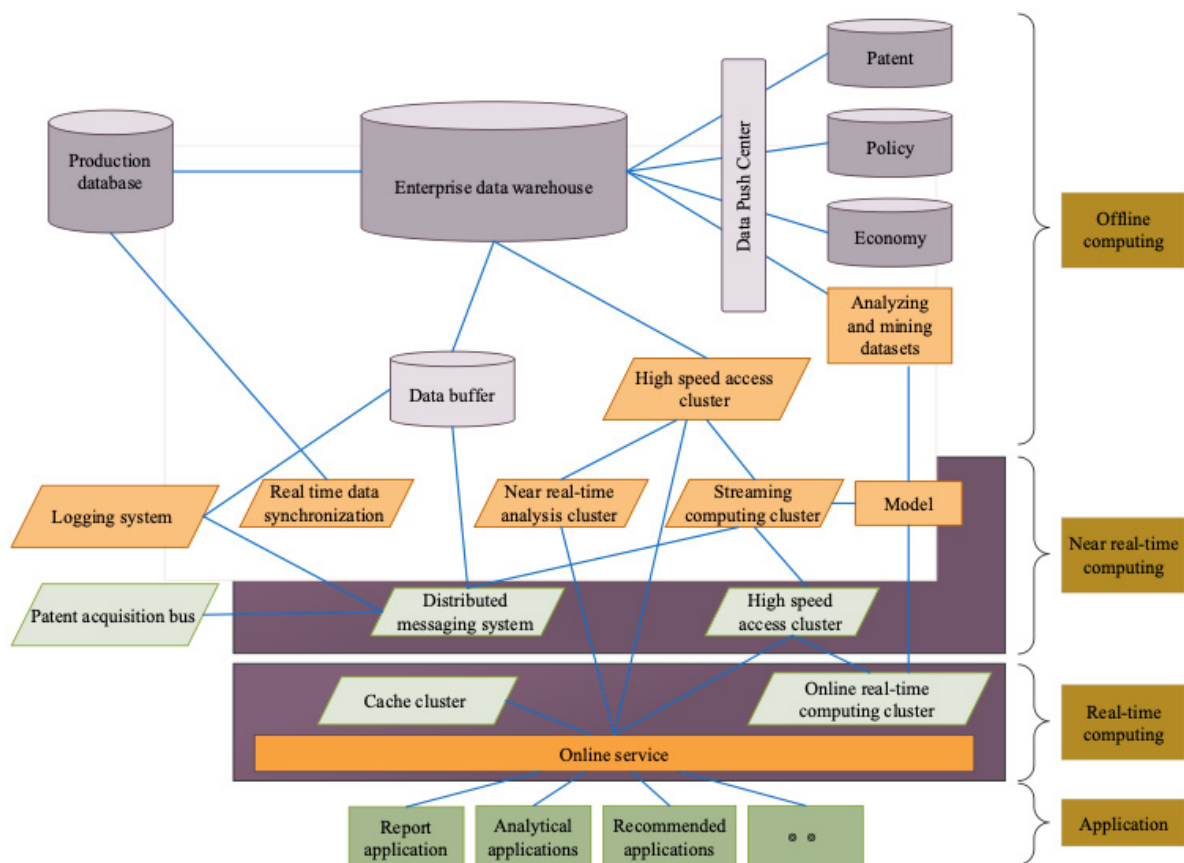


Figure 2. Data acquisition process

4.2. MODEL BUILDING

The interdependence between the analyzed factors. In addition, the structure of the factors and sub-factors is characterized by ambiguity, vagueness and uncertainty. Therefore, this study proposes a model to solve the problems encountered in the process of measuring and evaluating the PEST analysis. The composition of the model is shown in Fig. 3. The interdependence between the sub-factors is also taken into account. The comprehensive structure of the PESTEL sub-factors is modeled using the NCM. A quantitative analysis is also carried out on the basis of the static analysis.

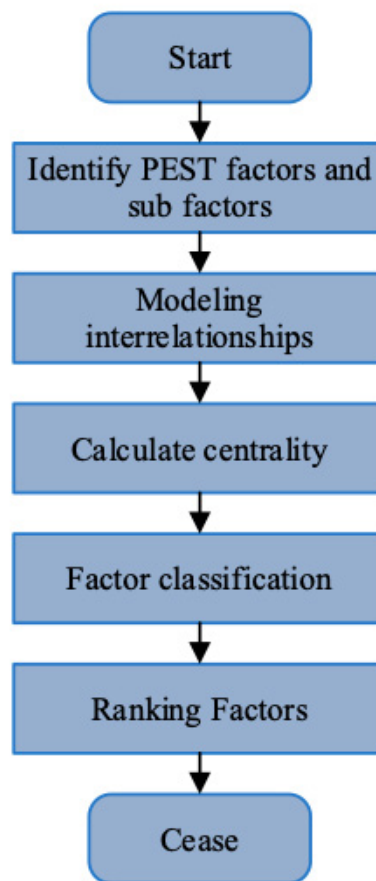


Figure 3. Proposed framework for PEST analysis.

Neutral logic was introduced in 1995 as a generalization of fuzzy logic, especially intuitionistic fuzzy logic. The logical proposition P is characterized by three neutral components.

$$NL(P) = (T, I, F) \quad (1)$$

Where T is the degree of truth, F is the degree of falsity and I is the degree of uncertainty.

A neutral matrix is a matrix in which the elements $a = (a_{ij})$ have been replaced by elements in $\langle R \cup I \rangle$, where $\langle R \cup I \rangle$ is a ring of neutral integers. a neutral map is a map in which at least one of the edges is a neutral edge. a cognitive map is called a neutral cognitive map if uncertainty is introduced into the cognitive map. the NCM uses neutral logic to represent the uncertainty and uncertainty in the cognitive map. a NCM is a directed graph in which at least one edge is uncertainty as represented by the dashed line, an example of a fuzzy neutral cognitive map is shown in Fig. 4. An example of a fuzzy neutral cognitive map is shown in Figure 4. The static analysis results of the mental model in the form of NCM are in the form of neutral numbers. Finally, a de-neutralization process is applied to give the final ranking values. In this study, the model is extended and detailed to deal with the classification and prioritization of factors.

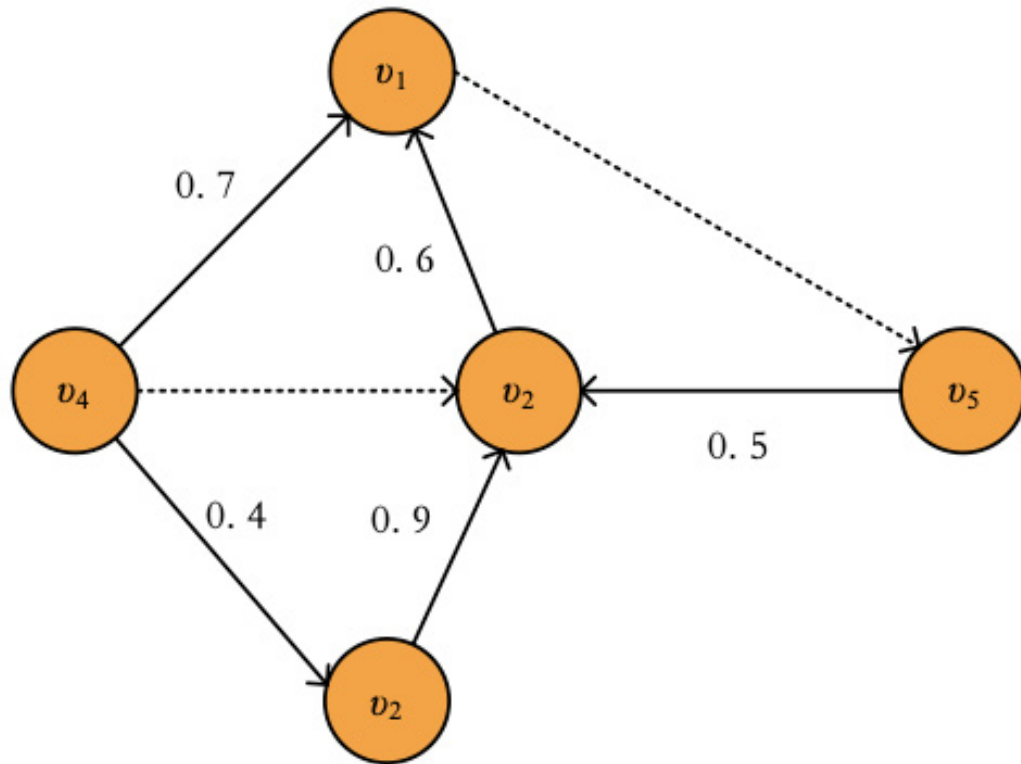


Figure 4. Fuzzy Neutrosophic Cognitive Maps example.

4.3. IMPACT FACTOR METRICS

4.3.1. COMPUTATIONAL CENTRALITY MEASURE

The following metrics are computed using the absolute values of the NCM adjacency matrix.

1. The out-degree $od(v_i)$ is the row sum of the absolute values of the variables in the neutral adjacency matrix, showing the cumulative strength c_{ij} of the connections of the exit variables.

$$od(v_i) = \sum_{j=1}^N c_{ij} \quad (2)$$

2. Input $id(v_i)$ is the column sum of the absolute values of the variables, showing the cumulative strength of the input variables.

$$id(v_i) = \sum_{j=1}^N c_{ji} \quad (3)$$

3. The total degree of centrality of a variable, $td(v_i)$, is the sum of its in- and out-degrees, which is then calculated as follows.

$$td(v_i) = od(v_i) + id(v_i) \quad (4)$$

4.3.2. FACTOR CLASSIFICATION

Factors are categorized according to the following rules.

1. Transmitter variables have positive or uncertain out-degree $od(v_i)$ and zero in-degree $id(v_i)$.
2. Receiver variables have positive or uncertain in-degree $id(v_i)$, and zero out-degree $od(v_i)$.
3. Ordinary variables have non-zero in-degrees, and ordinary variables can be more or less receiver or transmitter variables, depending on the ratio of their in-degrees to their out-degrees.

4.3.3. RANKING FACTORS

The process of de-neutralization gives the number of intervals of centrality. this is based on the maximum and minimum values of I . Neutrality values are transformed in intervals with two values, the maximum and the minimum $[0,1]$.

The contribution of a variable in a cognitive map can be understood by calculating its degree centrality, which shows how well the variable is connected to other variables and what is the cumulative strength of these connections. the median of the extremes is used to give the centrality value.

$$\lambda([a_1, a_2]) = \frac{a_1 + a_2}{2} \quad (5)$$

Then:

$$A > B \Leftrightarrow \frac{a_1 + a_2}{2} > \frac{b_1 + b_2}{2} \quad (6)$$

Hierarchical refinement of the impact of breeding technology on agricultural science and technology based on PEST, the variables were ranked as shown in Table 1 for factor prioritization and/or reduced values.

Table 1. The hierarchical model of PEST of breeding patents.

Political	Economic	Social	Technology
Political stability (P1)	Labor force level (E1)	Entrepreneurial spirit (S1)	Government investment measures (T1)
Intellectual Property (P2)	Investment incentive measures (E2)	Purchase product (S2)	Government support for scientific research (T2)
Environmental Protection Law (P3)	National Income (E3)	Citizen attitudes towards breeding technology (S3)	Technological Innovation (T3)
		Positive media promotion (S4)	

5. MECHANISM OF ACTION ANALYSIS

5.1. PERFORMANCE OF CHINESE AND U.S. BREEDING PATENTS ON DIFFERENT PEST DIMENSIONS

The data on the political, economic, social and technological dimensions of breeding patents in China and the United States were collected through the data collection system, and hypothetical analyses were conducted to investigate the significance of the impact of these factors on breeding patents. Table 2 shows the results of the hypothetical analyses. The policy factor represents the impact of the political environment on breeding patents, including policy support, changes in the law, etc. The economic impact factor includes R&D investment, market size, etc. The social impact factor reflects social attitudes, consumer preferences, etc. The technological impact factor represents technological progress, innovation speed, etc. The number of breeding patents is the number of applications filed by the country in a given year. The social influence factor reflects the social attitude and consumer preference, etc. The technology influence factor represents the technological progress and innovation speed, and the number of breeding patents is the number of breeding patent applications in a specific year. The political influence factor of China and the United States increases year by year from 2019 to 2021, and by 2022, the technology influence factor reaches 0.70, and the economic influence factor reaches 0.60, which reflects that the governments of the two countries increase the number of breeding patents during this period. This reflects that the governments of the two countries have increased their policy support for agricultural science and technology during this period, such as providing more R&D funds and optimizing the intellectual property protection system, etc. This improvement in the policy environment may have played a positive role in promoting the application and implementation of breeding patents.

Table 2. Hypothesis Analysis Results

Time	Country	Political influence factors	Economic impact factors	Social impact factors	Technical impact factors	Number of breeding patents
2019	United States	45	0.60	0.50	0.70	150
2019	China	0.50	0.55	0.45	0.65	130
2020	United States	0.47	0.62	0.52	0.72	155
2020	China	152	0.58	0.48	0.68	135
2021	United States	49	0.65	0.55	0.75	160
2022	China	0.55	0.60	0.50	0.70	140

The NCM was used to identify and model the interdependencies. The weights of the NCM are shown in Table 3. The weights are all below 0.5.

Table 3. Neutrosophic Adjacency Matrix

	P1	P3	E1	E2	E3	S1	S2	S3	S4	T1	T2	T3	P1
P1	0	0	0	0	0	0	0	0	0	0	0.7	0.6	0
P3	0	0	0	0	0.4	0	0	0	0	0	0	0	1
E1	0	0	0	0	0	0	0	0	0	0	0	0	0
E2	0	0	0	0	0	0	0.6	0	0	0	0	0	0
E3	0	0	0	0	0	0.3	0.4	0	0	0	0	0	0
S1	0	0	0	0	0	0	0	0.8	0	0	0	0	0
S2	0	0	0	0	0	0	0	0	0	0	0	0	0
S3	0	0	0	0	0	0	0	0	0	0	0	0	0
S4	0	0	0	0	0	0	0	0	0	0	0	0	0
T1	0	0	0	0	0	0	0	0	0	0	0	0	0
T2	0	0	0	0.2	0	0	0	0	0	0	0	0	0
T3	0	0	0	0	0	1	1	0	0.4	0.5	0	0	0
0	0	0	0	0	0	0	0.4	0	0	0	0	0	0

5.2. THE ROLE OF BREEDING PATENTS IN THE DEVELOPMENT OF AGRICULTURAL SCIENCE AND TECHNOLOGY

5.2.1. CHANGES IN THE AGRICULTURAL ECONOMY

China and the United States agricultural science and technology cooperation, directly promote China's agricultural science and technology level, and the level of agricultural science and technology is called the important driving force of the development of the agricultural economy. therefore, this paper adopts the trade in agricultural products as a measure of the index to measure the impact of China-US cooperation in agricultural science and technology on the agricultural economy has a certain degree of reality and reasonableness. figure 5 for the species of the country's agricultural output value index in the year 2001-2023 ring changes in the trend of agricultural output value index, from the From the point of view of agricultural output value index, after excluding the price fluctuation factor, the output value index of agriculture, forestry, animal husbandry, fishery, plantation, forestry, pasture and fishery are all greater than 100 except for a few years, indicating that China's agricultural output value is still showing an obvious year-on-year growth, which also fully demonstrates the momentum of China's agricultural development.

From 2001 to 2023, the index of agricultural output value shows an overall trend of first growth and then decline, and gradually tends to stabilize, in which the index of total output value and agricultural output value reached the maximum value in 2008, while the index of forestry, animal husbandry and fishery output value reached the maximum value in 2007, from the point of view of the stability of the index of recent years, they are all stable at 105 or above, that is, in recent years, the index of total output value of agriculture is still showing obvious growth year by year, which also shows that China's agriculture has a rapid development momentum. From the perspective of the flat stability of the chain index in recent years, they are all stabilized at 105 or above, which means that the agricultural industry has shown a coordinated growth in recent years, and the growth rate of the chain index is around 5%.

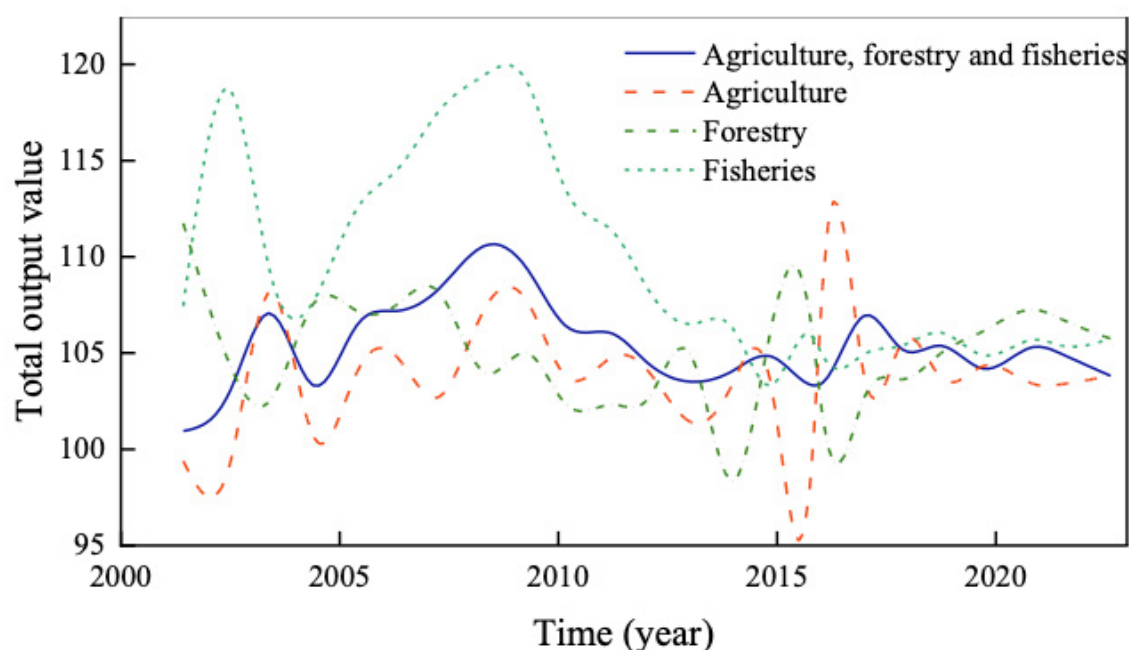


Figure 5. 2001-2023 trend of the output value index

5.2.2. U.S. IMPORTS OF CHINESE AGRICULTURAL PRODUCTS

Agricultural products is the final reflection of the results of agricultural science and technology, China and the United States agricultural trade is an important carrier of agricultural science and technology cooperation between the U.S. and China. China and the United States agricultural products there are greater complementarity, in recent years in the agricultural trade in the cooperation is becoming closer and closer. figure 6 for the U.S. imports of agricultural products from China's total amount and share of the 2009 year, the U.S. exports of agricultural products year-on-year will be reduced by 17 billion U.S. dollars, while the amount of China's exports of agricultural products to the United States will be Further increase, to 3.42 billion U.S. dollars, the past four years China's total exports of agricultural products to the U.S. has doubled. from the development trend, 1990-2008 U.S. imports of agricultural products from China's total amount and share of the total amount of obvious growth. 1990 U.S. imports of agricultural products from China's amount of 273 million U.S. dollars, accounting for the U.S. value of the total value of agricultural products imported 1.19%. 2008 U.S. imports of agricultural products of Chinese origin and share of the total value of the U.S. value of 1.19%. In 2008, the total value of U.S. imports of agricultural products of Chinese origin amounted to 3454 million U.S. dollars, an increase of 11.65 times compared with 1990, with an average annual growth rate of 15.14%. 2008 imports of agricultural products of Chinese origin accounted for the proportion of U.S. imports of agricultural products to the total value of 4.29%, an increase of 3.1 percentage points compared with 1990.

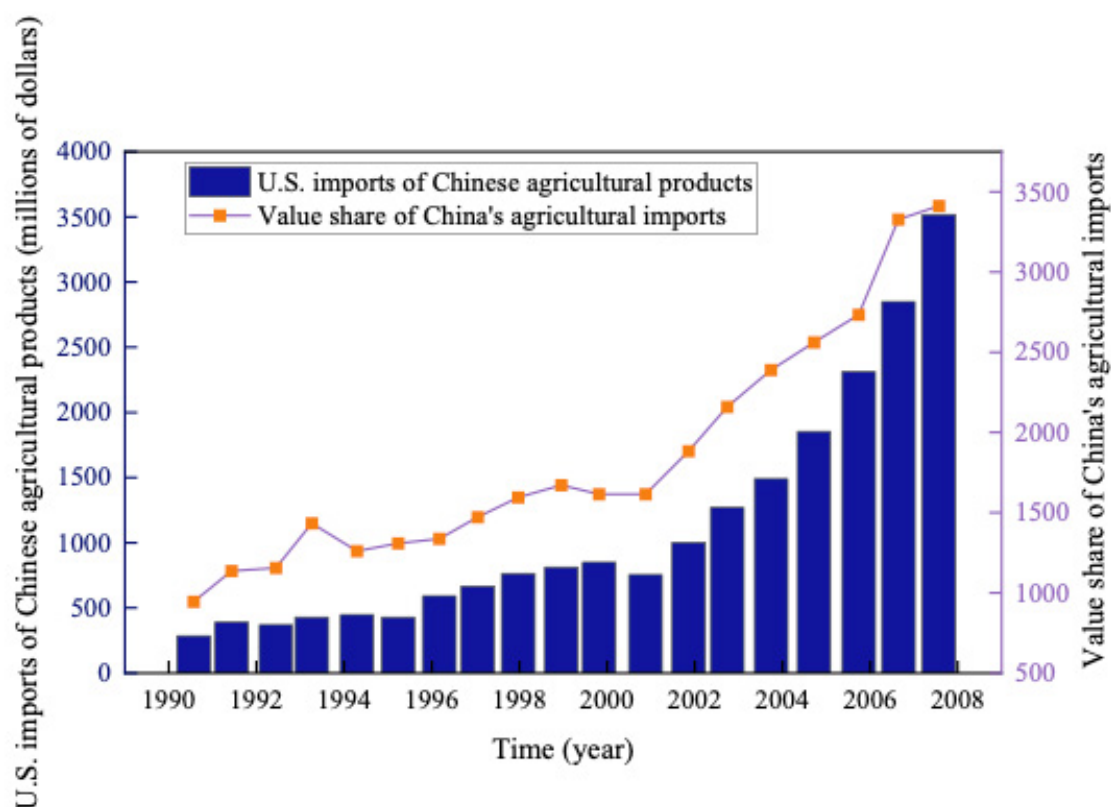


Figure 6. Total amount and proportion of U. S. imports of agricultural products from China

6. CONCLUSION

In this paper, the impact and mechanism of U.S. breeding patents on the development of agricultural science and technology is taken as the target, and the PEST analysis combined with the static analysis of sexual cognitive map is used to construct the model of the impact factors and validate it. The conclusions are as follows.

1. For the performance of Chinese and American breeding patents in different PEST dimensions, by 2022, the technological impact factor reaches 0.70, and the economic impact factor reaches 0.60, reflecting that the governments of the two countries have increased their policy support for agricultural science and technology during this period, and this improvement in the policy environment may play a positive role in promoting the application and implementation of breeding patents.
2. In the analysis of the role of breeding patents on the development of agricultural science and technology, Chinese and American breeding patents make China's total agricultural output value is greater than 100, and in 2008, imports of agricultural products of Chinese origin accounted for the proportion of total U.S. imports of agricultural products also rose to 4.29%.

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THE USE OF FULL-COST REFINEMENT MANAGEMENT IN ENTERPRISE ECONOMIC MANAGEMENT

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ABSTRACT

This paper firstly structures the control system to ensure that the full-cost refinement management has a basis and forms a closure in the management chain. Secondly, it enhances the project system management, solidifies all the nodes, puts the communication mechanism in front, and ensures the efficient synergy and reasonable division of labor while establishing the efficient management and communication mechanism, so that it is located in the full-cost refinement management. Finally, the AHP method is used to choose the implementation method of the information system, so as to adapt the full-cost refinement management to the needs of each level and realize the application of full-cost refinement management in the economic management of the enterprise. The final simulation results show that the consistency ratio calculations of the decision-making level management organization, the executive level management organization, the basic level production department, and the other learning and growth, CR are 0.017, 0.023, 0.031, and 0.013, respectively, which are all less than 0.1, and pass the consistency test and do not need to be adjusted. It shows that the results of the calculation of the stratified weight assessment of the full-cost refined management provide an effective guarantee for the economic management of the enterprise, and can be found to be unreasonable in the process of practice, and make timely adjustments to solve the problem.

KEYWORDS

Full-cost refinement management; enterprise economic management; communication mechanism; AHP approach

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1. INTRODUCTION

In the very competitive economic market, based on the cost control refinement management, is conducive to improving the cost control environment and promoting new development. Improving the efficiency of enterprise economic operation and management is a favorable condition for realizing the economic development goal, cost control refinement of economic management, focus on economic management objectives, under the management perspective, create operation and management environment [1-2]. Effective management system is to ensure that the basic conditions of standardized management of enterprises, and at this stage, enterprises in the cost control refinement of economic management, the lack of a sound system as a safeguard, resulting in the refinement of the management of the form of a nullity, still applying the sloppy management, cost control effect is very significant problems. For modern enterprises, the cost control refinement management economy focuses on the management of multi-faceted, cost control is the most important performance is arbitrary, easy to cause the phenomenon of cost control confusion, resulting in the construction of internal control of the enterprise is hindered [3].

Profit-oriented nature of every enterprise, in the complex market environment, based on the short-term economic benefits of the development of the layout, will affect the enterprise cost control refinement of economic management work. Affected by the planned economy, business leaders and financial personnel do not pay attention to cost management, only take into account the immediate interests, resulting in a lack of control consciousness [4]. From the strategic development level to start controlling costs, the need for enterprise cost control implementation of refined management, and effectively optimize the current cost control problems. In the enterprise cost control refinement economic management needs to increase the enterprise cost control refinement economic management efforts to promote its existence of the significance of the full play out, and promote the healthy development of enterprises [5-7].

Literature [8] There is a tendency for economic growth targets to expand from top to bottom across regions, which is explained by the decreasing level of capacity utilization by local firms. The government used hard constraint vocabulary when setting economic growth targets and intervened in the production capacity decisions of local firms, including strengthening private exchanges with local firms and liberalizing business policies for local firms. Empirical studies have found that the government is detrimental to the regional economy and the long-term development of regional firms. Literature [9] Water has complex cost factors and is considered a scarce commodity under a reduce-recycle-reuse system that employs a full cost recovery strategy. Single and multi-block pricing models were created and the effect of externalities were considered to analyze their impact on the cost of water production and payback periods were calculated. The results showed that the unit cost of potable and non-potable water was reduced by 34.04% and 43.13% with the use of multi-block pricing strategy. Literature [10] describes two different types of SOEs in China, i.e., SOEs in Chinese towns and cities and township and village enterprises in

Chinese villages, both of which are unique to China. Successful cases of TVEs and SOEs are compared and an in-depth analysis of capital and labor relations after the restructuring of SOEs is presented. Literature [11] examined how economic policy uncertainty affects firms' innovative capabilities in innovative cities, and obtained conclusions that differed from existing studies. The empirical analysis found some credible evidence that government investment in firms is incentivized in innovative cities. Literature [12] conducted an empirical study on the perspectives of 81 Romanian non-profit organizations on sustainable development. Five main sustainability factors were measured, namely talent, business model, operating model, strategy, and culture, through the success factor analysis of the multidimensional sustainability measurement system as a theoretical model. Literature [13] In the context of digital economy, strengthening the quality management of e-commerce enterprises can promote fair competition in the e-commerce market, and it is of great significance to enhance the brand rights and interests of e-commerce enterprises, and improve their core competitiveness. On this basis, the eco-network problem in enterprise quality management is discussed in the light of the actual situation in practical work. Literature [14] summarized the existing studies on initial public offerings of family-owned enterprises and reviewed the related studies at home and abroad. The new conceptual framework of Input-Process-Output is introduced to provide targeted policy interventions for the IPO process of private enterprises, which has important academic value and practical significance. Literature [15] explored the relationship between the internal elements of the enterprise and other business activities of the enterprise and external environmental factors, and qualitatively modeled the model using the impulse component weight map method to obtain predictive information about future development trends. The results of the study found that even when macroeconomic risks arise, being able to take positive measures on some of the indices can enhance the potential of enterprises' overseas investment to a greater extent.

In this paper, the full-cost refinement management is applied to the enterprise economic management design, firstly, through the structure of the control system, so that the enterprise's full-cost refinement management chain is more clear and visualized, and the management implementation is more in place. Secondly, the process communication mechanism is established to pull through the management of the various costs of the enterprise, solidify all the nodes, realize the real responsibility cost management information system, and take AHP as the design idea of the construct to achieve the purpose of decision-making mechanism refinement. Finally, the economic management upgrading and transformation process is designed for the new demand, and the demand collection is carried out at each level of the enterprise, and the operation management demand indexes are rearranged and summarized, so as to make the full-cost refinement management adapt to the demand of each level, and to realize the application of full-cost refinement management in the economic management of the enterprise. And through simulation experiments to its consistency test, and combined with the analysis of the economic benefits of an enterprise for six

years, to verify the feasibility and effectiveness of the full-cost refinement management.

2. FULL-COST REFINEMENT MANAGEMENT APPLICATION DESIGN

2.1. CONTROL SYSTEM ARCHITECTURE

The establishment of the control system needs to be safeguarded through a scientific and reasonable organizational structure, and it is necessary to clarify the lead department of the full-cost refinement control system, which is responsible for the full-cost budget issuance and execution assessment, and secondly, to set up a professional management team of the full-cost refinement control system to form a comprehensive and professional working group, which will focus on the preparation of the management system and guidelines, and the formulation of the assessment logic and bylaws. The organization can set up an auditing agency under it to carry out special supervision and rectification of problems found in the business to ensure that the full-cost refinement management is based on evidence and to form a closure in the management chain. Finally, from the ideological point of view, the company executives should firmly support the establishment of the structure of the full-cost refinement of the control system, and require the business departments to be unified in their thinking, attach great importance to and actively cooperate with the implementation of all kinds of cost management initiatives, and to give the lead department a larger assessment authority and incentive authority, and to form a fixed cycle of reporting decision-making mechanism. Only the enterprise organization as a solid guarantee, the establishment of the management structure of the full cost refinement control system management structure has the basis for stable development [16-18].

If you want to make the cost management of the enterprise effective, the main management aspects focused on the control level, combined with the cost data measurement, you can get the full cost data of the entire project, and then combined with the respective cost classification and special matters matching classification becomes the target cost of the project. Each plan to control the cost of decomposition to the various departments and related personnel, enterprises and regions to encourage the fine control of functional lines through certain assessment incentives, the contract is expected to be contracted for the decomposition of a good comprehensive contract planning work. Through the target contract plan to guide the project's full cycle of business development, to maintain the unity of opinion of each department and leadership of the enterprise, to realize the whole staff has a cost consciousness, the department of interoperability, in the project system through the establishment of the project as a unit of the full cost of the communication mechanism.

In the specific contract implementation process of a certain stage of the cost of the occurrence of tracking summary, continuous analysis and update the contract planning, to provide accurate guidance for the project's target cost, and then use the dynamic cost management process of all kinds of matters in the process of supervision and early warning, to achieve the dynamic process control based on the target cost, the cost of fine management control system management structure as shown in Figure 1.

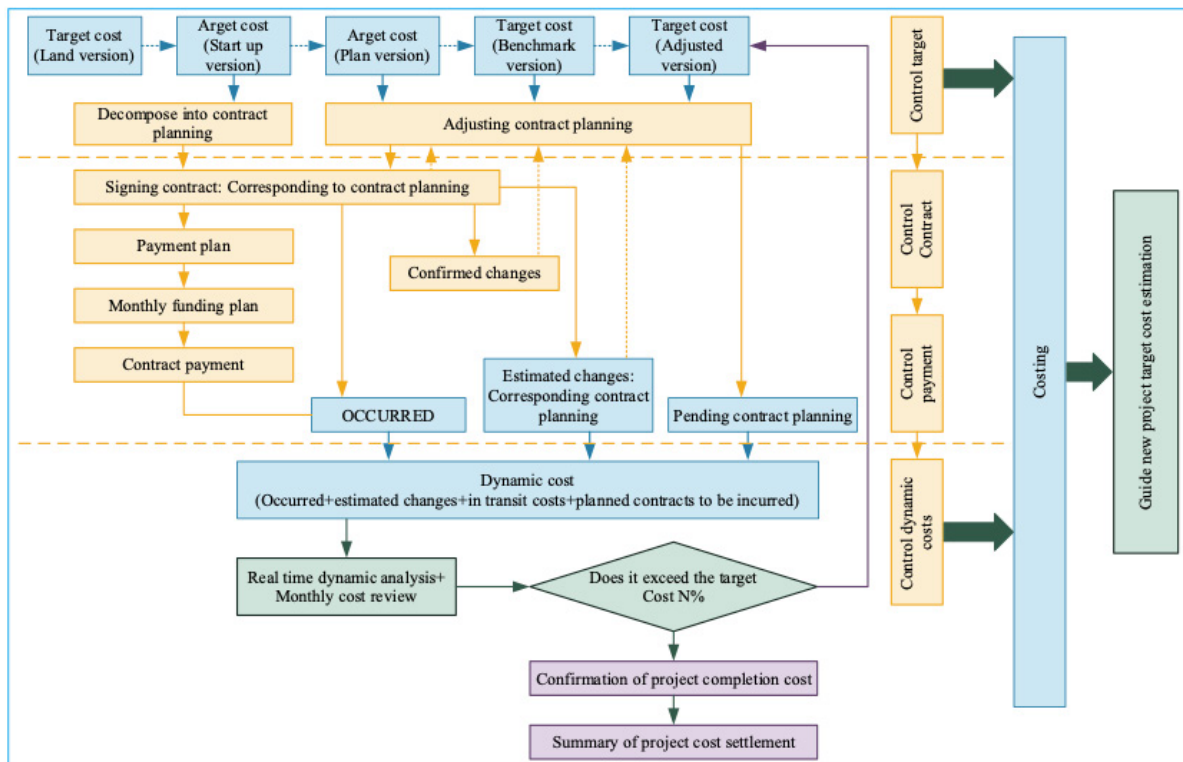


Figure 1. Management structure diagram of the whole cost refinement control system

The establishment of the full cost refinement control system structure can better organize all departments to carry out cost management work in accordance with business processes and operational nodes, so that the cost management chain of the enterprise is more clear and visualized, and the combination of operational nodes and dynamic cost management can be realized. Under the guarantee of orderly organization of the enterprise, it makes the execution of the control system smoother and the management execution more in place.

2.2. ESTABLISHMENT OF PROCESS COMMUNICATION MECHANISMS

Process communication mechanism to establish the main focus on the interdepartmental fuzzy space, the first need to enhance the project system management, project system members need to pull through the management of the enterprise's costs, communication mechanism needs to be landed at the project level, in the regional enterprise level by the functional line responsible for specific business

decisions and upward communication. The second need to form a cost control system process, the project since the beginning to the end of the whole process of node sorting, and then set up a specific timeline under the respective nodes, all the nodes solidified, the communication mechanism front. And in the establishment of efficient management and communication mechanisms to ensure efficient collaboration and rational division of labor, located in the cost of division of labor management, emphasizing the horizontal division of labor at the level of cost accounts and expense accounts, through the horizontal division of labor to clarify the cost of the main body of the responsibility to achieve the real responsibility of the cost management system. Adopting the structure of project system, the division of labor is shown in Table 1.

Table 1. Horizontal division of labor for project costing

Position	Main Responsible Subjects	Description of Main Duties
Project Responsible Person	Full Project Costs	Responsible for all project costs. Checking and supervising.
Project Cost Manager	Development Costs	Responsible person for development cost. Lead and responsible for the preparation of target cost and contract planning and dynamic cost monthly review. Statistics and early warning of marketing costs.
Project Marketing Manager	Marketing Costs	Responsible person for marketing expenses.
Project Finance Manager	Sectoral cost-sharing	Responsible for departmental cost sharing. Project budgeting. Project revenue analysis and tracking.

The horizontal division of labor should also focus on solving the four key divisions and synergies of the whole process cost management, i.e., cost and design, cost and contract, cost and engineering, and cost and finance. Cross synergy with different departments to form a scientific and integrated process communication mechanism is shown in Table 2.

Table 2. Horizontal division of costs among multiple sectors

Relationships	Collaboration Essentials	Collaboration Notes
Cost & Design	Development of target cost, implementation of limit design and management of design changes	Design provides corresponding planning and design target costs, and the design should be based on the company's established limit targets to guarantee the target costs.
Cost & Contracting	Preparation and execution of contract planning and coordination of procurement process	Contract planning is led by the contract department and corresponds with the cost accounts to clarify the target cost of the contract.
Cost & Engineering	Contract planning, visa management	Contract planning requires the participation of the engineering department to give advice on the division of project sections to facilitate the preparation of contract planning.
Cost & Finance	Cost accounts, cost accounting	The setup of cost accounts should consider the correspondence with the cost accounts of the financial system, not forcing complete consistency, but to clarify the correspondence.

Good communication mechanism can create more efficient management value for the enterprise, through the project system within the cross-complementary and the coordination of the management of each department, emphasizing the cost of interoperability, only the cost of connecting the line, so that each department knows each other the impact of cost implementation will make the company's cost control system work. After the management boundaries of each department are clearly defined, the division of responsibility for cost overruns will be clearer in the future, and the company will be able to better carry out cost review work.

2.3. COMPOSITION OF CONTROL INFORMATIONIZATION SYSTEM

The implementation of information technology system is a complex and heavy workload of the complete system project, which requires enterprises from the organization of human resources to support the work. If this work is not done properly, as professional skills level is not enough, with coordination is not effective, poor stress tolerance and other direct impact on the project schedule and the smooth implementation of the project. Decision-makers led by corporate management to set up a steering group, the group's main job is to make decisions on the general direction of information technology, to determine the scope and depth of the implementation of information technology. Each project department should set up a fixed position dedicated to the implementation of information technology with the implementation team to carry out the implementation of information technology, each project department as a representative of a person to collect demand for the implementation of the team, to be on-line as a representative of the system to

familiarize themselves with the operation of the system, a person will first lead a department will gradually expand the impact of the area to reduce the pressure of training.

Using the AHP method to select the implementation of information technology system, the goal of the demand, key factors and demand objects according to their interrelationships are divided into the target layer, guideline layer, program layer [19-20]. The drawn hierarchy is shown in Figure 2.

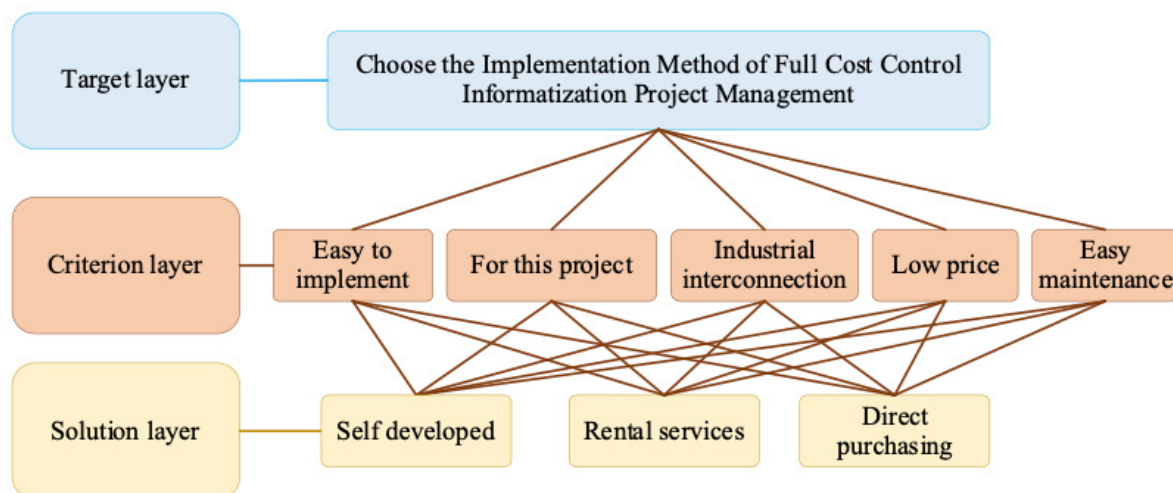


Figure 2. AHP model

For each pairwise comparison matrix, the largest eigenvalue and its corresponding eigenvector are calculated, and the consistency test is done by using the consistency index, random consistency index and consistency ratio. If the test passes, the eigenvectors are the weight vectors, if not, the pairwise comparison matrices need to be reconstructed. Finally, calculate the total ordering weight vector and do the consistency test, calculate the weight vector of the bottom layer to the top layer total ordering, and use the total ordering consistency ratio CR to do the test. The formula is as follows:

$$CR = \frac{a_1 CI_1 + a_2 CI_2 + \dots + a_m CI_m}{a_1 RI_1 + a_2 RI_2 + \dots + a_m RI_m} \quad (1)$$

In general $CR < 0.1$ means pass and the decision can be made according to the results expressed by the total ranking weight vector. Otherwise, the model needs to be reconsidered or the pairwise comparison matrices that have larger consistency ratios need to be reconstructed.

The judgment matrix is constructed using the target layer T and criterion layer M of the hierarchy, and its mathematical expression is as follows:

$$A = (a_{ij})_{n \times n} \quad (2)$$

Where a_{ij} denotes the difference in importance of A_i over A_j . If we set the importance of $A_k (k \in I, I = \{1, 2, \dots, n\})$ to be w_k , we have:

$$a_{ij} = w_i - w_j, i, j \in I \quad (3)$$

The judgment matrix constructed in hierarchical analysis is called the objection judgment matrix. If $\forall i, j \in I$ exists, $a_{if} = -a_{ji}, a_{ii} = 0$ holds. The purpose of constructing the judgment matrix in the hierarchical analysis method is to mathematize the thinking process of decision-making, and then derive the weight vector of each evaluation object from it for the purpose of decision-making.

The method of calculating the single-level weights and maximum eigenvalues according to the square root approximation is as follows:

$$M_i = \prod_{j=1}^n u_{ij}, i = 1, 2, \dots, n \quad (4)$$

$$\bar{W}_i = \sqrt[n]{M_i} \quad (5)$$

Normalizing \bar{W}_i to W_i , W_i is the required eigenvector formula as follows:

$$W_i = \frac{\bar{W}_i}{\sum_{j=1}^n \bar{W}_j} \quad (6)$$

Since it is usually difficult to satisfy the consistency principle for the order construction of judgment matrices, test metrics were introduced in AHP to measure the consistency of judgment matrices, where:

$$CR = \frac{CI}{RI}, CI = \frac{\lambda_{\max} - n}{n - 1} \quad (7)$$

Where CI is the stochastic consistency index, a constant of statistical significance given that the inconsistent judgment matrix is acceptable when $CR < 0.1$. It can be seen that the smaller CR is, the better the consistency of the judgment matrix is, and when CR is equal to zero, the judgment matrix is perfectly consistent.

For each judgment matrix constructed from CR, the weight vector can be derived using the eigenvalue method:

$$w = (w_1, w_2, \dots, w_n)^T \quad (8)$$

When A is a consistency matrix, $a_{ij} = w_i/w_j, i, j = 1, 2, \dots, n$, therefore it is most efficient to measure the consistency of the judgment matrix by the deviation of a_{ij} from w_i/w_j .

This can be derived from the maximum deviation value and the definition of the mean square deviation:

$$s = \max_{i,j} \left| a_{ij} - \frac{w_i}{w_j} \right| \quad (9)$$

$$\sigma = \frac{\sqrt{\sum_{i=1}^n \sum_{j=1}^n \left(a_{ij} - \frac{w_i}{w_j} \right)^2}}{n} \quad (10)$$

In the formula, the maximum deviation is s , and the mean square deviation is σ , which can be concluded that the consistency is better when the values of the maximum deviation and the mean square deviation are smaller. Then, summarizing the above consistency test results, the feature vector is derived as the weight vector, and the design idea of AHP as a construct is realized to achieve the purpose of decision-making mechanism refinement.

2.4. DESIGN OF MANAGEMENT EVALUATION INDICATORS

The main points of establishing layered indicators are process, planning and systematic, in order to increase the turnover of the enterprise, improve the utilization of assets and control a reasonable financial structure at the guideline level set two key indicators, which are the profitability of assets, asset turnover [21]. Satisfaction of the company's departments, increasing the share of the enterprise's business in the market, and the increase in market share are the main indicators of performance assessment at the management level. So that enterprises always maintain a strong market competitiveness continue to improve the quality of talent, thick and thin to provide potential power for future development. The analysis of evaluation indexes of each aspect of full-cost refinement management is shown in Table 3.

Table 3. Analysis of evaluation indicators for full-cost refinement management

Objective	Elements of Establishment	Relevant stratified indicators
Increase in operating income to reduce costs	Increase business turnover	Asset profitability
Improve asset management efficiency	Improve the efficiency of the comprehensive use of funds	Asset turnover ratio
Departments are satisfied with the management module	Increase employee satisfaction	Departmental satisfaction
Getting more business	Increase market share	Market share
Get more vendor resources	Increase resource utilization	Amount of resource accumulation
Product quality that exceeds customer expectations	Improve the quality of engineering	Quality product productivity
Understanding customer needs	Create a good reputation for the enterprise	Order fulfillment rate
Improve production office efficiency	Improve labor efficiency	Residual value rate
Optimize production business processes	Dynamic continuous process optimization	Business process optimization
Enrich the cultural life of the enterprise	Enhance the quality of cultural life	Enterprise personnel cohesion
Enhance employees' sense of identification with the company	Improve employee satisfaction	Employee adhesion to the company
Enhance labor skills through training	Improvement of personnel quality	Employee labor rate

2.5. UPGRADING PROCESS OF ENTERPRISE ECONOMIC MANAGEMENT

In the implementation process of full-cost refinement, a dynamic escalation project management method is adopted, and the construction project is sequentially divided into project preparation, demand solicitation, workflow routes, system architecture design, implementation preparation, implementation support, and later maintenance and upgrading phases, so that the key steps are found and focused on in the implementation sequence. By adopting the project management method of dynamic upgrading, the specific work of basic data entry can be carried out in different operation processes at the same time, and the timeframe for the implementation of full-cost refinement management is shortened to a large extent. Workflow refers to the automated network environment, the enterprise employees in various positions in accordance with the schedule and production, need to enter program data on the full-cost refinement management platform. Using the method of job flow can be categorized and organized for all the jobs in the enterprise, all the work is first qualitative in quantitative, standardized delivery of information, written materials and management of work tasks. Job process design, for the new needs to design the process of economic management upgrading and transformation is shown in Figure 3.

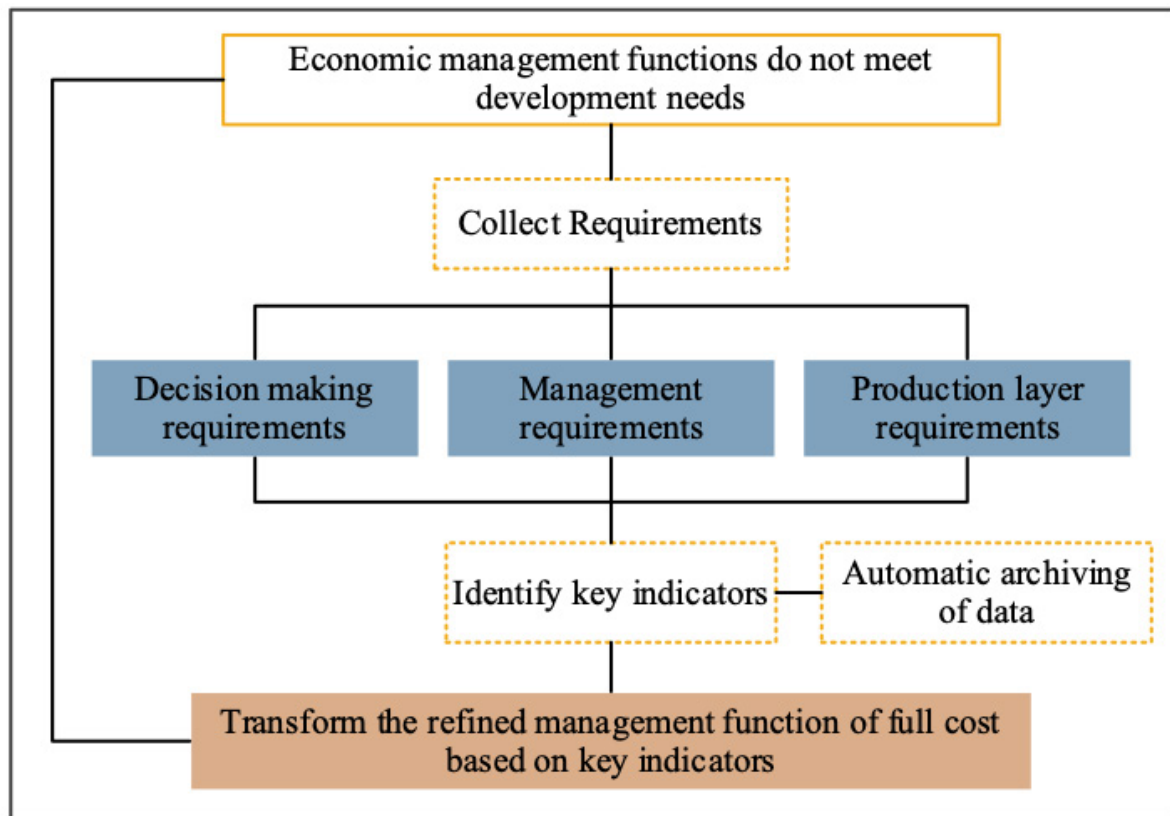


Figure 3. Full cost refinement management upgrade process

It collects demands from all levels of the enterprise, classifies, analyzes and decomposes all the work contents, separates the main work, rearranges and summarizes the demand indicators of operation management, so that the full-cost refinement management can adapt to the demands of all levels, and the process can be more easy to operate, so that it is easy to optimize and upgrade in the later stage of scale expansion. In line with the hierarchical management of the linear organizational structure of the enterprise, key indicators are selected after summarizing the indicators at each level through hierarchical weight calculation. Records of management lessons learned from each module are summarized and shared openly, and management work is optimized without interruption to meet the dynamic needs of enterprise economic management.

3. FULL-COST REFINEMENT MANAGEMENT SIMULATION EXPERIMENT ANALYSIS

3.1. VALIDATION OF THE CALCULATION OF HIERARCHICAL WEIGHTS FOR EVALUATION INDICATORS

In order to test the performance of full-cost refinement management, the total indicators of each layer of weight calculation, 10 directors randomly selected from the members of the board of directors of an enterprise, fill out a questionnaire, the results are shown in Table 4 below. The consistency ratio of the weights of the 2 design

indicators under the decision-making level management organization, calculated by the formula of this paper, is $CR=0.017<0.1$, which passes the test, indicating that the judgment matrix construction passes the consistency test and does not need to be adjusted. And the weight consistency ratio of the three design indicators under the executive level management organization is calculated as $CR=0.023<0.1$, which passes the test and also indicates that the judgment matrix construction passes the consistency test and does not need to be adjusted. While the weight set of the performance evaluation index system of the production department of the basic layer and the weight set of the performance evaluation index system of other learning and growth are calculated, the consistency ratio calculation results are $CR=0.031<0.1$ and $CR=0.013<0.1$ respectively, which indicates that it passes the consistency test and does not need to be adjusted. It shows that the results of the calculation of the stratified weight assessment of the full-cost refinement management provide an effective guarantee for the economic management of the enterprise, and it can find irrationality in the process of practice, and make adjustments to solve the problem in time.

Table 4. Indicators for the design of the tiered assessment system

Indicators	Not important	Slightly important	Important	Significantly important	Definitely important
Indicators for policymaking-level governing bodies	0	1	4	3	2
Indicators for executive management organizations	0	2	3	4	1
Indicators for the production department at the basic level	0	2	4	3	1
Other cultural management indicators	0	1	3	4	2

As can be seen from the table, all four indicators account for more than 90% of the votes for important and above, so all the indicators above important should be retained. Applying the pairwise comparison indicator scale of Table 4 to assign values to the importance, set unimportant as 1, slightly important as 3, important as 5, obviously important as 7, absolutely important as 9. If only important and above are counted, the weight of important is 0.24, obviously important is 0.33, and absolutely important is 0.43. The following calculates the weight value of each indicator as shown in Table 5.

Table 5. Weight Table of Hierarchical Evaluation Design Indicators

Index	Weight	Index	Index weight	
Weight value of indicators of leading institutions at decision-making level	265	Asset profitability	87	23
		Asset turnover ratio	83	22
Weight value of indicators of executive management institutions	236	Departmental satisfaction	420	99
		Market share	370	0.0873
		Amount of resource accumulation	340	782
Index Weight Value of Production Department in Basic Layer	225	Quality product productivity	280	63
		Order fulfillment rate	180	40
		Residual value rate	230	52
		Business process optimization	190	43
Weight values of other cultural management indicators	233	Enterprise personnel cohesion	170	39
		Employee adhesion to the company	190	44
		Employee labor rate	130	30

3.2. ANALYSIS OF THE BENEFITS OF ENTERPRISE ECONOMIC MANAGEMENT

This paper validates the economic management benefits of enterprises under the application of full-cost refinement management, and the experimental test object is a trade circulation enterprise that has achieved certain results, and investigates the operating profits of the enterprise. After the application of full-cost refinement management, the enterprise business volume has been stimulated by a certain promotion, income has been increased to a certain extent, Figure 4 shows the results of the enterprise business indicators during the six-year period.

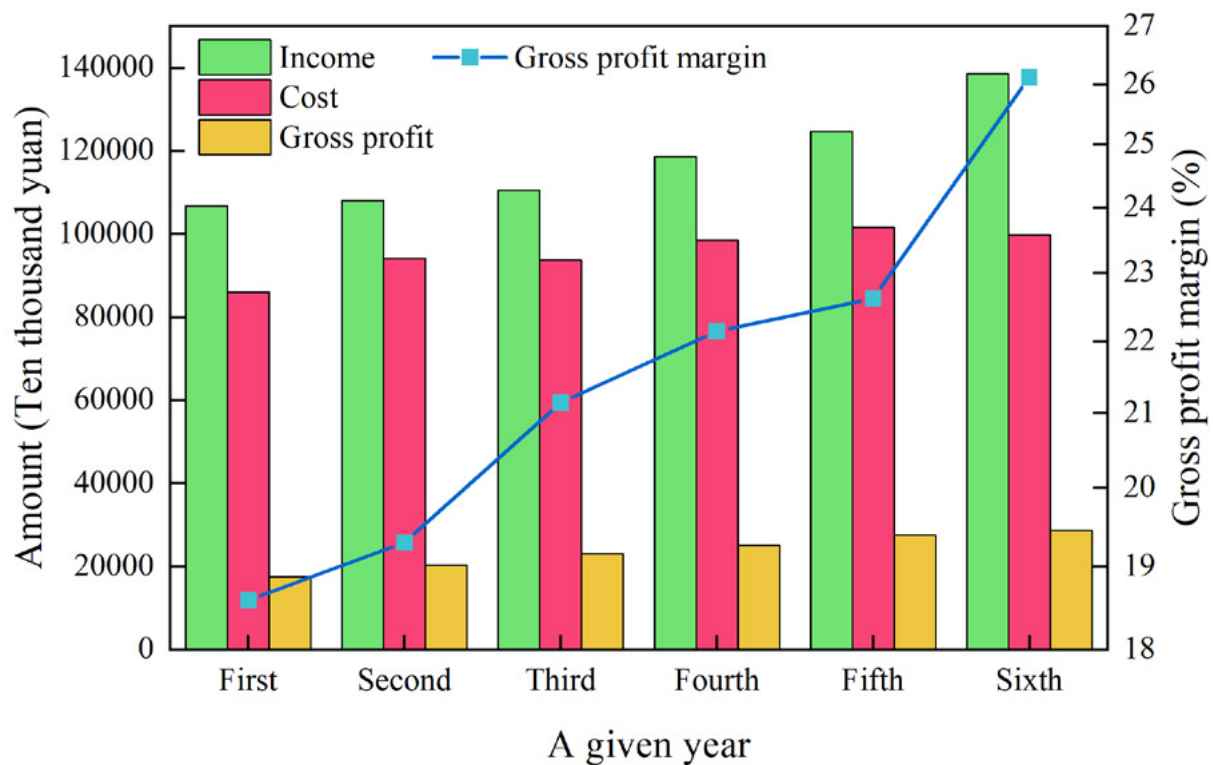


Figure 4. The results of business indicators in six years

As can be seen from the data in the figure, the enterprise operating efficiency increases year by year, the gross profit increases year by year, the enterprise economic efficiency continues to grow, compared to the first year, the 6th year than the gross profit increased by 7.49%, which indicates that for the enterprise profit growth, this paper is designed to help the enterprise economic management under the application of the full-cost refinement of the enterprise's economic management. And the operating income of the enterprise for 6 years, respectively, is 1067,668,100 Yuan, 1080,601,000 Yuan, 1104,603,000 Yuan, 118,524,100 Yuan, 124,642,750,000 Yuan, 138,507,400,000 Yuan, under the application of the full-cost refined management, the operating income in the 6th year has increased by 317,423,000 Yuan compared with the 1st year, which is an increase of 22.92%, with obvious economic benefits. The reason is that the full-cost refinement management based on the analysis of enterprise data hierarchy, the analysis of the relationship between the asset profitability, market share, production and operation efficiency, employee labor rate, in the process of enterprise development to give full play to the role of each other, which to a certain extent, to increase the operating income of the enterprise as well as the economic management of the favorable, and the development of the enterprise with the actual status quo.

4. CONCLUSION

This paper realizes the use of full-cost refinement management in enterprise economic management, through the structure of the control system, the management chain is more clear, visualization, so that the management implementation is more in

place, and the cost of the various pull-through management, to realize the real full-cost management information system. Secondly, the AHP method is used for the construction to achieve the purpose of decision-making mechanism refinement, and at the same time, demand collection is carried out for each level of the enterprise, and the economic management upgrading and transformation process is designed for the new demand, so as to make the full-cost refinement management adaptable to the needs of each level. The final simulation experiment results show that the weight consistency ratio CR of the decision-making level management organization is 0.017, the CR of the executive level management organization is 0.023, the CR of the production department of the basic level is 0.031, and the CR of the other learning and growth is 0.013, which are all less than 0.1, and have passed the consistency test. At the same time an enterprise economic management benefit analysis results show that in the use of full-cost refinement management, the enterprise economic benefits continue to grow, compared to the first year, the sixth year than the gross profit increased by 7.49%, which shows that for the enterprise profit growth, it can be shown that the full-cost refinement management of the enterprise's economic management to provide an effective guarantee, and the development of the actual status quo of the enterprise is in line with.

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/08/

INTELLIGENT APPLICATION OF DIGITAL SHARED MANAGEMENT SYSTEM IN JOURNAL RESOURCE INTEGRATION

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ABSTRACT

In this paper, a journal resource integration system under digital sharing was designed to assess the symmetry of the journal resource matrix using the shared resource matrix analysis method, so that the journal resources can transmit information covertly among the subjects. Subsequently, the collected journal resource data were processed to improve the accuracy of information categorization and integration to form a perfect resource management system. The nature of journal resources was deeply understood by calculating the characteristic observable vectors of journal resources. Finally, with the help of ant colony particle optimization algorithm, the sharing sequence and time of journal resources were calculated, and the metadata format of all journals was unified and standardized to complete the design of journal resource integration system. The results show that the whole average integration efficiency of journal resources is 92.8%. Compared with the traditional integration system, the integration efficiency is improved by 28.3%, which fully confirms the significant performance improvement of the designed digital system in the integration of shared journal resources.

KEYWORDS

Digital sharing; journal resource integration; shared resource matrix; ant colony particle; shared sequence

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1. INTRODUCTION

Journals are the most utilized and have the highest information value, with the characteristics of short publication cycle, novel content, large amount of information, and the ability to systematically reflect the latest scientific and technological developments, which makes them essential materials for teachers and students of colleges and universities to engage in teaching and scientific research activities [1-2]. The so-called integration of periodical resources refers to the orderly organization of periodical resources of different types and formats based on certain needs and requirements, and presenting them to readers in a unified way through intermediate technology. The periodical resource system through integration, with integrated search function, is a new type of periodical resource system with cross-platform, cross-database and cross-content [3-4]. With the construction of digital libraries, digital resources are becoming more and more abundant, especially journal resources [5]. There are many kinds of journal resources, large amount of data, and different forms, and different journal resources often have independent databases, retrieval systems, and distribution systems, which makes the journal resources relatively scattered and cluttered, and causes a lot of inconvenience for readers to retrieve and utilize them [6]. Therefore, intelligent integration of journal resources has become an important part of the construction of digital digital sharing management system, which will improve the effective utilization of journal resources by readers.

Ahmad, N identified three categories of critical success factors (CSFs), namely, program design and implementation, quality culture and excellence, and institutional infrastructure and support, for a total of 11 CSFs, through the observation of several programs of King Khalid University in the process of ABET accreditation. Using the fuzzy hierarchical analysis and the method of perfect agreement, the SFs and their dimensions in terms of continuous academic quality assurance, ABET accreditation were Relative importance was ranked comprehensively [7]. Rini, G. P et al. explored the intrinsic link between customer orientation in terms of unique resource integration, exchange memory system. Identify the key factors affecting customer service performance based on the theory of competitive advantage of firms. Using Indonesian hotel managers and administrators as research subjects, 327 valid questionnaires were distributed with a validity rate of 70.6%. It was found that firm-specific resource integration enhances customer service quality, with customer-oriented antecedents of customer orientation and interactive memory [8]. Eppard, J et al. tested the flipped learning approach in a class for one semester, triangulated by exam scores of the students, interviews with participants, and instructor's reflections. The results indicated that flipped learning had positive outcomes in terms of increasing student self-efficacy, promoting leaner independent learning, and providing resources for concept introduction and review [9]. Wunderlich, J et al. suggest that there is still a gap in how to select appropriate assemblies for different purposes and a need for guidance for practitioners. An architecture is proposed with three components to guide the integration effort, designing a four-stage integration evaluation methodology and classifying integration based on qualitative explorations into three categories, and finally proposing an incremental approach to selecting the appropriate aggregation

approach based on the needs of the evaluation [10]. Bae, J et al. proposed a reinforcement learning based network scheduling algorithm for single-hop downlink scenarios, whereby the network optimization problem is formalized as a Markov decision process problem by introducing a new state-action value function. And a reinforcement learning algorithm for upper confidence bound exploration is designed to ensure that the loss of performance is minimized [11]. In modern cities, transportation digitization plays a crucial role as an important means of connecting all kinds of transportation service providers and users. Jabbari, M et al. based on the existing pedestrian road network model. The digital modeling took urban residents as the main body and constructed a multi-level pedestrian system with the help of digital technology [12]. Rajabi, E et al. made e-learning content public on the Internet, which is conducive to achieving the sharing and reuse of teaching resources, and enhances the interoperability of data in the network. Utilizing the principle of Linked Data, educational metadata is made public as Linked Open Data and its content is interconnected with web datasets in order to improve the interoperability of web resources and thus achieve the sharing and reuse of educational resources [13]. Nijs, M et al. proposed that the online educational repository is a good global resource for science and technology and that the global virtual teaching and online lectures can provide the audience around the world with evidence-based evidence-based knowledge from which knowledge including distance learning can be gained. The library is an excellent resource tool for conducting resource sharing workshops for ART professionals and providing effective hands-on vocational education training for ART professionals through virtual training tools, thus reducing unnecessary duplication of efforts [14].

In this paper, first of all, through the shared resource matrix analysis method, the system carries out in-depth analysis of periodical resources, determines the symmetry of the matrix to the periodical resources, and realizes the hidden transmission of information between the subjects. A complete journal resource library is established, and a multi-level intelligent walking system is constructed through fine processing and classification and integration. The system further calculates the observable vectors of journal resource features to deeply understand the nature of journal resources. Through the determination of feature similarity, it provides the basis of intelligent decision-making for the subsequent resource integration. In the resource integration scheme of the shared management system, the system optimizes the adaptation values and solves the optimal values through intelligent algorithms to ensure that the diversity of resources and user needs are fully considered in the integration process. An intelligent journal resource integration process is designed to make the system more efficient and intelligent in the integration process. Finally, the design of the digital sharing system adopts an intelligent classification and search module, which enables users to obtain the required journal resources more conveniently and intelligently. The construction of the overall framework ensures that the structure of the system is reasonable and stable.

2. INTELLIGENT DESIGN OF JOURNAL RESOURCE INTEGRATION SYSTEM UNDER DIGITAL SHARING

2.1. SHARED RESOURCE MATRIX ANALYSIS

Shared Resource Matrix Analysis was first proposed by R. Kemmerer in 1982, the algorithm stores the trusted computing base of the system in the form of a matrix, where the original language has access rights to the trusted computing base variables [15-16]. Under the operation of the system, the storage is the read and write permissions that the system calls have on the shared resource variables. When using the shared resource matrix analysis method, it is first necessary to check all shared resources that can be accessed by the subjects, and then to determine whether they are able to pass information covertly between all subjects. In implementing this step, each of the original languages in the system needs to be carefully examined.

Given a matrix $A = [e_1, e_2, e_3, L, e_m]$ of size $1 \times m$, it needs to be satisfied if A is symmetric about journal resource e_i :

$$Less(A, e_i) - More(A, e_i) = 0 \quad (1)$$

In the formula, $Less(A, e_i)$ indicates the number of journal resources less than E in statistical array A , and $More(A, e_i)$ indicates the number of journal resources greater than E in statistical array A . Through the position of journal resources in the matrix, the symmetry of the matrix about the journal resources can be judged, if the matrix is symmetrical about the standard symmetry of the journal resources, formula (1) must be established, and the value of formula (1) also reflects the symmetry of the matrix about the journal resources.

Using matrix analysis to analyze the content of journal resources and resource search records, user interests can be fully explored so that resource recommendations can be given to users. The one-dimensional matrix is generalized to a high-dimensional space S of size $n \times m$, where n is the sample size and m is the dimension. Then the space can be described by a matrix Mar of size $n \times m$ as:

$$Mar = \begin{bmatrix} a_{11} & a_{12} & L & a_{1j} & L & a_{1m} \\ a_{21} & a_{22} & L & a_{2j} & L & a_{2m} \\ M & M & O & M & O & M \\ a_{n1} & a_{i2} & L & a_{ij} & L & a_{im} \\ M & M & O & M & O & M \\ a_{n1} & a_{n2} & L & a_{nj} & L & a_{nm} \end{bmatrix} \quad (2)$$

A point $x_i = [x_{i1}, x_{i2}, L, x_{im}]$ in a known space is symmetric about the projective position of x_i in every dimension if the space S is symmetric about x_i , i.e., the following condition is satisfied:

$$\begin{cases} Less(Mar_1, x_{i1}) - More(Mar_1, x_{i1}) = 0 \\ Less(Mar_2, x_{i2}) - More(Mar_2, x_{i2}) = 0 \\ Less(Mar_3, x_{i3}) - More(Mar_3, x_{i3}) = 0 \\ \vdots \\ Less(Mar_m, x_{im}) - More(Mar_m, x_{im}) = 0 \end{cases} \quad (3)$$

where Mar_m denotes the m rd column of matrix Mar , where denotes the j th dimension of x_i . In order to better represent the symmetry of space S about x_i , the concept of symmetry rate is designed as:

$$P_{xi} = \sum_{j=1}^m \frac{n - \left| Less(Mar_j, x_-) - More(Mar_j, x_{ij}) \right|}{n} \quad (4)$$

The symmetry ratio reflects the symmetry of the matrix with respect to the points; the higher the ratio, the more likely it is that the matrix is symmetric with respect to x_i .

2.2. ESTABLISHMENT OF A JOURNAL RESOURCE LIBRARY

In order to improve the accuracy of information classification and integration, the collected journal resource data are processed. Setting the resource training set as A , which contains n kinds of resources, through this setting, we can get the expected value of the classification result of the resource kinds, which can be expressed by the formula as follows:

$$Info(A) = - \sum_{i=1}^n p \lg p_i \quad (5)$$

Where $Info$ is the information in the journal resource, and p_i is the probability of data classification rationality. Connecting the repository and the terminal to form a complete resource management system to provide users and managers with more convenient and efficient journal resource services.

2.3. COMPUTING OBSERVABLE VECTORS FOR JOURNAL RESOURCE CHARACTERIZATION

First, the total number of characteristic variables of the initial sample is determined and denoted by n . Second, by orthogonally transforming the n characteristic variables $X = x_1, x_2, \dots, x_n$ of the initial sample to obtain u integrated variables (y_1, y_2, y_3) and constructing a coefficient matrix R , the resource integration characteristic equation is expressed as:

$$\lambda(i) = \frac{|R \otimes X|}{\{(y_1, y_2, y_3)\}} \otimes \frac{x_1, x_2, \dots, x_n}{u} \quad (6)$$

The non-negative eigenvalues of λ_i sample are sorted to meet the requirements of $\lambda_1 \geq \lambda_2 \geq \lambda_n \geq 0$. The top m resource integration features can be obtained through equation (6) with the following expression:

$$\Phi(p) = \frac{m \otimes \lambda(i)}{\xi(e)} \otimes \eta(r) \quad (7)$$

where $\eta(r)$ is the uncertainty of journal resource integration and $\xi(e)$ is the journal resource integration coefficient.

Using α to describe the first m journal resource features as the ratio of all first-order features is expressed as:

$$\alpha = \frac{m \otimes \beta(p)}{\mu(R)} \times v(e)(\sigma^* \otimes \kappa) \quad (8)$$

where $v(e)$ is the information of each type of feature and κ is the observed variable. The observable vector of resource features is calculated according to Eq. (8) and the expression is:

$$\partial(X) = \frac{X \otimes F}{\left(a_{ij}\right)_{n \times m}} \otimes c_i \otimes \varepsilon_i \times X_i \quad (9)$$

Where F is the unobservable vector, c_i is the factor loadings of journal resource integration features, and ε_i is the factor affecting c_i . By calculating the journal resource characteristic observable vector, it is possible to understand the journal resources more deeply.

2.4. FEATURE SIMILARITY DETERMINATION

In the process of journal resource integration, vectors are utilized to complete the representation of journal text information. The processed journal text information is

represented by vectors, firstly, the feature words in the journal text are extracted, assuming that the extracted feature word is m_1, m_2, \dots, m_x , then the journal text information of the metadata item can be represented as:

$$d_m = (m_1, q_1; m_2, q_2; \dots; m_x, q_x) \quad (10)$$

Where m_x is the feature term of the x nd text, and q_x is the weight occupied by this feature term.

It is calculated according to the similarity algorithm of cosine:

$$\cos_{dm}(x_1, x_2) = \frac{q_1 \times q'_1 + q_2 \times q'_2 + \dots + q_x \times q'_x}{\sqrt{\sum x q_x^2} \times \sqrt{\sum x q_x'^2}} \quad (11)$$

Where q'_x is the metadata item of journal resource information x_2 , and d_m is the weight occupied by the x th journal text information feature item.

According to the above calculation, the semantic similarity of journal resources can be derived as follows:

$$\cos(x_1, x_2) = q_{dm} \cos_{dm}(x_1, x_2) \quad (12)$$

Where q_{dm} denotes the weighted weights of the metadata items.

When the calculated similarity is 1, the resources represented by the two calculated sets of metadata are proved to be equivalent, and if the calculated similarity is between $\alpha \sim 1$, the two sets of journal resources are proved to be similar, where α denotes an empirical value and is usually considered to be $0.2 < \alpha < 1.0$.

3. SHARED MANAGEMENT SYSTEM RESOURCE CONSOLIDATION PROGRAMME

3.1. OPTIMIZING ADAPTATION VALUES

Using ant colony particle swarm optimization algorithm, according to the time given to the click frequency of journal resource categories and resource categories, respectively, click on the path of the 2 indicators of different weights, calculate the similarity of the user, as a way to improve the efficiency of pre-school periodical resource integration, to provide core support for the intelligent design of the journal resource integration system under the digital sharing [17-19].

Let there be n collection of journal resource tasks in the system, i.e., $T = \{T_1, T_2, \dots, T_n\}$, which needs to be implemented on the collection of resource nodes $G = \{G_1, G_2, \dots, G_m\}$, where the computational resource node is described by

$G_i = (i \in [1, m])$ and the standalone task is described by $T_i = (i \notin [1, n])$. A feasible sequence of journal resource assignments is described by particle positions, and if the journal resource tasks are realized on the resource nodes, the position of particle k is shown below:

$$X_k = \{x_1, x_2, L, x_j, L, x_n\} \quad (13)$$

where X_k denotes a feasible journal resource organization solution.

Set the time used by the journal resource task to achieve resource consolidation as $G_{ij} = (i \in \{1, 2, L, m\}, j \in \{1, 2, L, n\})$, the total elapsed time to perform the journal resource subtasks as G_i , and set G_{max} to be extremely small as the optimization objective. Then the adaptation value for one organizing is:

$$G_{max} = \max \{C_i\} \quad (14)$$

In the ant colony algorithm, the ant pheromone concentration is proportional to the selection probability. The click frequency of each resource category can be obtained by calculating the number of clicks on each resource category and the resources under the resource category visited by the user in each session, and quoting it with the total number of clicks on all the resources in this session. Then take the average value of the click frequency of the resource category in a certain period of time, construct the click frequency user matrix of the resource category, and find the similarity of the click frequency vector of the user's resource category by solving the similarity of the click frequency vector of the user's resource category in the frequency user matrix of the resource category. Initially each path has the same pheromone, in d moment i nodes, the ant is described by k , then the probability that the ant picks the next node is:

$$P_{ij}^k = \begin{cases} \frac{\frac{(T_{ij}(d))^\alpha}{Lq_{ij}(d)^\beta} \frac{1}{2} \frac{(EV_j^\alpha(d)^\gamma)}{Lq_{ij}(d)^\beta}}{\sum_{n \in e(k)} \frac{(T_{ij}(d))^\alpha}{Lq_{ij}(d)^\beta} \frac{1}{2} \frac{(EV_n^\alpha(d)^\gamma)}{Lq_{in}(d)^\beta}} \\ 0, \end{cases} \quad (15)$$

Where, γ denotes the relative weight of the predicted value of computational power, P_{ij}^k denotes the quality of the line of the ant k at the i node, $u(k) = \{0, 1, L, n-1\} - e(k)$ denotes the node of computational resources that the ant did not choose, α denotes the relative weight of pheromone, $e(k)$ denotes the forbidden table of the ant, β denotes the relative weight of the quality of the line, $T_{ij}(d)$ denotes the strength of pheromone of the ant to view the j node at the d th moment, from the i th node, and q_0 is a constant, and q is a random coefficient.

3.2. OPTIMAL VALUE SOLUTION

In order to solve the global optimal solution and ensure that the line quality or pheromone value of the node is extremely high, this paper controls the probability of the ants selecting a node by using random coefficients and constants assigning a forgetting factor to each access path to the journal resource category by the user in a certain period of time [20]. For nodes whose pheromone concentration is not 0, the solution is:

$$T_{ij}(t+1) = \rho \times T_{ij}(t) \quad (16)$$

At moment n , the ant realizes a 1-times loop with an update rule for the amount of information on each path:

$$T_{ij}(t+n) = \rho \left(T_{ij}(t) + 1 \right) + \frac{1}{2} \Delta T_{ij} \quad (17)$$

$$\Delta T_{ij} = \sum_{k=1}^m \Delta T_{ij}^k \quad (18)$$

Where, ρ denotes the persistence of the ant trajectory, ΔT_{ij} is the informative increment of link (i, j) , Q denotes the number of pheromones left by ant k on link (i, j) within this cycle, and L_k denotes the length of the link that ant k traverses for a week, the informative increment of link (i, j) is updated by Eq:

$$\Delta T_{ij} = \begin{cases} \frac{Q}{L_k}, \\ 0, \end{cases} \quad (19)$$

Set the number of iterations to 0, i.e. $N = 0, u(k) = \{1, 2, L, n\}$, set n virtual nodes have m ants, in order to solve the node, need to initially organize the sequence, through the taboo table of ants to remove the resource node labeling, a calculation of the resource node j , which can be achieved through the formula (18) to select. Within the resource organizing sequence, set the j position of the node, based on the taboo table of ants to remove j . The completion time of the resource organizing sequence, according to the formula (17) to solve the optimal solution, to get the completion of the optimal periodicals resource organizing sequence with time [21].

3.3. JOURNAL RESOURCE INTEGRATION PROCESS

The main idea of the integration of journal resources is to unify and standardize the operation of all journal metadata formats, and then add all these metadata to the established journal database. The metadata of all journal databases to be imported are described in a unified Extensible Markup Language (XML) format, so as to lay a good foundation for future data exchange and dumping. Then these journal resource metadata described in XML format will be imported into the journal database, the

specific implementation process is shown in Figure 1. In the XML format metadata mapping to relational databases, the use of structural mapping approach, that is, in the storage of relational databases, the first according to the schema or mining out the schema information inherent in the document to generate the corresponding relational schema, and then according to the generated relational schema of the XML document to analyze the decomposition and will be stored in the corresponding data table. Journal resource data may come from different databases, they all have their own different complex formats, due to the customizability and extensibility, solves the problem of a unified interface for data, enough to express various types of data.

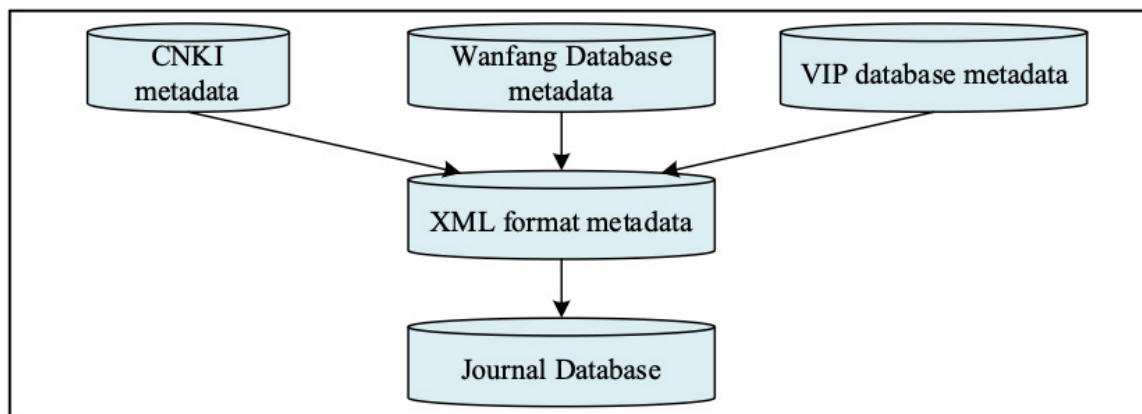


Figure 1. Journal resource integration realization process

4. DIGITAL SHARING SYSTEM DESIGN

4.1. GENERAL FRAMEWORK

The overall structure design of the system is to divide the system into logical structures on the basis of the demand analysis, to determine the distribution of functions among the levels and parts within the levels, and to determine the interrelationships among the levels and parts. The system can be divided into three layers, i.e., data layer, business processing layer and application layer. After the system is separated by layers, the change of functions can be realized by changing the related layers, and due to the relative independence of each layer, the change of a certain layer will not have an impact on other layers. The advantage of dividing the system into so many levels is that it can make the system architecture more clear, so that the function accomplished by each level is relatively single, and the code of the function is regular, which makes it possible to put more energy into the processing of business logic. The overall framework of the system is shown in Figure 2. The unified database retrieval module is an effective way to integrate journal resources, due to the rich content of journal resources with diverse carriers, for which a retrieval module should be set up to integrate the journal resource databases into one, so that the readers can conveniently retrieve the required documents across the databases through the unified retrieval interface. In the classification search module, it mainly provides users with three ways of searching by database, searching by journal and

searching by category [22]. These three ways also provide first letter navigation, and also provide a secondary search function, that is, on the basis of the first search results and then further search.

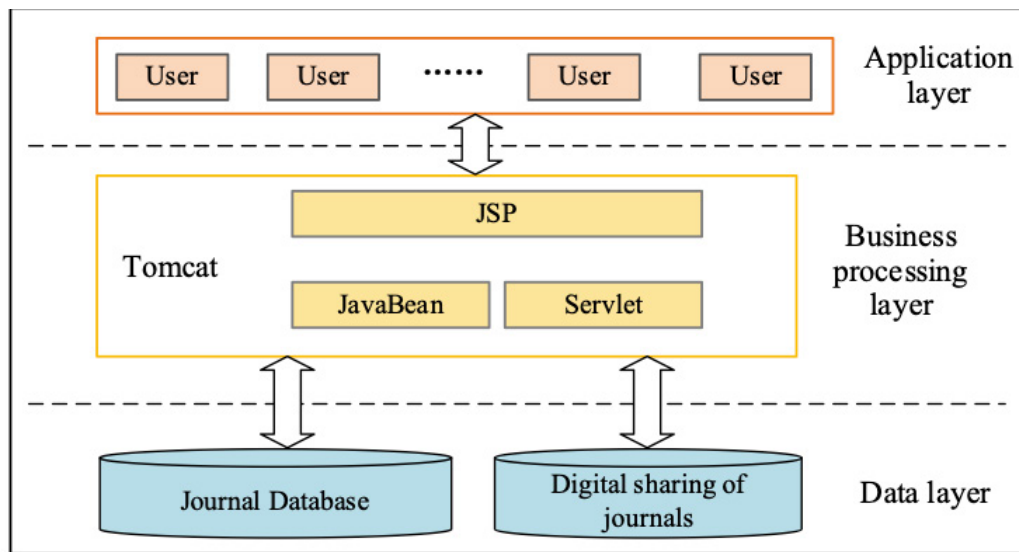


Figure 2. Overall system framework diagram

4.2. CATEGORIZED SEARCH MODULE

The whole structure of the classification search module is shown in Figure 3. The application of digital sharing management technology in the integration of journal resources mainly lies in realizing the rapid query and sharing of journal resources, and the reasonable management of resources is particularly important due to its huge data and information base. Digital sharing management technology is used to organize idle resources and solve communication and computing needs, thus saving a large number of duplicated investments and improving the utilization rate of resources.

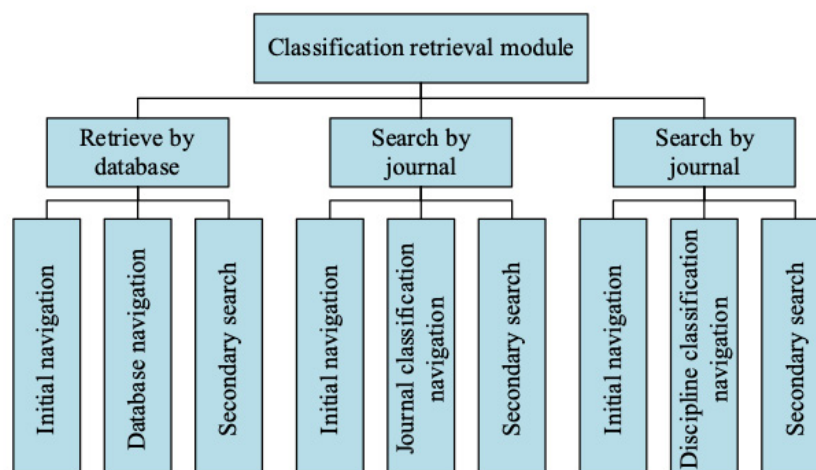


Figure 3. Structure of the classification search module

Functional architecture design as shown in Figure 4, the system is divided into digital resource submission function module, resource audit management function

module, resource use function module and system management function module 4 parts. However, due to the system startup, the database needs to be initialized and set up, after entering the user name and the correct password, the journal resource integration system can be started to ensure that the management of system files is safe This part needs to be set up using a computer program. After completing the above operations, the integration of journal resources is realized.

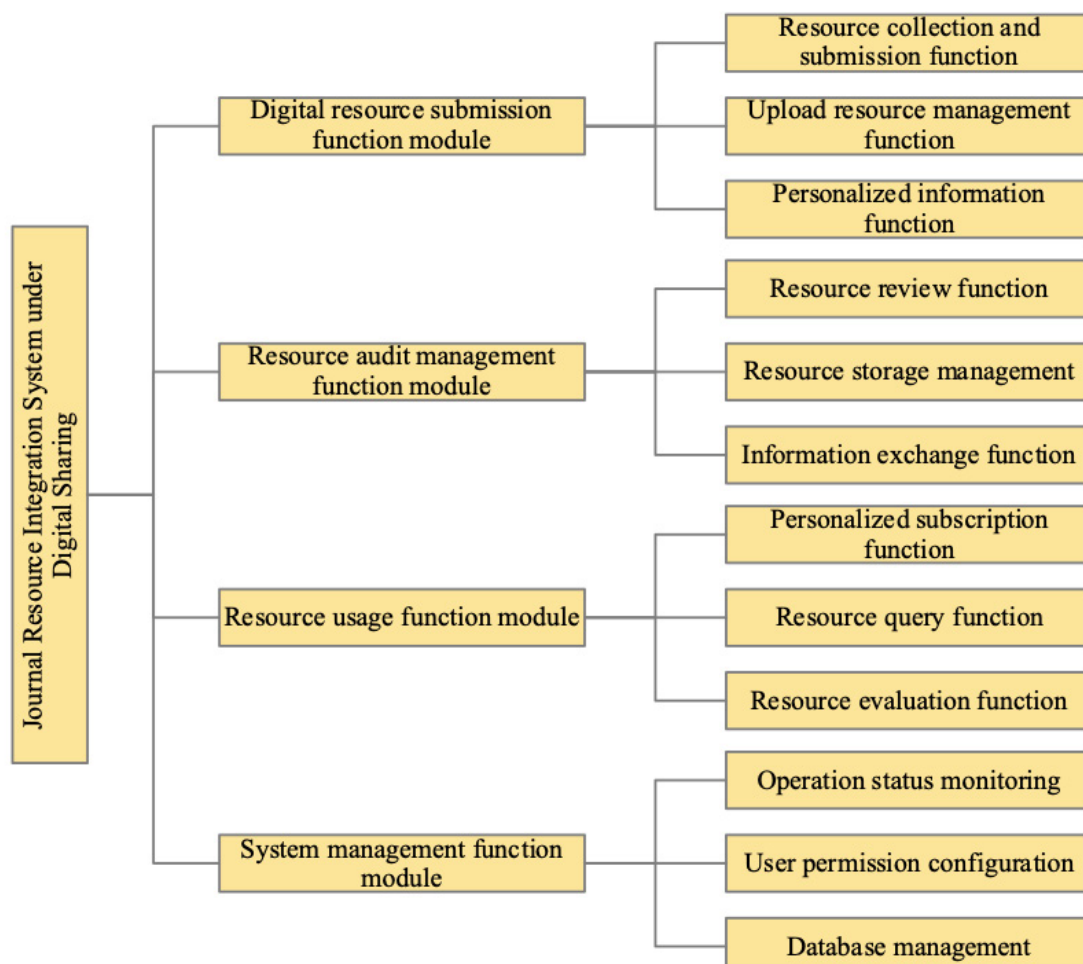


Figure 4. Functional architecture design

5. ANALYSIS OF THE EFFECT OF INTELLIGENT APPLICATION OF JOURNAL RESOURCE INTEGRATION

5.1. COMPARISON OF SUCCESS RATES

From a university library, 120,000 shared digital journal resources are randomly selected for integration, detecting the loss rate and misdetection rate of the resources after the integration of this paper's system with the traditional integration system and the Hadoop-based digital resource integration system for digital journal resources in this university library, and comparing the integration success rate of each system with the performance of the system. Table 1 shows the results of the loss rate and false

detection rate of the three systems, and with the increase of the number of resources, the performance of the system in this paper is still able to remain stable. For example, at 120,000 resources integration, the loss rate is only 0.31% and the misdetection rate is 0.10%, reflecting the excellent performance of the system in large-scale digital journal resources integration. In contrast, the traditional integration system shows a higher loss rate of 2.43% for the complete 120,000 shared digital journal resources, while the Hadoop-based digital resource integration system still lags behind this paper's system in terms of the integration success rate, with a loss rate of around 1.45%, although it incorporates Hadoop technology. It shows that the system in this paper improves 2.12% in terms of loss rate compared with the traditional integration system, and leads the Hadoop-based system in terms of integration success rate. The system in this paper performs well when the number of resources is less than 80,000, which further confirms its efficiency in small-scale resource integration scenarios. It is possible to confirm that the journal resource integration system designed in this paper under digital sharing shows more excellent performance in terms of integration success rate, loss rate and false detection rate, which validates the superiority of the system.

Table 1. Comparison of loss rate and false detection rate results of three systems

Number of resources / Article	This paper integrates the system		Traditional integration system		Hadoop-based integration system	
	Attrition rate /%	False Detection Rate /%	Attrition rate /%	False Detection Rate /%	Attrition rate /%	False Detection Rate /%
20000	0	0	0.38	0.31	0.27	0.21
40000	0	0	0.79	0.41	0.46	0.29
60000	0	0	1.21	0.56	0.78	0.37
80000	0.12	0	1.56	0.95	0.95	0.46
100000	0.20	0.09	1.89	1.47	1.23	0.53
120000	0.31	0.10	2.43	2.38	1.45	0.79

5.2. COMPARISON OF INTEGRATION EFFICIENCY

In order to further analyze the reliability of the integration system, it can be analyzed by comparing the integration efficiency of journal resources, the higher the integration efficiency of journal resources, the better the integration stability of its system, and the integration efficiency of the traditional integration system and the Hadoop-based digital resource integration system. Figure 5 shows the test results of integration efficiency, the average integration efficiency of traditional integration system is 64.5%, and the highest efficiency is only 66.8%. In contrast, the average integration efficiency of the Hadoop-based digital resource integration system is 78.6%, and the highest efficiency is 83.4%, showing an improvement of 14.1% after

integrating Hadoop technology. Despite the improvement in system performance, it still falls short of practical application and requires further improvement. In contrast, the journal resource integration system designed in this paper under digital sharing shows higher integration efficiency when the number of iterations gradually increases. The integration efficiency of journal resources is 91.8%, 92.9%, 92.2%, 93.3%, 93.8%, and the average integration efficiency is 92.8%. Compared with the traditional integration system, the system in this paper has improved 28.3% in terms of integration efficiency, which provides a strong support for the excellent performance of the system. It is clearly demonstrated that the designed system for integrating journal resources under digital sharing has significant advantages in terms of the reliability of the integration of shared journal resources.

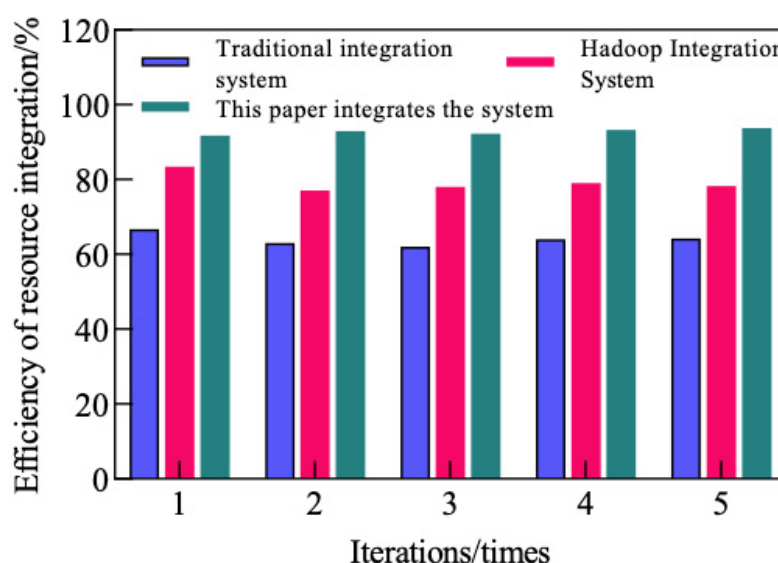


Figure 5. Comparative results of journal resource integration efficiency

5.3. INTEGRATION TIME COMPARISON

Finally, the system in this paper and the traditional integration system, Hadoop-based digital resource integration system for university library journal resource integration time, and record the results of the analysis and comparison, has been verified that the system integrates the efficient performance of the journal resources, the comparison is shown in Figure 6. In this paper, the digital sharing of journal resources integration system in the integration of digital journal resources in college libraries, the time used is the shortest, and with the growth of the number of resources, the overall rise in the time used is relatively slow, and there is no phenomenon of time-consuming due to the growth of the number of resources is too long. After the number of journal resources increased in turn, the integration system in this paper took 49ms, 55ms, 79ms, 82ms, 96ms, 120ms, the overall time is shorter, and in the case of the highest number of resources, the time is also in the 150ms below, stable performance. While the other two systems have faster growth in the time used when the number of resources is higher, the time used by the traditional integration system is 362ms, 401ms, 495ms, 517ms, 844ms, and 909ms, and the

time used by the Hadoop-based digital resource integration system is 300ms, 398ms, 469ms, 503ms, 790ms, and 811ms, respectively, and the time used by the Hadoop-based digital resource integration system is 300ms, 398ms, 469ms, 503ms, 790ms, and 811ms, respectively, and the performance is stable. Hadoop's digital resource integration system is not excellent although its effect is refined. It indicates that the performance of the other two systems is not stable, which further confirms the excellent performance of the system in this paper in the field of digital journal resource integration, and provides strong support for the efficient operation of the system.

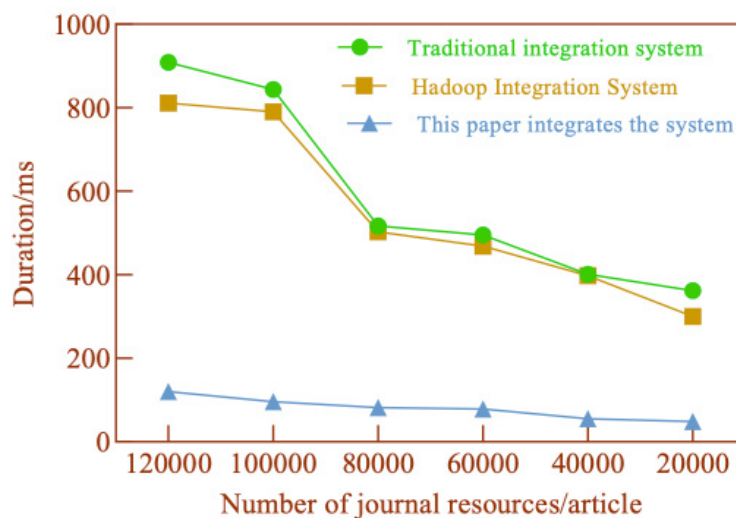


Figure 6. Comparison of time spent on integration of different systems

6. CONCLUSION

In this paper, we design the journal resource integration system under digital sharing, unify and standardize the operation of all journal metadata formats, and then add all these metadata into the established journal database to complete the design of the journal resource integration system under digital sharing. The performance of this paper's system is verified through the comparison of success rate, integration efficiency, and integration time, and the results show that the system performance of this paper's system remains stable with the increasing number of resources, and the loss rate is only 0.31% at 12,0000,. The average integration efficiency of this paper's system is 92.8%, which is 28.3% higher than the traditional integration system, and the overall time is shorter, which is below 150ms in the case of the highest number of resources. Therefore, it shows that this paper proposes a journal resource integration system under digital sharing, with high integration efficiency and stable performance, and the intelligent simulation application is of practical significance.

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/09/

OPERATIONAL AND ENVIRONMENTAL ASSESSMENT FOR NIGHT MARKETS UNDER THE INFORMAL ECONOMY IMPACTS: INSIGHTS FROM THE CASE STUDY OF SELANGOR, MALAYSIA

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ABSTRACT

As an expression of the informal economy, the night market is not only a place that could attract locals to buy goods but also a place where tourists can experience the local characteristics. While the night market brought economic vitality to the city's economy, it also brought some issues. A comprehensive literature review of night markets revealed that existing studies paid less attention to outdoor night markets' spatial operations and waste management. Grounded in the connection between sustainability and night markets, the present study reflected on existing research findings by adopting different periods of fieldwork to conduct a case study of the night market in Jalan 17/1A, Selangor, Malaysia. The study focused on three aspects of night markets: spatial operations, waste, and waste recycling. It found that night market operations brought localized regional economic benefits while causing more severe pollution issues, significantly affecting the region's environmental health and sustainable development. The findings revealed that local government regulation of night market businesses in Malaysia is weak (the issuance of business licenses is informed of the operational guidelines), and there is also no relevant monitoring and penalties by the local government to intervene in the misbehavior of night market consumers. Based on the results of the field survey and combined with the concept of sustainable development, the present study recommended suggestions for the future spatial operation and waste management of night markets. Innovative and novel perspectives of the study combined qualitative observations and data analysis to comprehensively examine how spatial considerations and waste management strategies intersect in the unique context of night markets—aiming to fill the gaps in the sustainability of night market operations and to protect the ecology of the surrounding territorial environment, contributing to the discourse on sustainable development.

KEYWORDS

Night Markets; Informal Economy; Case Assessment; Field Survey; Spatial Operation; Environmental Impact; Sustainability

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1. INTRODUCTION

The world was in an essential period of development and revolution, with development as a critical theme. How to drive economic, scientific, technological, social, and industrial innovation was a vital issue for the progress and development of human society. The United Nations proposed seventeen Sustainable Development Goals (SDGs) to promote the realization of socially, economically, and environmentally sustainable and inclusive development. Sustainable development integrates the organic unity of national and regional, overall and local, economic and social aspects, intending to ultimately realize win-win coordination, fairness and justice, efficient cooperation, and multidimensional development [1]. Among the three main elements of sustainable development, environmental sustainability was often tricky to intertwine harmoniously with economic and social sustainability [2]. Protecting environmental ecosystems while enhancing and improving the quality and standard of human life was one of the critical issues on which academics focused their discussions. As one of the essential components of the regional economy, the informal economy plays a crucial role in encouraging consumption, alleviating the pressure of unemployment, safeguarding people's livelihoods, and maintaining social stability [1]. While the informal economy permitted by the government gives some people employment opportunities in the towns and eases the employment of the unemployed, jobless, or poor, most people employed in the informal economy have fewer educational opportunities to learn about ecosystems and have a poor understanding of sustainable development management and waste recycling. Furthermore, the stereotype that night markets were run by the unemployed, the jobless, or the poor in China was gradually broken, and students and young people (many of them undergraduates or postgraduates) were actively joining the night markets because the night market which as a low-cost entrepreneurial way of starting up a business, greatly lays the practical groundwork for surviving periods of unemployment and disorientation, or for later entering the formal market [3]. Studies revealed that informal policies developed in modern urban development as a flexible strategy favored and benefited urban development [4]. As a manifestation of the informal economy, night markets were not only convenient places to attract locals to buy goods but were also places where tourists traveled to experience local characteristics, especially in Asian cities [5]. Traditional night markets were outdoor street markets that generally operated from evening to midnight, and their informal manifestation led to their operation usually being neglected by stakeholder management [5, 6, 7]. In addition, solid waste management is a serious issue not only for developed countries but also for developing countries due to the increasing population [8]. Night markets, as one of the dynamic economic expressions, were scattered like fireworks worldwide [9]. However, night markets operating outdoors were characterized by severe environmental impacts due to their direct contact with the environment [5], such as plastic packaging hazards [10], vendors' and visitors' views and behavior [11, 12], garbage pollution and hygiene problems [13], and environmental degradation [14].

According to news reports, Malaysia disposed of about 3,000 tons of preventable food waste daily [15]. As the largest contributor to solid waste and the largest source

of hazardous greenhouse gases in Malaysia, households produce enormous amounts of food waste, followed by other sources such as night markets and wet markets [15]. Evidence revealed that an average of about 38,000 tons of solid waste was sent to more than 100 landfills per day in Malaysia, with approximately 2,500 tons of solid waste collected daily from the capital city of Kuala Lumpur alone [16]. In particular, the widespread use of plastics in solid waste poses a huge disposal and environmental challenge [17]. The informality of night markets led to some neglect by stakeholders, which in turn led to issues of ecological pollution. Studies have found that concentrations of air pollutants such as carbon monoxide (CO), carbon dioxide (CO₂), particulate matter 10 (PM10), particulate matter 2.5 (PM2.5), formaldehyde (HCHO), and polycyclic aromatic hydrocarbons (PAHs) during the operating period of the night market were higher than during the non-operating period due to cooking activities, with barbecue activities cause the most severe air pollution [18]. In addition, the dumping of organic wastes into the environment might contribute to global warming, and policy actions were needed to target air pollution problems at different levels of management to create synergistic effects and reduce the impact of climate change [19, 20]. Existing studies involving the night market area included solid waste recycling from garbage bins [21], wastewater pollution generated [5], hazards of exhaust gases generated [18, 22, 23], sources of electricity for operations [6], tableware materials [24], dangers of plastic packaging for hot food [25], perceptions of using plastic packaging [26], willingness of merchants to have environmentally friendly packaging [10], and biodegradation potential of recycled wastes [27]. Sustainable development is one of the critical environmental challenges to be addressed by all parties, including governments, consumers, and producers, who need to take responsibility for the environment [28]. Establishing a sustainable pattern facilitated changes in consumer behavior, government policies, and business practices [29].

A comprehensive literature review of night markets found that there was less academic research on night markets in general, and the existing research was skewed in the direction of environmental science and monitoring, which focuses on monitoring certain types of substances involved in night markets. The results indicated that fewer existing studies consider the direction of town planning and night market governance. Some scholars' research perspectives focused on solid waste and garbage bins in night markets and lacked considerations incorporating spatial operations. Sustainable management of night markets was beneficial in helping to address several waste challenges and develop targeted and innovative solutions for organizations and society [30]. In addition, proactive management facilitated cost reductions, provided long-term value, and played a role in reducing environmental waste and improving social outcomes [31, 32]. The concept of night market operations had gained social acceptance and had been recognized by local governments as an informal form of economy, as a temporary open market operating in a public space with physical characteristics similar to those of other markets, such as issues of accessibility, transportation, infrastructure, parking, safety and security, hygiene, and cleanliness [33, 34]. Traditional tolerance of the informal economy in some Asian countries has its purpose, partly due to the local authorities' desire to gain political

support from more street vendors through a more relaxed political administration [4]. However, there were fewer academic concerns in the direction of spatial operations and waste management in outdoor night markets, probably because the operating attributes of the informal economy have led some scholars to ignore the marginal economy. Some scholars observed that night market facilities have improved significantly due to the proactive approach of the local authorities in dealing with traffic flow and parking issues, the implementation of regulations against bad behavior and excessive noise, and the rigorous cleaning of the night market premises [33, 34]. Therefore, this paper initiated an empirical study on the spatial operation and waste management of night markets in Malaysia by conducting a field survey and obtaining primary data on the actual situation of night markets at different operation times in 2023. The study focused on night markets' spatial operation and waste management aspects and recommended sustainable optimization of future night market development. The study results had research value in grasping the operational logic and mechanism of specific night market spaces in Malaysia, and the proposed optimized management measures were essential for the future sustainable development of the city and society.

2. METHODOLOGY

2.1. DESCRIPTION OF THE STUDY AREA

Malaysia is located in Southeast Asia, and its capital is Wilayah Persekutuan Kuala Lumpur (W.P. Kuala Lumpur). The country is composed of thirteen states and three federal territories. The national territory consists of the southern part of the Malay Peninsula (West Malaysia) and the northern part of the island of Kalimantan (East Malaysia) (Figure 1). As a developing country, Malaysia has achieved extensive economic progress. The resulting economic development influenced the rapid growth of population, industry, and towns. The increase in population was accompanied by an increase in the amount of merchandise consumed and waste disposed of in each region.

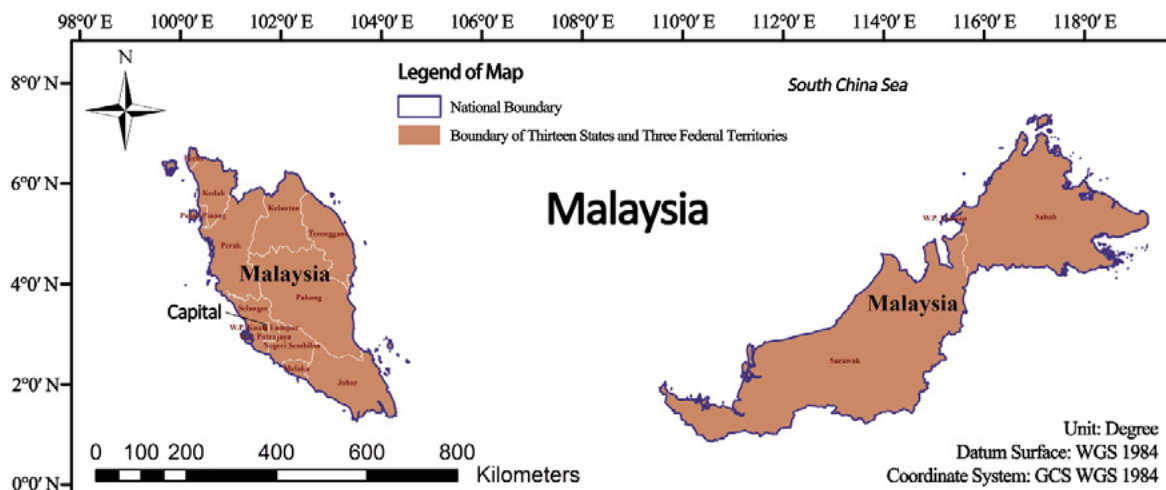


Figure 1. Geo-location and scope of Malaysia

Note: National geographical administrative data for Malaysia were obtained from publicly available data in the Humanitarian Data Exchange (HDE) (<https://data.humdata.org/>).

Night markets in Malaysia are defined as temporary weekly events that usually take place in available open spaces, temporarily closed roads or parking lots, the use of which had significant implications for the local authorities since it had to plan and control the area, especially the timing and movement of traders in and out of the area [33, 34]. There are many famous night markets in Selangor and W.P. Kuala Lumpur of Malaysia, such as Pasar Malam SS2, Pasar Malam Sri Petaling, Pasar Malam Taman Connaught, Plaza Mont Kiara Fiesta Nite Market, Pasar Malam Seksyen 3 Kota Damansara, Pasar Malam Setia Alam, Pasar Malam Taman Megah, etc [35]. These night markets were usually located in the capital city of Malaysia and other core areas, famous tourist attractions, and tourist check-in spots. As Malaysia's more famous night markets, these night markets were usually reported by the news media and recommended by mainstream travel apps. Some of them have gradually matured and improved access control, operational measures, and management systems in the feedback and evaluation of many consumers. Therefore, to maximize the generality of the study and the typicality of the results, a less well-known night market area, one located in Jalan 17/1A, was chosen to reflect the general situation of the night market in Malaysia (Figure 2). It was located in the eastern part of Petaling County within Selangor State, near the southwestern part of W.P. Kuala Lumpur (Figure 3).



Figure 2. Actual view of the night market in Jalan 17/1A (Photographed on December 5, 2023, at 5:30 and 8:30 pm)



Figure 3. Location of the night market in the study area (Coordinate of Google Maps: 3.11915N, 101.63700E)

Note: Study area surroundings information from Open Street Map (OSM) (<https://www.openstreetmap.org/>).

2.2. DATA COLLECTION

The night market's surroundings were informed by the Open Street Map (OSM) and the functional attributes of its neighboring buildings through Google Maps. The geological information provided data about roads, buildings, and other characteristics. The authenticity of its data sources could be verified, and its accuracy updated by other users and contributors through remotely sensed imagery, GPS devices, and field measurements. The night market's basic information and operational data were derived from precise on-site field exploration and measurement, and the actual data was recorded, counted, and analyzed in depth through modern electronic equipment (cell phones, cameras, and tablets). These technical tools ensured access to trustworthy, accurate, and comprehensive primary data, providing a reliable basis for the in-depth understanding of the night market's basic information and operational mechanisms. The methodology based on integrating technologies and the field

provided more depth and reasonableness to the study and gave strong data support for the night market research.

2.3. DESIGN OF THE STUDY

After selecting the night market in Jalan 17/1A of Petaling, Selangor, Malaysia, the present study investigated the background situation related to the night market by exploring the scope information, location information, and the surrounding environment and collected the background information through the secondary open data platforms, such as Open Street Maps (OSM) and Google Maps. To further understand the night market's spatial operation and waste management, the present study used fieldwork to collect primary data on the spatial operation, waste issues, and waste recycling aspects. Specifically, knowing that the night market operated from Tuesday afternoon to midnight, the present study adopted a time-phased fieldwork method to analyze the environment of the night market and its surrounding area, which mainly included three time periods during the operation of the night market (5:30-8:30 pm on December 5, 2023), after the night market (9:30-11:30 pm on December 5, 2023) and the next day after the night market (1:30-3:30 pm and 9:30-11:30 pm on December 6, 2023).

The field survey was conducted using a four-step process: visual recording, photographic recording, statistical surveys, and inductive analysis. The specific design of the research process was implemented in three steps. The first step of the fieldwork was conducted through visual records and filming records to collect basic information about the night market and the spatial management, waste information, and waste recycling under consideration. The second step was to analyze and summarize the issues and impacts of the night market in three periods through survey statistics: during the night market operation, after the night market operation, and the next day after the night market operation. The third step aimed to investigate the night market operation issues and propose sustainable optimization strategies for future night market operations.

3. RESULTS AND FINDINGS

3.1. BACKGROUND OF THE NIGHT MARKET IN JALAN 17/1A

3.1.1. SURROUNDINGS OF THE NIGHT MARKET IN JALAN 17/1A

Selangor is one of the thirteen states under Malaysia, located in the central west coast region of West Malaysia. The night market was on Jalan 17/1A, Petaling Jaya, Petaling County, Selangor. The surrounding environment included residential areas, shopping malls, universities, hospitals, and other building infrastructure (Figure 4). The night market in Jalan 17/1A was located in the northern part of Jaya One, and the

night market in the area was open every Tuesday afternoon until midnight. The south region of the night market was a park (Section 17 Flats Park) for people to relax and enjoy. For residents in the neighborhood, the temporary night market greatly facilitated their daily needs, with some of the night market's items offering very cost-effective prices.

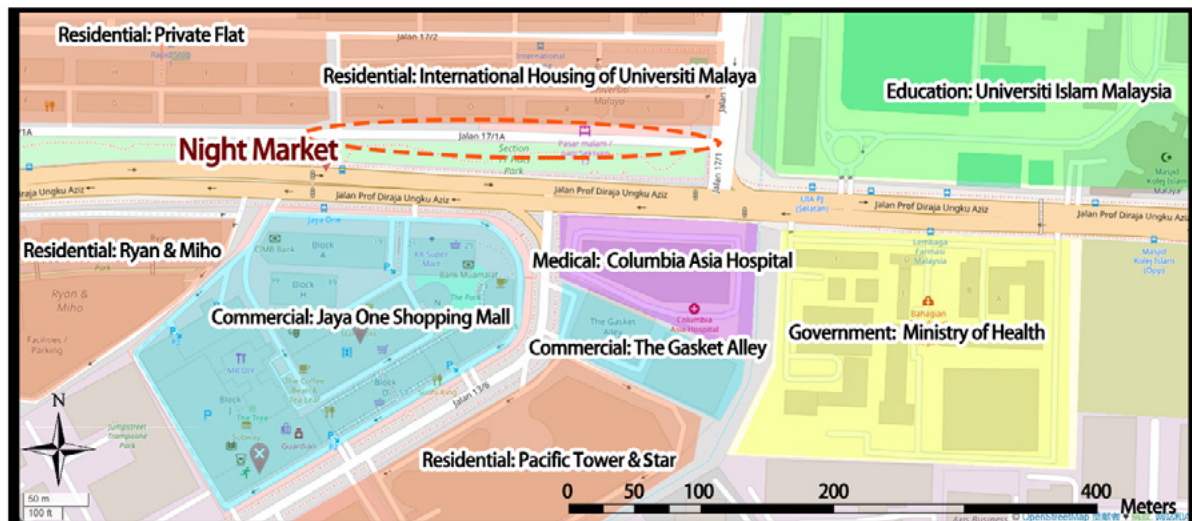


Figure 4. Information on the surroundings of the night markets

Note: Surroundings information from Open Street Map (OSM) (<https://www.openstreetmap.org/>).

3.1.2. COMPOSITION OF BUSINESSES AT NIGHT MARKETS IN JALAN 17/1A

Malaysia's night markets were based on the concept of open-air shopping, with street vendors or small traders occupying designated areas of the street to set up stalls, and could be seen as small incubators for aspiring entrepreneurs, as they required very little investment to set up a business and had little risk of failure while having the opportunity to earn a good income [33, 34]. All of the businesses at the night market site were mobile and temporary, with operations primarily relying on minor traffic space normally used for vehicle traffic, which would leave and vacate the traffic space at the end of the night market. The visual analysis of fieldwork was used to analyze the composition of the night market businesses, and it was found that the businesses were mainly Malays and included a few Chinese. Regarding scholars' various categorization standards for outdoor goods, this study combined the observations from the field survey to re-divide the varieties of goods operated by multiple types of businesses in the night market and the categories of goods operated by businesses in the night market involved such as fast food, apparel, fruit, vegetable, fresh meat, beverage, and other daily items, totaling seven types [36, 37]. Based on the survey statistics and analysis of night market businesses on Tuesday, December 5, 2023, it was found that the number of night market businesses totaled 129, where the dominant categories of the night market were fast food and apparel (Table 1).

Table 1. Composition information of the night market businesses in Jalan 17/1A

Note: Night Market business information was based on fieldwork conducted on Tuesday, December 5, 2023, from 6-8 pm under sunny weather.

Type of Businesses	Items	Number of Businesses (n)
Fast food	Pancakes, economy rice, hot dogs, fried chicken, burgers, skewers, grilled lamb, purple rice pancakes, spicy hot pot, grilled chicken thighs, grilled corn, etc.	36
Apparel	Dresses, short sleeves, pants, socks, shoes, underwear, bags, earrings, etc.	29
Fruit	Strawberry, mangosteen, rambutan, orange, longan, watermelon, banana, tangerine, grape, papaya, longan, coconut, mango, pineapple, durian, etc.	17
Vegetable	Peppers, bitter melon, tomatoes, potatoes, cucumbers, cauliflower, carrots, okra, loofah, ginger, cabbage, broccoli, etc.	15
Other Daily Items	Cell phone film, headphones, cell phone cases, combs, perfume, locks, key copies, bed sheets, toys, etc.	13
Fresh Meat	Chicken, lamb, eggs, shrimp, fish, beef, etc.	10
Beverage	Pressed coconut juice, pomegranate juice, coconut smoothies, sugar cane juice, blended juices, canned beverages, 100Plus beverages, etc.	9
Total	/	129

Further analysis of night market businesses revealed that the type of fast food had the highest number, with 36 of the night market businesses accounting for 28% of the total. The type of apparel had the second highest number of businesses, with 29 of the night market businesses accounting for 22% of the total, and these two items accounted for nearly half of all businesses in the night market (Figure 5). Fresh meat and beverages were less numerous, with 10 and 9 businesses representing 8% and 7% of the total night market businesses, respectively.

■ Fast Food ■ Apparel ■ Fruit ■ Vegetable ■ Other Daily Items ■ Fresh Meat ■ Beverage

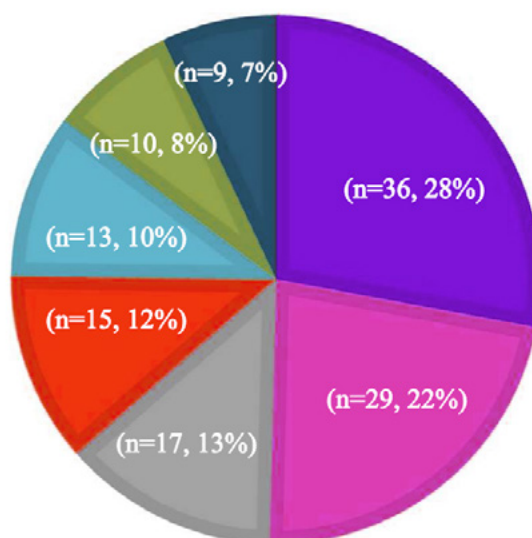


Figure 5. Percentage of each business type for the night market in Jalan 17/1A

3.1.3. COMPOSITION OF CONSUMERS AT NIGHT MARKETS IN JALAN 17/1A

Malaysia is a multi-ethnic country with three major ethnic groups: Malays, Chinese, and Indians. Visual, listening, and communicative observations of the demographic information of the night market consumers were conducted through fieldwork in the night market to infer their ethnicity through their looks, skin color, demeanor, mannerisms, and the way of speaking and the language of conversation when buying. The night market consumers were Malays, Chinese, Indians, and foreigners (mainly international students from China). Visual and listening observations through multiple trips to and from the entrance on one side of the night market and the exit on the other revealed that the night market's main consumers were Malays. By analyzing the environment around the night market, it was revealed that there were Malaysian universities and international student housing (including Universiti Islam Malaysia and Universiti Malaya) in the vicinity. Therefore, the night market was patronized by Malaysian locals and international students from various countries (mainly from China).

3.2. OPERATION ISSUES AND IMPACTS OF THE NIGHT MARKET IN JALAN 17/1A

3.2.1. DURING THE OPERATION OF THE NIGHT MARKET IN JALAN 17/1A (FROM 5:30-8:30 PM)

During the night market operation, the present study organized the actual situation through visual recording, photographic recording, statistical surveys, and inductive

analysis, focusing on three aspects of the night market operation: spatial, waste, and waste recycling. The specific conditions were summarized as follows (Table 2).

Table 2. Issues and impacts during the operation of night markets in Jalan 17/1A

Analytical perspectives	Classification in different dimensions		Issues and impacts
Spatial aspects	Businesses Consumers Surroundings	/	<div><div>1.</div><div>Night markets were less flexible due to their cramped and crowded nature, where businesses had to enter early, and were too dense in some areas and too sparse in others.</div><div>2.</div><div>Narrow routes for people to move around and the high volume of consumers at the night market's peak triggered congestion and overcrowding problems.</div><div>3.</div><div>The lack of warning signs on the closed sections of the night market led to traffic congestion caused by some vehicles driving to the vicinity of the night market and finding that the intersection was closed.</div></div>

Waste aspects	Solid waste	<ol style="list-style-type: none"> 1. Fast Food: packaging bags, lunch boxes, bamboo sticks, chicken bones, paper bags, sheep bones, plastic bags, corn picks, eating corn on the cob, packing box straps, beef bones, plastic spoons, chopsticks, etc. 2. Apparel: plastic bags, packaging bags, packaging boxes, cartons, wrapping paper, waste newspapers, etc. 3. Fruit: durian peel, rotten mangosteen, rotten orange, pomegranate peel, orange peel, coconut shell, longan core, longan peel, grape peel, rambutan peel, watermelon peel, fruit packaging, etc. 4. Vegetables: rotten vegetable leaves, fallen leaves, vegetable peels, packaging, etc. 5. Other daily items: masks, cigarette butts, cigarette boxes, mobile phone cases, packaging boxes, napkins, packaging bags, packaging boxes, paper labels, invoices, labels, tags, etc. 6. Fresh meat: shrimp shells, fish scales, fish bones, beef bones, chicken bones, egg shells, etc. 7. Beverage: plastic cups, bags, straws, coconut shells, unfinished drinks, cans, etc. 	<ol style="list-style-type: none"> 1. Solid waste mainly came from the two processes of selling products by businesses and using products by consumers. The solid waste during the night market operation mainly came from fast food, beverages, and other daily items. Food waste is one of the more serious ones. 2. Due to the difficulty in collecting waste liquid and the mobility of waste liquid, some businesses dumped a large amount of waste liquid into the nearest gutter. In contrast, a small amount of waste liquid was spilled on the ground. In addition, some consumers threw away unfinished drinks. 3. Many businesses used high-powered gasoline generators and gas canisters, and fewer used environmentally friendly machines. In addition, the barbecue and frying operated by some businesses resulted in a large amount of smoke and pungent odors in the air.
	Waste liquid	<ol style="list-style-type: none"> 1. Water after cleaning pots, water for cleaning aquatic products, blood water from fresh meat, oil for frying, poured juice, scattered sauces, spilled drinks, egg liquid, 	

	Harmful gas	1. Pollutant gases produced by barbecues, polluted gases produced by generators burning gasoline, polluted gases produced by frying in iron pots, etc.	
Waste recovery aspects	Businesses Consumers	1. Not cleaned up and sprayed on the side of the road. 2. Cleared and left on the side of the road. 3. Cleaned up and taken away/put in trash.	1. There were no dedicated garbage bins for the night market, and the number of garbage bins in the surrounding area was grossly insufficient (one red and eight blue garbage bins exist) to recycle the large amount of waste generated during the night market operation. 2. Existing garbage bins were too small, poorly categorized, and poorly located, making it inconvenient for businesses and consumers to recycle their waste. 3. Differences in the quality of people's behavior during the night market operation, both among businesses and consumers, led to positive or negative actions towards waste recycling.

To explore the issues of spatial operation in the night market, the present study was based on three perspectives: businesses in the space, consumers in the space, and people surrounding the space. It was found that in terms of the businesses in the space, the businesses were less flexible due to the narrow and crowded nature of the night market after they had entered the night market early, resulting in the emergence of high and low-crowd-density zones in the night market space (Figure 6a). In terms of consumers in the space, the high number of consumers in the area during the peak period of the night market led to the problems of congestion and narrow congestion (Figure 6b). Regarding the surrounding crowds in the space, the lack of warning signs for the closed sections of the night market caused some vehicles to drive to the entrance to find that they could not enter, which caused traffic jams (Figure 6c).



Figure 6. People flow and traffic during the operation of the night markets

To explore the waste management issues in the night market operation, the present study divided the waste for the night market into three main categories: solid waste, waste liquid, and harmful gas. Solid waste was mainly generated from businesses' two processes of selling items in the night market and using the items by consumers. Based on the seven categories of products in the night market, it was found that solid waste was mainly generated from fast food, beverages, and other daily items (Figure 7a). Due to the difficulty of collecting the waste liquid and its mobility, some businesses directly discharged a large amount of waste liquid into the nearest gutter. In contrast, a small amount of wastewater was directly spilled on the ground (Figure 7b). Some consumers threw away unfinished drinks (Figure 7b). In addition, high-powered gasoline generators and gas canisters were everywhere in the night market, and barbecue and frying operated by some businesses resulted in pungent odors and lots of smoke in the air (Figure 7c).



Figure 7. Potential environmental hazards during the operation of night markets

The study investigated and analyzed the recycling of waste from the night market and found that there were no particular garbage bins for the night market in the area and that there were one red and eight blue garbage bins (located in the park to the south of the night market) within a 20 meter of the night market. The number of garbage bins in the immediate area was grossly insufficient to recycle the large amount of waste generated during the operation of the night market (Figure 8a). Existing garbage bins lacked waste segregation, were too small, and positioned too far away from people, making it inconvenient for businesses and consumers to recycle waste (Figure 8b). In addition, there was a big difference in the behavioral qualities of different people among consumers and businesses, leading to positive and negative practices towards waste recycling (Figure 8c).



Figure 8. Waste recycling during the operation of night markets

3.2.2. AFTER THE OPERATION OF THE NIGHT MARKET IN JALAN 17/1A (FROM 9:30-11:30 PM)

At the end of the night market operation, the spatial environmental conditions after the area was used that night were investigated and analyzed from two perspectives: the site where the night market operated and the surrounding area where the night market operated. Different businesses were found to have different behaviors towards the waste in the night market area where they were operating, with some businesses scattering the waste directly on the roadside without cleaning it up after the night market (Figure 9a); some businesses bagging the waste and then setting it aside on the roadside (Figure 9b); as well as some businesses bagging the waste and taking it away. In addition, the waste surrounding the area where the night market operates

was not attended to, and garbage was still everywhere compared to when the night market was in operation (Figure 9c).



Figure 9. Spatial environment after the operation of night markets

Following the end of the night market operation at approximately 11 pm, the area of the night market operation was cleaned up by the solid waste removal department's garbage trucks (truck information: KDEB WASTE, #Smart Selangor), with the project involving solid waste on the roadway surface (Figure 10a). However, a small amount of solid waste that was small and difficult to clean remained after the cleanup (Figure 10b). In addition, the waste removal trucks only targeted solid waste on the roadway surface of the night market. The solid waste in the surrounding areas of the night market was a priority area that they neglected, including the park lawn south of the night market, the drainage ditch near the night market, the flower basins near the night market, the pavilions near the night market; and outdoor fitness equipment near

the night market (Figure 10c). The field survey revealed that a large amount of solid waste around the night market was generated by people using the waste after purchasing at the night market, including various categories of solid and liquid waste.



Figure 10. Night markets and surroundings after being cleaned up by the solid waste department

3.2.3. AFTER THE OPERATION OF THE NIGHT MARKET IN JALAN 17/1A (THE NEXT DAY FROM 1:30-3:30 PM & 9:30-11:30 PM)

Malaysia is near the equator and has a tropical rainforest climate with high temperatures and yearly rainfall. In the early morning of December 6, 2023, the liquid and solid waste in the night market operation area was affected by gravity due to the

heavy rainfall weather. The rainwater washed them away to the low-lying areas in the pavement area of the night market, such as the drainage ditch near the night market (Figure 11a). A field investigation on December 6, 2023, at 1:30 pm found that the drainage ditch became a solid and liquid waste-infested area after the night market operation (Figure 11b), with a pungent odor of rotting garbage and infested with flying insects in the air (Figure 11c), and the area was in terrible environmental condition. Additionally, as of 11:30 pm on December 6, 2023, garbage bins surrounding the night market had not been professionally picked up (Figure 11d), and solid waste was still everywhere (Figure 11d). Therefore, the surrounding environmental conditions resulting from the night market operation were terrible, and sustainable management measures needed to be devised to guarantee the night market operation and promote the surrounding area's positive development.



Figure 11. Environmental conditions on the day after the night market operation

4. DISCUSSIONS

4.1. OPTIMIZATION STRATEGIES OF THE NIGHT MARKET IN JALAN 17/1A

4.1.1. EFFECTIVE WASTE MANAGEMENT, SEGREGATION, AND RECYCLING

In response to the issues of waste management and recycling in night markets, it is recommended that the relevant departments and organizations (such as the National Solid Waste Management Department, Solid Waste and Public Cleansing Management Corporation, and Non-governmental Organizations for Waste Environment Protection) take proactive measures to protect the environment. The provision of specialized garbage bins can be increased for informal night markets or prepared by the business owners themselves, and more garbage bins need to be planned for the surrounding areas of the night markets to increase the overall waste holding capacity. In particular, large-sized garbage bins should be provided to meet the demand for bulky waste capacity. The newly deployed garbage bins are equipped with clear segregation signs to encourage night market participants to put out their waste in an orderly manner, facilitating effective waste segregation and recycling. Optimizing the spatial location of garbage bins to match the behavior of participants and adjusting the layout of garbage bins according to people's usage behavior could help improve the effectiveness of drop-offs and increase recycling efficiency. In addition, garbage bins in the surrounding area of the night market should be recycled more frequently, especially after the night market, and the garbage bins should be cleaned out promptly to ensure that the waste management system can be operated efficiently and realize sustainable development.

4.1.2. PROMOTION OF ENVIRONMENTAL AWARENESS AND USE OF SUSTAINABLE RESOURCES

In response to the issues of weak environmental awareness and the use of high-powered polluting machines in night markets, it is suggested that the relevant departments and organizations (such as Solid Waste and Public Cleansing Management Corporation and Non-governmental Organizations for Waste Environment Protection) should take proactive measures to protect the environment. Businesses could be encouraged to be more environmentally conscious and to pack the waste generated in their area after the night market. It is recommended that businesses that generate a lot of waste, such as fast food, beverage, and fruit, have garbage bins and provide consumers with adequate and convenient disposal services. The use of biodegradable plastics, eco-friendly cartons, and other materials in the packaging of items offered by businesses is strongly advocated to minimize the adverse impact on the surrounding environment. Regarding the source of electricity

required for operations, businesses are encouraged to use environmentally friendly practices, such as LED or green batteries, to replace traditional generator lighting, with the aim of meeting lighting needs while reducing the burden on the environment. In addition, it could promote green, environmentally friendly, and sustainable concepts to businesses and encourage the adoption of low-energy consumption and environmentally friendly machines, avoiding the use of high-power and highly polluting equipment. In addition, if technological conditions permit, renewable energy, such as solar energy, could be advocated for a more environmentally friendly night market operation. Through environmental awareness campaigns on the hazards of pollution, businesses and consumers could be sensitized to the sustainable use of energy, which would further lead to a wider consensus on environmental protection and promote substantial progress in sustainability.

4.1.3. RATIONAL SPATIAL PLANNING AND SECURITY MANAGEMENT

In response to the spatial planning and safety management issues arising from the operation of night markets, it is recommended that the relevant departments and organizations (such as the Ministry of Housing and local authorities) take proactive measures to protect the environment. Security or safety guards could be assigned to the night market during operation to ensure safety and reasonable crowd control. It is suggested that the main vehicle entrances and exits within 30 meters of the closed sections for the night market should be marked with eye-catching signs, vehicles be encouraged to choose other roads to pass, and pedestrian-vehicle segregation be implemented to improve the safety of the night market. Where technological and economic conditions permit, intelligent monitoring systems could be introduced to monitor the operation of night markets in real-time to ensure the effective implementation of spatial planning measures and further enhance the safety and regulatory level. On the other hand, the night market planning and evacuation proposal emphasizes planning interventions, rational planning, and evacuation design for dense areas to ensure effective use of night market and space safety. Consideration of adjustments to the layout of business stalls and evacuation adjustments could reduce overcrowding and improve the flow of people in night market operations, which would help minimize potential hazards. Providing holistic spatial planning and safety management aims to create a more pleasant environment for the night market and a new vitality for sustainable development.

4.1.4. MONITORING OF WASTE MANAGEMENT EFFICACY

In optimizing night markets' sustainability and waste management, monitoring waste management efficacy is a critical part of the process. Waste management efficiency is an issue that needs to be focused on, which is an essential factor contributing to the environmental problems observed in this study in night markets. Businesses in Malaysian night markets have operational guidelines from the local

government at the time of their business license issuance. However, the observations suggest that the macro rules guidance is ineffective. The local authority approving business licenses and collecting part of the taxpayers' fees also requires the local authority to contribute more effort to the night market control and governance. Although the macro-operational guidance for night markets exists, weak regulation and lack of detail in some sub-programs lead to almost ineffective governance implementation. In addition, it is not desirable to increase the governance pressure on businesses alone, and more importantly, the misbehavior of night market consumers is nearly not intervened by the local authorities. Therefore, when it comes to the efficiency of waste governance, government regulators need to take responsibility for improving the efficiency of personnel governance for various stakeholders (including government personnel, contractors (who exist in some night markets), merchants, consumers, etc.), and to strengthen the monitoring mechanism among various stakeholders. Encourage the government or local authorities to provide incentives and subsidies for good environmental practices rather than just asking people to initiate change, as most people, including businesses or consumers operating in night markets, might be less understanding of sustainable ecology and less awareness of the need to protect the environment on one's own.

4.1.5. DEVELOPING REGULATIONS AND STRENGTHENING SUPERVISION

In optimizing night markets' sustainability and waste management, formulating regulations and strong supervision is a critical part of the process. It is recommended that the local authorities of Solid Waste Management and Public Cleansing Management set out more detailed regulations and standards for informal and temporary night markets and clarify who is responsible for the waste disposal. Night market traders could be encouraged to set up night market management committees, with the business owners taking turns acting as regulators. Conduct feasibility analysis and implement specific policies to meet the waste disposal needs of night markets, both in terms of allocating particular garbage bins for night markets and increasing the number of garbage bins in the surrounding area. Strengthen law enforcement to monitor waste around the night market, with special attention to critical regions of waste concentration, and regularly clean solid waste from the drains to ensure proper functioning of the drainage system. Poor solid waste management might lead to inefficiency or malfunctioning of the drainage system, which could lead to problems such as flash flooding, while uncleared solid waste covering greenery might also affect the efficiency of rainwater infiltration during heavy rainstorms and regional waterlogging. Modifying and adjusting the existing recycling frequency and encouraging the increase of recycling frequency of garbage bins in the area around the night market could help to reduce the accumulation of waste and pollution issues effectively. On the other hand, scientific assessment could lead to the development of feasible mechanisms for waste management to effectively promote better environmental responsibility among night market participants by rewarding businesses that clean up their waste in an orderly manner and penalizing those that fail to dispose

of their waste. In addition, businesses that emit large amounts of pollutant gases could be restricted and encouraged to replace their equipment with environmentally friendly ones to safeguard the environmental quality and operation towards the sustainable development of the night market.

4.2. NIGHT MARKETS AND WASTE MANAGEMENT PRACTICES AND EXPERIENCE FROM MALAYSIA

The study of spatial operations and waste management generated in the Jalan 17/1A night market in Selangor, Malaysia, reflected the negligence of the Malaysian government towards spontaneous night market spaces formed in the context of the informal economy within a specific region and the challenges of waste management practices in Malaysian night markets. Since 2005, Malaysia's National Strategic Plan (NSP) had a vision for Malaysia to achieve the waste management target of recycling 22% of waste by 2020; however, it was reported that nearly 90% of waste is disposed of in landfills and only 10.5% is recycled [38]. In terms of regulation and enforcement, the two main agencies in Malaysia responsible for the implementation of solid waste management policies and enforcement of regulations are the National Solid Waste Management Department (abbreviated as JPSPN in Malay) and Solid Waste and Public Cleansing Management Corporation (SWCorp), which are under Ministry of Housing and local authorities (abbreviated as KPKT in Malay), and operates and implemented following the Solid Waste and Public Cleansing Management Act 2007 (Act 672) [39]. Evidence revealed that an average of about 38,000 tons of solid waste was sent to more than 100 landfills per day in Malaysia, with approximately 2,500 tons of solid waste collected daily from the capital city of Kuala Lumpur alone, which could be piled up to the height of the Twin Towers in just one week [16]. Therefore, the huge amount of solid waste disposal overloaded the traditional landfill way of disposal in Malaysia (it takes about 20 years to rehabilitate a landfill after it is filled and closed), and the government was trying to build waste-to-energy (WTE) plants and Integrated Recycling Facility (which had an anaerobic digester facility to produce biogas, electricity, and bio-fertilizer) to cope with the shortage of landfills [16].

The night market is indeed a popular activity place for locals in Malaysia; however, night market usually generates a large amount of waste, especially the use of single-use plastics, and some of the zero-waste promoters respond to environmental protection by bringing their utensils and containers to consume at SS2 night market, a behavior that might be rewarded with a certain amount of discounts [40]. The government authorities and waste operations departments have been actively pursuing options for sustainable waste treatment and management by attempting to introduce circular economy and waste recycling practices from developed countries into Malaysia's waste management, but the results have been ineffective in terms of public initiative in sorting, difficulty in sorting wastes, public awareness in recycling, difficulty in recycling, reuse of wastes and energy conversion [16, 39]. Relevant waste management had been actively collaborating with stakeholders, including the community, business sector, and government agencies, to publicize the huge potential

of waste management; nevertheless, after many recycling campaigns conducted by the government over the past decades, most Malaysians still failed to realize the high commodity value of the garbage generated by them, such as causing Malaysia to lose RM476 million worth of recyclable resources annually simply because recycling practices have yet to become the norm in the country [16].

Regulatory controls on waste segregation in Malaysia included fines for people, but people could take advantage of the lack of regulation to avoid the fines, which proved inefficient and even ineffective due to the regulation because there were not enough supervisors [41]. In addition, illegal corruption, management corruption, and insufficient funds were the major reasons that affected the speed of the sustainable waste management process in Malaysia; the local authorities in charge of solid waste management usually outsourced the collection and disposal of solid waste to private companies for operation due to the limited capacity of the governmental personnel in the department, but the municipal solid waste companies that contracted with the local authorities often illegally collected commercial and industrial wastes and other solid wastes to increase the load and difficulty of their operation to obtain more financial expenses, and even imported illegal plastics from other countries overseas for recycling [39]. Therefore, there are several challenges in the exposure of waste management in Malaysia, including the lack of system development for sustainable waste and circular economy, the challenges of waste collection strategy, waste recycling strategy, and waste disposal strategy, and also the lack of people's awareness of waste recycling and environmental protection, which contributed significantly to the problems with the operation and waste management of the night market space in this study.

5. CONCLUSIONS

As one of the dynamic economic manifestations, night markets opened like fireworks in all corners of the world. However, the informality of night markets led to some neglect by stakeholders, which further led to the issues of ecological and environmental pollution. The spatial operation and waste management direction of outdoor night markets had received less attention from academics. In this paper, a field survey on the spatial operation and waste management of night markets in Malaysia was conducted, and the night market in Jalan 17/1A was selected as the case study area to conduct the study at different periods. The result of analyzing the basic information of the night market in Jalan 17/1A showed that many residential areas around the night market brought many consumers, and Malays mainly dominated the businesses. The businesses at the night market specialized in seven types of items: fast food, apparel, fruits, vegetables, fresh meat, beverages, and other daily items. The most numerous of these merchant-operated programs were mostly fast food and apparel. A field study was conducted on the operation of the night market during three critical periods: during the night market operation (5:30-8:30 pm), after the night market operation (9:30-11:30 pm), and the next day after the night market operation (1:30-3:30 pm and 9:30-11:30 pm). The study results found that

night market operations, as a type of urban informal economy, brought economic vitality and economic benefits to the region while simultaneously creating some social and environmental issues. Social issues included overcrowding, traffic congestion, behavioral quality differences, safety hazards, noise from high-power equipment, clogged drains, lack of garbage bins, ill-designed garbage bins, and low frequency of recycling in the waste system. Environmental issues included the three main types of solid waste: fast food, beverages, and other daily items; liquid waste from indiscriminate disposal; high-powered equipment; and smoke gas pollution from cooking.

Based on the night market information analysis results and the time-phased field survey, it is recommended that the relevant departments and organizations take active measures to protect the environment by focusing on the issues arising from spatial operation and waste management. Concentrate on the problems and challenges exposed by night markets, the future sustainable optimization of night markets could emphasize five aspects: effective waste management, segregation, and recycling; promotion of environmental awareness and use of sustainable resources; rational spatial planning and security management; monitoring of waste management efficacy; and developing regulations and strengthening supervision. Recommend targeted and sustainable strategies for the spatial operation and waste management of the night market, aiming to promote the positive development of the surrounding area, creating a more pleasant environment and a newly energized night market. In addition, some policies, practices, and challenges in night markets and waste management in Malaysia were discussed. The study contributed to the broader understanding of sustainable urban practices, with potential implications for urban planning and waste management policies.

This paper conducted a case study on the night market in Selangor, Malaysia, which could focus on the actual situation of the Malaysian night market to a certain extent. However, the results of the fieldwork were only focused on a specific period. Therefore, the present study's findings reflected some of the characteristics and problems of the Malaysian night market but with some limitations. The present study hoped that spatial operation and waste management of night markets would receive more attention from government departments, environmental organizations, and other stakeholders. Hope other researchers explore the sustainable development of night markets in more different regions or by using a more extended period of fieldwork in the future.

6. DATA AVAILABILITY

All the data for this study is available upon request to the author.

7. CONFLICT OF INTEREST

The authors declare that the research has no financial or personal relationships with other people or organizations that can interfere with it.

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