Research on Community Grid Management Mode Based on System Database Processing

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Abstract In the process of urbanization, living and working areas are increasing, and the population is also increasing, which makes community management more difficult and reduces the life quality of residents. In order to improve the quality of community management, this paper briefly introduced the concept of community grid management mode based on the system database and conducted a case study on Taocheng District, Hengshui City, Hebei Province. The local community grid management mode used in the area was introduced; moreover, the effectiveness of the community grid management mode was evaluated using the framework of the analytic hierarchy process. The results showed that with the full implementation and improvement of the community grid management mode, the efficiency, effectiveness, and benefits of the community management significantly improved.

Keywords Database · Community · Grid · Analytic hierarchy process

Introduction

Rapid economic development drives urbanization, and the increase in urbanization enhances the attractiveness of talent, which further drives economic development [1]. Improvement of urbanization level not only enhances the economy but also leads to an increase in the resident population due to the attraction of talents. For a city, an increase in the resident population can bring more revenue, but it also increases the difficulty and cost of management; once the management level is reduced, the living standard of city residents will be seriously affected [2]. A lower standard of living will make the city less attractive to talents, which will inhibit economic development and result in a vicious circle. At the same time, as the urban population increases, communities emerge. In the face of the increasing urban population and increasingly complex community structure, traditional community management methods can no longer meet the needs of community management, and the emergence of Internet information technology has led to the emergence of community grid management mode [3]. Wang et al. [4] provided a community service architecture based on WebGIS technology through grid management and crowdsourcing services, applied it to Huangdao District, Qingdao, and won the title of “2015 National Social Governance Innovation Typical Case.” Lee [5] designed a smart home management system. The community intermediary role in the system integrated community services, thus reducing the workload of community managers, providing electronic information services, and deepening the integration of the community with the surrounding environment. In response to the epidemic of coronavirus disease 2019, a grid-based management of the community is needed to implement precise control measures. Ling et al. [6] considered that grid management mode could promote the refinement and comprehensiveness of community management and help strengthen the prevention and control of community epidemics. This paper briefly introduced the relevant concepts of the system database-based community grid management mode and performed an example analysis of Taocheng District, Hengshui City, Hebei Province. Besides introducing the local community...
grid management mode, this paper also evaluated the effectiveness of the mode with the framework of the analytic hierarchy process.

Community Grid Management

Relevant Concepts

The traditional community management mode is dominated by government agencies, which take the lead and implement a top-down management approach [7]. When community management is implemented, instructions are given by the top government authorities and then decentralized to the grassroots level; in the above process, the middle management level is only responsible for the transmission of information [8]. Also, due to this top-down management mode, the grassroots report their feedback to the higher authorities at different levels under regular circumstances, and people may even run around in different departments because the feedback involves different departments. The rigidity of the government-led management mechanism also leads to the difficulty of correcting decisions made at the top that are far from the grassroots and deviate from reality. In addition, the missing of the communication mechanism between different departments makes cooperation between departments more difficult, which ultimately makes the community inefficient.

The development of modern information technology has promoted the reform of community management mode. Under the guidance of “putting people first,” the community (including urban, rural, street, etc.) is divided into plural grid areas according to the set division standards, modern information technology is applied to digitally manage the grid area, and the grid data are integrated and managed in the digital platform [9]. In simple terms, a large community is “reduced to pieces” and allocated with managers for management. Since the community grid is smaller than the whole community, the grid managers can easily grasp the information of the residents in the grid, so that the decision can reach the grassroots level.

In community grid management, government agencies delegate management authority to the managers of community grids, i.e., they mainly play a guiding role in community management, so that organizations closer to the grassroots, such as enterprises, institutions, and residents’ autonomous organizations, can jointly participate in community management. A network information platform is used to connect management units between different grids to realize the integration, communication, and sharing of information resources, avoiding lack of cooperation induced by information disruption in management units of different grids, and the management processes specified in the platform are used to improve the efficiency of collaboration [10].

System Database-Based Community Grid Management

Figure 1 shows the time sequence of grid information processing when using the system database-based community grid management mode to manage the community. When using this management mode for community management, it is necessary to first divide the community into grids according to the population size, community road planning, setting of enterprises and institutions, etc. Every grid is used as the responsible unit and work carrier and is allocated with an appropriate number of administrators. The specific division criteria and the number of personnel assigned will be adjusted according to the specific community conditions. In Fig. 1, the community has been divided into grids and assigned the corresponding grid administrators by default [11].

When administrators use the network information platform for grid management, the interaction of grid information involves the grid administrator, the network information management interface, and the system database, respectively. Grid administrators have different permissions on the network information platform according to their responsibilities, including permissions to add, modify and delete information. The network information management interface is the application layer of the network information platform, mainly used for direct information interaction with users, through which administrators send information to the system database in the platform, and the system database feeds information to users through this interface. The system database is the core of the web information platform, and its main role is to store the community grid information uploaded by the grid administrator and provide the function of information integration and analysis [12].

The types of items that need to be managed in the community grid management mode vary according to the actual situation of the local community, and the relatively basic items are residents’ information, residential information, community enterprise information, etc. The flow chart in Fig. 1 is the general process of community grid management. The difference in the time sequence flow of different management items mainly lies in the information interaction channel selected by the management interface of the platform. In general, the operations of grid administrators when using the network information platform for management mainly include adding, modifying, and deleting grid information.

The first flow is adding community grid information. The grid administrator first logs into the platform using his permission verification. The grid information management interface of the platform selects the required management item information input port for grid information input, and the administrator confirms whether the input information is correct. The system database of the platform queries
the input information and verifies whether the information input operation is feasible. If it is not feasible (e.g., duplicate information, missing necessary information, etc.), the information entry failure is fed back to the management interface, and if it is feasible, the successful information entry is fed back to the management interface after storage by the system database.

The second flow is modifying community grid information. The grid administrator logs into the platform using permission verification. The administrator selects the modification function of the management item on the grid information management interface and input the modified grid information. The management interface gives feedback to the grid administrator to confirm whether the modified information is accurate. If the modified information was wrong, the modified information would be adjusted, and if the modified information was correct, the input of the modified information would be confirmed on the management interface. The management interface updates the system database with the input modified information and gives feedback to the management interface that the information has been successfully modified.

The last flow is deleting community grid information. The grid administrator logs into the platform using his permission verification. The administrator selects the deletion function of the management item on the grid information management interface. He queries the grid information in the system database through the management interface and selects the grid information to be deleted from it. The management interface confirms with the grid administrator whether to delete the selected grid information. After the administrator confirms, the system database is updated to delete the selected grid information and feeds back to the administrator that the information has been successfully deleted.

Fig. 1 The flow chart of community grid information management based on the system database
Example Analysis

Overview of Taocheng District

Taocheng District, Hengshui City, Hebei Province, is in the southeastern part of Henan Province. The area was established in July 1996 with a total area of 591 km² and a continental monsoon climate [13]. According to the seventh census, the resident population of Taocheng District is 608,580,000 as of November 1, 2020. The local gross regional product reaches 23.5 billion yuan in 2020, with an average annual growth rate of 6.2% compared to 2016. Taocheng District rules four street offices (Hexi Street, Hedong Street, Lubei Street, and Zhonghua Street Street), three towns (Zhaojiaquan Town, Zhengjiaheyan Town, and Dengzhuang Town), and three villages (Hejiazhuang Village, Panshecun Village, and Damasen Village). Taocheng District set up 66 community neighborhood committees and 342 village committees.

Community Grid Management Mode in Taocheng District

In the process of development, many new problems and contradictions have been revealed in the Taocheng District because the management level cannot match the speed of urban development, which has restricted the local economic development and reduced the life quality of local residents. Therefore, a new community management mode is adopted to replace the original rough management mode to strengthen the local urban community management level. The implementation of the community grid management mode in Taocheng District has three phases, including a preparatory phase, a full implementation phase, and a comprehensive improvement phase.

2015–2016 was the preparation phase for implementing community grid management in Taocheng District, in which the main focus was on grid division and establishment of a grid organization structure for Taocheng District. Firstly, the grid was divided. Based on the field survey of local streets, villages, and towns, an average of 110 households was taken as a large grid, and then, small grids were further divided according to the distribution of infrastructure, enterprises, and institutions. Finally, 750 large grids and 2521 small grids were divided in the Taocheng District, forming a district-street-community-grid working system. In addition, a grid management platform for information integration, exchange, and analysis was built in the preparation stage. As the system database-based platform is large, this paper only presents the management of basic information of community residents. The entity attributes needed by the database include full name, data of birth, degree of education, gender, gridnum (grid number), home address, ID number, and number of information released. These entity attributes can be used as the indexes for the grid information management platform to retrieve information. The storage structure of the MySQL database of the basic information of community residents in the platform is shown in Table 1.

In 2017, Taocheng District entered the phase of full implementation of grid management, in which grid managers were assigned to the divided grids. In this paper, grid managers were assigned following the principle of “diversity in unity and one for multiple usages.” Firstly, every grid was assigned a full-time grid staff and a grid manager. Then, people from government agencies such as city management, environmental protection, market supervision, and public security were trained to be professional grid staff. Moreover, part-time grid staff was recruited from every grid [14], and the recruiting targets include resident party members, volunteers, property administrators, etc. Finally, every leader from local streets, towns, and villages was assigned to one community to regularly inspect the grids within the community. Civil servants at the street, town, and village levels were responsible for inspecting small grids and worked in the grid at any time when needed.

2018–2020 was the phase of comprehensive improvement of grid management in Taocheng District. In this phase, street and township leaders and serving civil servants took the grid management center platform as the pivot to coordinate the grid information summarized by the platform and finally realized a closed loop of “discovering the source of the problem → collecting and filing the problem → shunting

Fig. 2 The E-R diagram of the management for the basic information of community residents in the grid information platform
and assigning → checking the treatment scheme → feeding back the result.” The detailed measures for improvement included expanding the number of grid managers, further subdividing the grid, and further subdividing the working time of grid managers to avoid conflicting schedules and leave enough free time for every grid manager.

### Evaluation of Community Grid Management Mode

Effectively evaluating the community grid management mode can find out and improve the shortcomings and deficiencies in the operation of the grid management mode and optimize it. This paper borrowed the framework of the analytic hierarchy process [15] and divided the issues to be evaluated into different levels, as shown in Table 2. The objectives to be evaluated were divided into the objective level, first-level indicators, and second-level indicators, where the objective level was the achievement of the grid management mode in Taocheng District; the first-level indicators included management efficiency, management achievement, and management benefits.

The second-level indicators are the refinement of the first-level indicators. Management efficiency included the number of cases handled and the number of information released; management effectiveness included the number of cases communicated and exchanged and public satisfaction surveyed by questionnaire; management benefits included economic benefits, environmental benefits and social benefits. This paper used the gross regional product to measure economic benefits, the degree of landscaping to measure environmental benefits, and the improvement of public security to measure social benefits. Number of cases handles and number of information released were collected from the website of Taocheng District, and the number of cases communicated and exchanged was also collected from the website.

### Analysis Results

Figure 3 shows the management efficiency of Taocheng District in phases of preparation, full implementation, and comprehensive improvement when implementing grid-based management. In the preparation phase, the number of cases handled was 7853, and the number of information released by the platform was 1423; in the full implementation phase, the number of cases handled was 8326, and the number of information released by the platform was 1623; in the comprehensive improvement stage, the number of cases handled was 8646, and the number of information released by the platform was 1862. It is shown from Fig. 3 that the management efficiency of the grid management mode rose with the advancement of the mode phase.

Figure 4 shows the management effect of Taocheng District in phases of preparation, full implementation, and comprehensive improvement when implementing grid management. The management effect was divided into the number of cases communicated and exchanged and the public satisfaction rate. Figure 4 shows that the number of cases communicated and exchanged in the preparation phase, full implementation phase and improvement phase was 53, 71, and 78. The public satisfaction rate was surveyed by questionnaire. The public satisfaction rate was 41% in the

### Table 1 The storage structure of the MySQL database of the basic information of community residents

| Column name          | Type of data | Length of data | Can it be null |
|----------------------|--------------|----------------|---------------|
| Full name            | Varchar      | 7              | No            |
| Date of birth        | Varchar      | 5              | No            |
| Degree of Education  | Varchar      | 29             | No            |
| Gender               | Varchar      | 2              | No            |
| Gridnum              | Varchar      | 5              | No            |
| Home address         | Varchar      | 17             | No            |
| ID number            | Varchar      | 50             | No            |
| Number of information released | Varchar | 50             | No            |

### Table 2 The achievement evaluation indicator system of the grid management mode in Taocheng District

| Target layer | Achievement of the grid management mode in Taocheng District |
|--------------|-------------------------------------------------------------|
| First-level  | Management efficiency                                       |
| indicator    | Management effectiveness                                    |
|              | Management benefits                                        |

| Second-level | Number of cases handled | Number of information released | Number of cases communicated and exchanged | Public satisfaction rate | Economic benefits | Environmental benefits | Social benefits |
|--------------|-------------------------|-------------------------------|--------------------------------------------|--------------------------|-------------------|-----------------------|-----------------|
| indicator    |                         |                               |                                            |                          |                   |                       |                 |
preparation phase, 69% in the full implementation phase, and 78% in the improvement phase. In conclusion, with the promotion of grid management, the interaction between the government and the public on the platform has been strengthened, and the public satisfaction rate has improved.

Table 2 shows the management benefits of Taocheng District in phases of preparation, full implementation, and comprehensive improvement when implementing grid management. The gross regional product measured the economic benefits, the green area per capita measured the environmental benefits, the number of registered claims and the crime detection rate measured the security improvement, and the specific values are shown in Table 3. It is shown from Table 3 that with the implementation of grid-based management, the gross regional product of Taocheng District has increased, the green area per capita has increased, the

| Table 3 | Management benefits of the grid management mode in Taocheng District |
|---------|---------------------------------------------------------------|
|          | The preparation phase | The full implementation phase | The comprehensive improvement phase |
| Gross regional product/billion yuan | 183 | 212 | 235 |
| Green area per capita/m² | 14.58 | 16.25 | 18.36 |
| Number of registered claims/n | 2605 | 1821 | 1478 |
| Crime detection rate/% | 25.9 | 39.8 | 55.9 |

Fig. 3 Management efficiency of grid management mode in Taocheng District

Fig. 4 Management effect of grid management mode in Taocheng District
number of cases filed has decreased, and the crime detection rate has increased.

Discussion

The improvement of urbanization level has not only increased the size of cities but also attracted more people. As the number of people in a city increases, the difficulty of managing the city rises. A good management model can improve the management efficiency of urban communities, thus improving the life quality of the residents in the community. For urban community management, the number of people in the community is one of the difficulties. Traditional management methods can be useful when the number of people in the community is relatively small, but as the number of people increases, the rough management mode makes the transmission of management opinions inefficient. In order to improve management efficiency, the grid management mode was proposed. The basic idea of grid management is to break up the whole into parts, i.e., dividing a city according to the administrative level, dividing the divided areas into smaller areas, and managing every subdivided small areas by grassroots managers. In the community grid management mode, the government delegates the management authority to the grassroots level, and the grassroots personnel, who are closer to the daily life of the residents and directly manage residents, including communicating the management regulations, handling disputes, and collecting information from the residents. In the grid management mode, the efficiency is greatly enhanced because the management measures of the grassroots personnel do not need to be declared to the superior level, and the managers are only responsible for a portion of the residents, which does not create a heavy workload.

Although grassroots managers have high authority to directly manage their areas in the grid management mode, it does not mean that they do not need to report to the superior level. The overall direction of management is still determined by superiors, but they only play a guiding role in the management process. The grassroots managers report the information collected from the residents and the various management measures to the higher-level managers, who then summarize the information and report it to the higher level.

In the grid management mode, the transfer of management information is very important. The emergence of the Internet provides an effective management information transfer tool for grid management. This paper is about the community grid management based on system database, which means that managers at different levels can upload management information to a grid community management platform constructed on the Internet or query the corresponding management information according to their authority.

Then, an example analysis was conducted in Taocheng District, which adopted grid community management, and the community grid management was evaluated using the analytic hierarchy process, and the final evaluation results are shown above. The analytic hierarchy process divided the achievement of grid management into management efficiency, management effectiveness, and management benefits. Management efficiency was measured by the number of cases handled and information released. Management effectiveness was measured by the number of cases communicated and exchanged and public satisfaction rate. Management benefit was measured by economic benefits, environmental benefits, and social benefits. The analytic hierarchy process was conducted for the three grid management phases between 2015 and 2020. The analysis results showed that the local community management efficiency, management effectiveness, and management benefits were gradually improved as the grid management phases progressed.

In the preparation phase of grid management, the grid management platform has just been built, and the original traditional management methods and related management information need to be gradually transferred to the system database of the management platform. In addition, residents and managers in the community also need to gradually adapt to the new community management mode and establish trust in the new management mode. Thus, the management efficiency, effectiveness and efficiency were the lowest in this stage. In the phase of full implementation, since the management mode has been implemented for a certain period of time, and the original management information has been transferred to the system database of the platform, the storage of management information afterward does not require additional processing of the past management information, so the efficiency is improved. The trust of residents and grid managers in the new management mode also made them prefer the grid management mode when dealing with community affairs, improving the management effectiveness. In the phase of comprehensive improvement, because the grid management mode has been fully implemented, residents and managers have been adapted, and both efficiency, effectiveness, and efficiency have been maintained. Because of the continuous application of the first two phases, the shortcomings in the practical application of this management mode were collected, and targeted improvements were made. Thus, the management efficiency, effectiveness, and benefits of this phase were improved, but the improvement was relatively small.
Conclusion

This paper briefly introduced the concepts related to the system database-based community grid management mode and analyzed Taocheng District, Hengshui City, Hebei Province. In addition to introducing the community grid management mode adopted locally, the effectiveness of the community grid management mode was evaluated using the framework of the analytic hierarchy process. The results are as follows. With the implementation and improvement of the community grid management mode, the number of cases handled and information released subsequently increased, the interaction with the public and the satisfaction of the public improved, and the economic, environmental, and social benefits increased.

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Declarations

Conflict of interest  The authors declare they have no conflicts of interests.

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