

A management decision support system for allocating housing loans

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Abstract

A system for supporting management decisions in the allocation of housing loans is presented. The system has been used in the Housing Fund of the Republic of Slovenia since 1991 for granting loans to citizens. Various activities are supported, such as priority ranking of applications, financial evaluation and analyses. The system is based on a knowledge base that contains several qualitative and quantitative decision models, and is combined with a database. In the paper, we present the design of the system, the principal stages of its development and utilization, and practical experience obtained in 11 completed floats of loans.

Keywords

Management decision support systems, knowledge-based systems, decision models, loan allocation, housing

1 INTRODUCTION

The Housing Fund of the Republic of Slovenia was founded in 1991 under provisions of the Housing Law for the purpose of financing the national housing programme and encouraging the construction, renovation and maintenance of housing. The Fund obtains financial resources for its operations from: an allocation from the Republic's budget, part of the proceeds of the sales of flats, subsidies from local and foreign organizations, the proceeds of the sale of the Fund's securities, and income earned by the Fund's business operations. The resources are earmarked primarily for loans with favorable terms (low interest rates and long repayment time) to citizens and non-profit housing organizations.

So far the Fund has granted more than 11 thousand loans in 11 floats with a total value of about 12 billion Slovenian tolar (approximately 74 million ECU). The floats differed from each other in the amount of available funds and the purpose of loan consumption (e.g., construction, renovation, maintenance). These differences reflected in different criteria that determine the priority of applicants, such as the present state of housing, family status, and the age of family members.

The amount requested by applicants usually exceeds the available financial resources. In such cases, applicants must be ranked in a loan priority order. A system that supports the loan allocation activities must, among other things, facilitate an efficient determination of priority order, considering both, the housing law and prescribed conditions within the float. Fast, reliable and transparent determining of priorities, which is fair for all applicants, is required. Transparency requires effective explanation of loan priority order, which is an important demand because of the sensitivity of housing affairs and interconnection of different factors. The problem increases due to the high number of applicants.

In this paper, we describe a management decision support system for supporting the activities related to loan allocation in the Housing Fund of Slovenia. The system is based on a combination of a knowledge-based system (Klein, Methlie 1995; Mallach 1994) and a database that contains numerous data items about applications, loans and priorities for all floats of loans. The central component of the knowledge base is a qualitative multi-criteria decision model (Rajkovič, Bohanec 1991; Gumesson 1991; Angehm 1992) for the evaluation of loan priority.

In the following section, the problem of loan allocation is presented. Section 3 describes our approach to the development of the system. Its utilization is illustrated in section 4 by focusing on some of its important phases. The paper is concluded by presenting some critical success factors.

2 PROBLEM DESCRIPTION AND REQUIREMENTS

The Housing Fund distributes financial resources in floats of loans. The Fund invites applicants to apply for the loans by filling in an application form. The financial resources are limited, and are usually exceeded by applicants' requests. Therefore, all applicants must be ranked in a priority order for the distribution of financial resources in accordance with criteria, prescribed in the corresponding tender. These criteria may vary from tender to tender. In addition to priority, the amount that is granted to an applicant depends also on some other factors, such as the amount already granted to the applicant in previous floats.

Due to a high number of applicants, which varies from several hundreds to several thousands per float, a fast and efficient supporting system is required. Other important demands are transparency, comprehensibility, and flexibility. The transparency is needed to report reasons for the calculated results and explain the loan priority order to both the Fund's management and applicants. The comprehensibility of the system means that its procedures should be well understood and trusted. All the system activities and obtained results should be presented to the management and applicants in a form that facilitates an overview of the underlying activities and procedures, and justification of the results. For instance, the system must enable tracing the path from application form data to the final determination of the loan

two levels of criteria in the model remain stable, while some leaves and decision rules are modified, added or deleted.

For a technical support of this process, we use DEX, an expert system shell for multi-attribute decision making (Bohanec, Rajkovič 1990). In addition to the creation and adaptation of the model itself, DEX provides a number of useful tools for the verification and explanation of decision rules and analysis of the evaluation process (Bohanec, Rajkovič 1993; Bohanec *et al* 1995).

3.2 Computational models

The application priority is just one of the factors that affect the amount of the loan granted to an applicant. Some other factors are also important, such as the amount the applicant has actually asked for, the size of the owned flat (if applicable), and the amounts already granted to the applicant in previous tenders. The involved calculations tend to be rather complex and difficult to comprehend, especially if they change from tender to tender. For this reason, we included in the knowledge base a number of *computational models* with which we tried to *visualize* these calculations.

An example of such a visualization is shown in Figure 3. It is based on a computational model for determining the final approved amount of a loan. This amount is a minimum of (1) requested amount, (2) difference between the normalized price of the credited flat and an already owned one, (3) the maximal amount that can be granted in this float with respect to priority ranking and the size of the applicant's family, and (4) the maximal amount that remained available for the applicant from previous floats. Note that the calculation of the third value depends on the evaluation of application priority, which is obtained from the qualitative model in Figure 2. Therefore, the two models are actually connected.

In addition to computational models that are related to finance, the knowledge base contains some other models for verifying the completeness and consistency of applications.

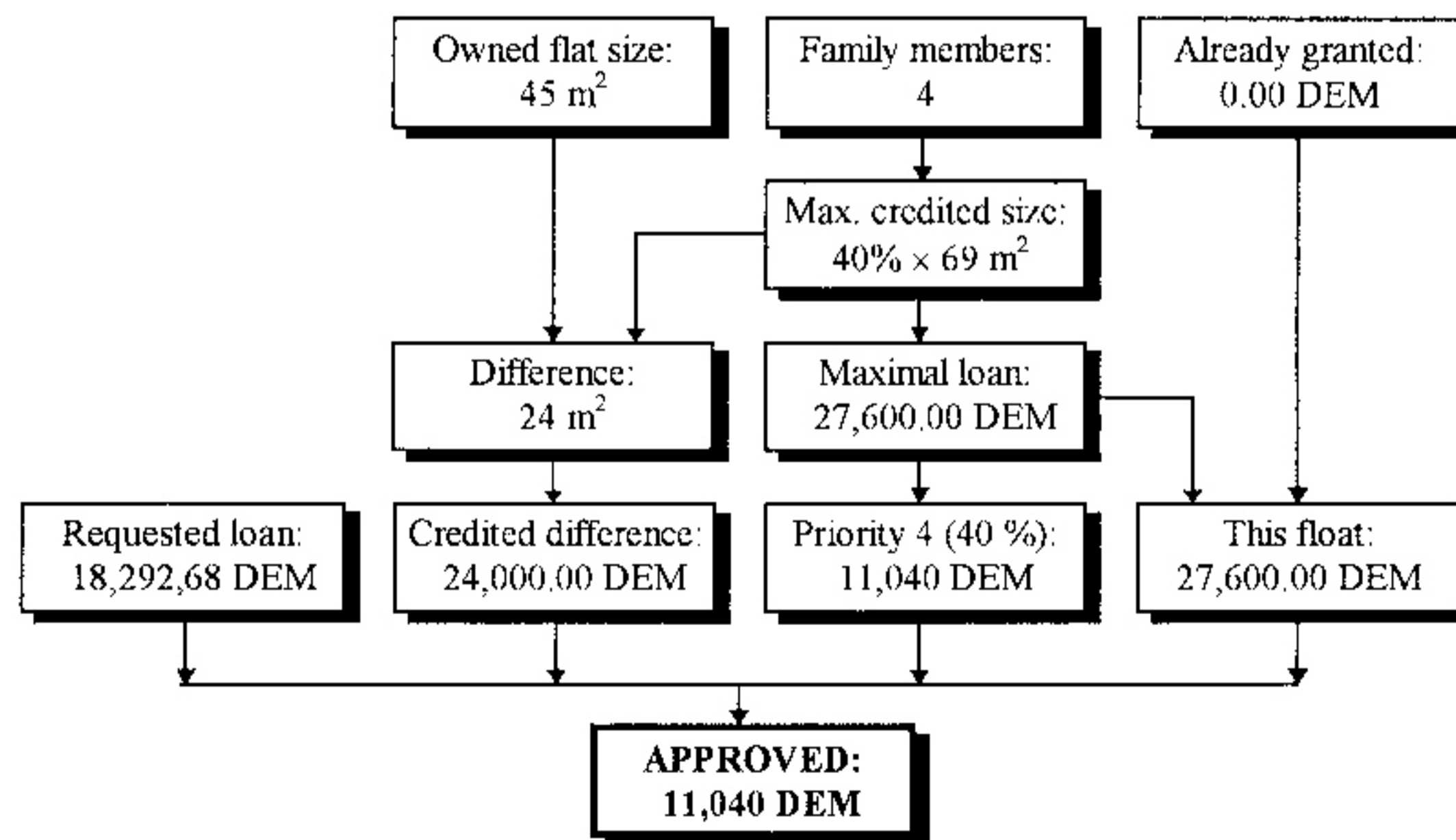


Figure 3 A calculation of approved loan amount.

3.3 Database design

Once the various models in the knowledge base have been built, they provide a valuable source of information for the initial design and subsequent adaptation of the remaining components of the system, particularly the database (see Figure 1). In order to perform their functions, all the models need some inputs; these are, for example, represented by leaves in the priority evaluation model (the rightmost criteria in Figure 2) and the topmost cells of the computational model in Figure 3. A collection of these inputs almost completely defines the data that has to be requested from applicants and stored in the database. In our case, we only extended this collection by applicants' personal data, which do not enter any of the models.

4 IMPLEMENTATION AND EXPERIENCE

In this section we illustrate the system's implementation by focusing on some of its important phases. For each phase, we present its essential features and highlight our experience obtained from the completed floats. The phases, which are captured from the time perspective, are the following: application gathering, data entry, loan approval, applicant notification, complaint handling, contract input, global database maintenance, and loan consumption verification.

The system supports three arrangements for gathering applications for a float: by a personal visit, by mail and by a personal visit at local municipalities. In the first issued tender, we decided to collect applications by mail. It was observed that due to the relatively high number of incomplete applications a substantial amount of time was spent just to contact the applicants and to inform them how to complete the applications. As a consequence, in the next float we had arranged that every citizen had to apply in person. We expected to achieve a higher standard of completed forms by having the applicants complete the forms on the spot. This eventually turned out to be correct. Besides, since a few thousands of citizens were expected to respond to the tender, we felt that we had to schedule their arrivals. To resolve that, every application form was labeled with a date and time of the suggested arrival. A special subsystem was developed for the task. Much to our surprise, the majority of applicants stuck to the suggested times; in this way, the waiting lines were drastically reduced. However, a considerable shortcoming was that citizens from distant regions of Slovenia had to come to the capital city. Therefore, in the next float we allowed application gathering and data entry in local municipalities. However, such arrangement turned out to be hard to control. So, in the next tenders we decided to use a combination of mail and personal visits with scheduled arrivals, which turned out to be the most effective.

Relevant data from each application are stored in the system's database in a local area network environment. For a typical float, up to 20 workstations are used for data entry. A printed application form, which contains data from an application, includes also a list of possible imperfections. Namely, the entered data are checked for completeness and consistency by computational models that contain specific restrictions of the tender. Every applicant can, therefore, determine the status of his or her application just by reading the printout. Moreover, since all applications are checked by the same computational model, the objectivity of evaluations increases.

Table 2 What-if analysis of an evaluation

Criterion	Value-1	Value	Value+1
PRIORITY		4	
HOUSING		2	
PRESENT		2	
ownership		1	2: PRIORITY=5
suitability	2: no change	3	
SOLVING		2	
cult-hist		1	2: no change
advantage	1: no change	2	
fin. sources		1	2: no change
stage		1	2: PRIORITY=5
STATUS		2	
earnings		1	2: no change
employed	1: no change	2	3: no change
children	1: no change	2	3: no change
SOCIAL-HEALTH		4	
health		1	2: no change
SOCIAL		4	
family	2: no change	3	4: no change
age	1: PRIORITY=2	2	

Soon after the applications are gathered and the data are stored in the database, a loan approving decision has to take place. The process of approving the loans consists of two phases: ranking the applications into five classes, and determining the percentage of approved amount for each class. Each complete application, which fulfills the tender requirements, is classified by the evaluation model according to their priority to be granted a loan.

At this stage, the what-if analysis turned out to be particularly valuable. The analysis points out the criteria that could, by changing the value for just one step, influence the final class. An example is shown in Table 2. The leftmost column displays the criteria structure, where the lower and upper-case entries represent basic and aggregate criteria, respectively. The column labeled 'Value' gives the evaluation results of an application at hand. This application has been classified into the fourth priority class. In the remaining two columns, the value of each basic criterion is independently varied for one step (if possible) and the influence of this change to the final priority is displayed. For example, if *ownership* changed from 1 to 2 (with all the remaining basic criteria unchanged), the application would be classified into the fifth priority class. On the other hand, the change of *suitability* from 3 to 2 does not affect the priority.

The utility of the analysis is not only in explaining why an applicant falls into a particular class, but also in understanding the model as a whole. To determine the percentage of approved amount for each rank, one has to first take into account the planned amount of funds for a specific tender. Usually, the approved sum should roughly equal to the earmarked amount. On the other hand, the decision is typically based on the known approximate description of classes. For example, since class four includes also young applicants with no children and an average family income for whom this was their first loan application, the percentage for the class was around 80 % in all issued tenders. This factor prevailed also in the

tenders where the approved amount was eventually more than three times greater than the earmarked amount.

An important role in the process of approving loans is played by statistical analyses. In fact, the analyses are useful in many phases, so the system includes a wide variety of them. For example, a distribution of applicants and requested amounts over priority ranks is a prerequisite for the decision. Some other distributions, like for instance over the criteria used in the priority evaluation model, are useful to obtain an overall impression of the database.

After the loans are approved, the applicants have to be informed about the outcome. Mailmerge technology is used for the task. Every applicant receives the final printout of his or her application data together with the notification of the approved amount. At the same time, the list of approved applicants is sent to a subcontracted bank that is responsible for completing loan contracts.

After the notification some of the applicants complain. Some of them argue that the data in the final printout are incorrect, while the others just disagree with the rejection explanation. Handling the complaints adds a time dimension to the database. Namely, it is desirable to know both the data before the complaint and after the correction. After collecting all complaints, the process of assessing the loans is carried out again for the complainants.

The bank that completes the loan contracts sends them to the Fund. The data from the contracts are added to the database. This phase is important since two events can happen. First, an applicant may for various reasons withdraw from the contract. Second, the granted amount in the contract can slightly deviate from the approved amount.

Another important phase is maintaining the global database of all applicants that responded to the tenders. First, it can serve as an archive of all applicants. More importantly, it is used to verify the upper limit of approved amount for every citizen that applies to more than one tender. Namely, the highest amount available to an individual borrower is 40 % of the value of the appropriate housing floor space determined according to the size of the family. This limit is regarded as a cumulative limit for all tenders. However, note that the limit for an individual citizen may change by, for example, increasing the size of the family.

Last but not least, there is a phase of verifying the purpose of the loan consumption. It typically takes place a year after a completed tender. For this phase, a small number of randomly selected approved applicants are selected according to their municipality and purpose of the loan consumption. Then, they are notified about the selection and are asked to contact the responsible person at the Fund in order to settle the date for the verification. We believe that the existence of such a procedure substantially decreases the number of approved applicants who spend the granted loan non-intentionally.

5 CONCLUSION

The system described in this paper is regularly used in the Housing Fund of the Republic of Slovenia and supports the Fund's principal activity: allocation of housing loans to citizens. In addition to a robust implementation of commonly used information system techniques (Rupnik-Miklič, Zupančič 1995), it incorporates some recently developed research methods from the area of qualitative decision support. The central component of the system is a knowledge base that consists of several qualitative and quantitative models.

This approach offers some important features regarding system design, utilization and maintenance. First, the system is flexible. A majority of adaptations to frequently changing requirements can be achieved by local modifications of the underlying models. The structure of the models themselves largely determines the remaining components of the system, i.e., the database and procedures. The second characteristic is transparency that is required for the users to comprehend and verify the information flow. This is particularly important in the design stage, which involves an intensive communication between the designer and managers. Here, the models provide an effective framework for the articulation of management's requirements. In the loan approval stage, the transparency facilitates explanation of the procedure and its results to the applicants.

According to the experience gained so far, it appears that problems of this type require permanent development and adaptation of the supporting system. Not only do the floats substantially differ from each other, but also unpredictable events occur that may alter the decision making policy within one float. For this reason, permanent participation of knowledge owners in the process is vital. Moreover, their participation is essential to provide the comprehensibility of the process in spite of its high complexity.

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8 BIOGRAPHY

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