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Multi Parameter Based High School Student Admission System

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Abstract: There are three parameters that are being concerned in high school student admission system in Indonesia, academic performance, home-school distance and poor students. In this research, we propose an automatic student admission system that accommodates these three aspects. Automatic model means students do not need to choose their preferred schools, so that, it can reduce the number of fail admission. The main purpose in developing this model is distributing smart students and poor students more equal in all schools that are in the system. Meanwhile, the home-school distances should be maintained low. In this research, we propose two models that then are compared to each other, round robin method and rank based method. There are parameters that are observed in this research are home-school distance, academic performance distribution and poor student distribution. Based on the simulation result, the round robin method performs better in increasing equality among schools and in maintaining the home-school distance low. In the other side, the rank based method performs better in appreciating the student's academic performance.

Key words: High school, round robin method, rank based method, automatic system, academic performance, admission

INTRODUCTION

Admission system is still being concerned and becomes a sensitive issue in Indonesia. Every year, government always makes changes and improvisation. The government argues that the purpose of the improvisation is to improve education quality and equality and to reduce home-school distance. The government wants to reduce the gap between favorite school and nonfavorite school. On the other side, most parents hope that their children can enter their preferred school, especially, favorite school.

In the economic aspect, the government has a policy that schools must accept poor students, so that, there is not any school, especially a public school that rejects poor students to enter schools. Based on this intention, the government decides quota for poor students in all public schools. This policy tends to prioritize poor students. Poor students must attach a poor certificate that is issued by the local government to use this quota.

In the new regulation, the public school must prioritize student with nearer home-school distance. In this case, the zoning system is implemented. Basically, this policy has a positive goal. If a student enters school that is near his home he can reduce his travel time to school, so that, this reduction can be allocated to more productive activities. Unfortunately, many parents respond to this policy by creating a fake family certificate. In this case, actually the student's house is far from the school.

Meanwhile, this policy is blamed as a policy that gives less incentive to smart students who have excellent academic performance. In the classic admission method, applicants are ranked based on their academic performance and students with higher academic performance are prioritized. Smart students will prior to entering favorite school. The advantage is this system can maintain competitive environment. Free market theory suggests that competition in student enrollment can make schools will be more responsive to the needs and interests of parents and students (Bosetti, 2004). On the other side, this classic method is blamed in maintaining the gap between schools still wide.

Although, the zoning system has some disadvantages, it has been adopted in many countries. Zoning system has been implemented in school admission system in Scandinavian countries, such as Estonia, Finland and Sweden (Poder *et al*., 2017), New Zealand (McCulloch, 1991; Beaven, 2003; Devonport, 2017) and America (Boser, 2013). Still in this research, student

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achievement is more depended on family background (Poder *et al*., 2017). In New Zealand, the main aim of zoning system is to creating freedom and equality among schools (McCulloch, 1991). It is because the gap or inequality among schools and community is wider (Gordon, 2003), for example is in Waikato Region (Devonport, 2017). The free market policy triggers fierce competition among schools where some schools fail to compete and they are forced to stop operation (Devonport, 2017). The free market policy was also blamed because the poor student is difficult to get schools because many schools accept only students that are suited to them (Devonport, 2017). In New Zealand, the zoning system mechanism is as follows. There is a static geographic boundary (Devonport, 2017). The in-zone students are guaranteed to enter their neighbor schools. Out-zone students may enter to the schools only if all of in-zone students have enter the schools and there are still available slots (Devonport, 2017). This policy creates discrimination between the in-zone student and the out-zone one.

Student transportation cost and travel time have been concerned in many kinds of research. In America, the cost of student transportation is about 4% of all current expenditure for public education (Devonport, 2017). In this research, student transport choice also has a correlation with the student's health and safety (Devonport, 2017). Students who frequently get solar exhaust may have lung health problem (Devonport, 2017). In the other side, Ewing *et al*. (2004) noted that school admission fails to control student travel time.

In the current admission system, a student must choose schools that they will attend. Students usually have three options. If a student is accepted in one of his preferred school he will be allocated to this school. If a student is accepted in more than one of his preferred school he will be allocated to his higher prioritized school. If he is rejected in all preferred school he fails to enter the public school even there is still school in the system that has an available slot.

Based on this problem, the purpose of this research is developing new automatic student admission model that accommodates the stakeholder's interest. This system is designed especially for high school. This system has some advantages and novelties. By using an automatic system, a student does not choose his preferred school, so as long as there is a school that has an available slot this student is accepted. The allocation process occurs automatically. The question is where this student will be allocated. This proposed model concerns in three aspects, academic performance, home-school distance and poor student distribution. This research is the continuation of our previous research in the high school enrollment system (Kusuma, 2018). In this previous research, we concern in two aspects only, home-school distance and national exam score (Kusuma, 2018). The poor student allocation has not been our concern yet (Kusuma, 2018). So, this research is the continuation and completion of our previous research.

Problem in public high school admission system: There are two important aspects in high school admission system in public school in Indonesia. First, a student that his home is nearer the school must be prioritized. Second, there is a minimum quota for a poor student in every school. Academic performance is not being concerned anymore because the government's main issue is developing equality among schools in a region. This issue is responded by neglecting academic performance in new student admission process because academic performance aspect is blamed as the main source of the increasing gap between favorite school and non-favorite school. Beside these two aspects, there is minimum quota or slots for poor students to be accepted in public school. This policy is issued, so that, students will not be rejected because of his economic condition. This special slot is mandatory. The public school that rejects poor student will be punished.

Based on these conflicting interests, local government issues three entrance paths that can be chosen in the new student admission system. There is a quota in each path. If there are unoccupied slots in some paths these slots will be allocated to other paths. The first path is zoning path. Students who admit through this path will be ranked based on their home-school distance which students with lower home-school distance will be prioritized. The second path is academic performance path. Students who admit through this path will be ranked based on their academic performance (national exam score) which students with higher national exam score will be prioritized. The third path is the poor student path. Students who admit through this path must attach a poor certificate in their application. If the number of students who use this path is equal to or lower than the poor student's quota then all of these students are accepted. Otherwise, there are two possible scenarios in selecting which students will be accepted. In the first scenario, academic performance based selection is applied. Meanwhile, in the second scenario, home-school distance based selection is applied. In some schools, to make the poor student path still selective, some schools implement minimum academic performance in their poor student path.

In current admission, a student must determine his preference in which schools he will try to enter. In many regions a student has two options. If he is accepted in his first school option, so that, he will enter his first school option. Else, he will be checked whether he is accepted in

Table 1: Student data

Students	p_{exam}	p_{dist} (km)	p_{econ}	Entrancepath
s_1	89	4.5	0	1
s_2	95	2.7	1	3
s_3	90	5.9	0	2
s_4	87	5.0	0	2
s_5	65	1.1	0	1
s_6	50	0.5	1	3
s_7	60	3.5	1	3
s_8	40	0.6	1	3
s_9	70	7.5	0	2
s_{10}	90	8.3	0	2
s_{11}	85	3.3	0	1
s_{12}	75	2.5	1	3
s_{13}	78	2.4	0	1
s_{14}	60	4.0	0	1
s_{15}	98	4.9	0	1

his second school option. If he is accepted in his second option school then he will enter his second option school. Else because there is not any his preferred school accepts him he will be rejected in the admission system.

The illustration of this three path system is as follows. Suppose that there are fifteen students who admit a school. Meanwhile, this school accepts only ten new students. The school applies three entrance paths, zoning, academic performance and a poor student. There are three student's parameters, national exam score (p_{exam}), home-school distance (p_{dist}) and economic status (p_{econ}). The national exam score ranges from 0-100. Home-school distance is presented in the kilometer. There are two possible economic statuses, 1 for poor and 0 for non-poor. The slots for each path are 50, 30 and 20%, consecutively. The data of the students are shown in Table 1.

Based on the illustration in Table 1, the result is as follows. In zoning path, there are 5 slots. So, the rank is $\{s_5, s_{13}, s_{11}, s_{14}, s_1, s_{15}\}$. In this case, student s_{15} fails to enter this school. In academic performance path, the rank is $\{s_3, s_{10}, s_4, s_9\}$. In this case, student s_9 fails to enter this school. Student s_3's rank is better than student s_{10}'s rank because, although, their academic performance is equal, student s_3's home-school distance is nearer than student s_{10}'s home-school distance. In a poor student path, the rank is $\{s_2, s_{12}, s_7, s_6, s_8\}$. In this case, student s_7, s_6 and s_8 fail to enter this school. It is because in this path, poor students are ranked based on their academic performance.

The weakness of this system is there will be empty seats potential, although, the number of available seats is higher than the total number of applicants because of the wrong choice. For example, in the previous case, student s_7, s_6 and s_8 are rejected from their preferred school. Meanwhile, in another school there are five remaining available slots for poor students. Unfortunately, these three students do not apply to enter this school. So, at the end of the process these three students fail to enter public school. Meanwhile, there are still empty slots for poor students. Based on this problem, it will be better if there is an admission system that runs automatically, so that, the dispatch system runs automatically, so that, there is not any potential lost.

MATERIALS AND METHODS

Proposed model: Based on the problem in the existing public high school admission system, we propose an automatic admission model that meets criterion based on stakeholder's interest. There is prioritization or some special slots for poor students and incentive for excellent students. Student's home-school distance must be maintained low or there is prioritization for a students that live near the school and on the other side, discrimination between the in-zone student and the out-zone student should be reduced. Excellent students must be distributed equally. The additional requirement for this model is that the dispatch process must be run automatically. As long as there is an available slot there will be no rejection.

In this model, the admission system is formalized as function f (S, A). S represents the set of schools. Meanwhile, A represents the set of applicants. As a set, S can be represented as $\{s_1, s_2, s_3, \ldots, s_{nschool}\}$. In this set, n_{school} denotes the number of schools in the system. A can be represented as $\{a_1, a_2, a_3, \ldots, a_{napplicant}\}$. In this set, $n_{applicant}$ denotes the number of applicants in the system. Every student contains four parameters $\{p_x, p_y, p_{exam}, p_{econ}\}$. Attribute p_x denotes, the student's home location in coordinate x. Attribute p_y denotes, the student's home location in coordinate y. Attribute p_{exam} denotes, the student's academic score or student's final score exam. Attribute p_{econ} denotes, the student's economic status. Status 1 means the student is a poor student while status 0 means the student is not a poor student. In the other side, every school contains three parameters $\{p_x, p_y, p_q\}$. Attribute p_x denotes, the location of the school in coordinate x. Attribute p_y denotes, the location of the school in coordinate y. Attribute p_q denotes, the quota of the schools. In this research, the admission model consists of two sub-models. The first sub model is poor student allocation model. The second sub model is the non-poor student allocation model. These processes are executed sequentially. This process is shown in the algorithm in Fig. 1.

In the poor student allocation model, the quota for poor student is determined previously. In this process, the dispatch will run until one of these two conditions is reached. First, all poor students in the system have been allocated successfully. Second, all poor student slots

```
Begin
  poor_student_allocation()
  non_poor_student_allocation()
end
```

Fig. 1: Main algorithm

```
begin
set(n_availstudent)
 set(n_poorslot)
 n_allocatedstudent ← 0
 n_allocatedpoorslot ← 0
 j ← 1
 while n_availstudent > 0 and n_availpoorslot > 0 do
 begin
  if s_availpoorslot,j > 0 then
  begin
   candidate ← find_candidate(s_j);
   allocate(s_j,candidate);
  end
  j ← next(j);
 end
end
```

Fig. 2: Round robin poor student allocation algorithm

have been filled, although, there are poor students that have been allocated. These remained poor students will compete in the second sub model. There are two methods that can be chosen in this first process, round robin method or ranked based method. Round robin method is adopted because this method is a popular method in scheduling and load balancing and it has been used widely in many areas, for example, in CPU process (Zouaoui *et al*., 2019; Srilatha *et al*., 2017) and network allocation (Varade *et al*., 2018).

In the round robin method, a set of schools can be viewed as a rotating wheel. Every school has a sequential turn to choose its most suit student. The rotation starts from school with the lowest index. After a school finds its student then the rotation will continue the school with the next index. When the school with the last index finds its student, the school with the lowest index will be the next school. The round robin has been used in our previous research (Kusuma, 2018). But in this previous research, the poor students are neglected (Kusuma, 2018). The algorithm of this process is shown in Fig. 2.

The initial process of round robin poor student allocation algorithm is as follows. First, the number of available students ($n_{availstudent}$) and the number of poor slot ($n_{poorslot}$) are set. Number of available students is the number of poor students in the system that has not been allocated to the specified school. The value of this variable is determined by using Eq. 1. Number of poor slot is total number of available slots or quota for poor students. The value of this variable is determined by using Eq. 2. In Eq. 2, it is shown that $n_{poorslot}$ is acquired by accumulating the poor student quota in every school ($s_{pq,j}$) in the system. In the beginning, the number of allocated student ($n_{allocatedstudent}$) and the number of allocated poor slot ($n_{allocatedpoorslot}$) set 0. The allocated student is student that has been allocated to specified school. In this case, the student means poor student. The allocated poor slot is the slot that has been allocated for the poor student:

$$n_{availstudent} = \sum_{i=1}^{n_{student}} 1, a_{p_{econ}, i} = 1 \quad (1)$$

$$n_{poorslot} = \sum_{j=1}^{n_{school}} S_{p_q, j} \quad (2)$$

The round robin algorithm is determined by using function next () as it is shown in Fig. 1. Meanwhile, the formalization of this function is shown in Eq. 3. In Eq. 3, it is shown that the rotating wheel is implemented that when the current school is the last school then the next school is the first school. Else, the next turn is the next school:

$$cur = \begin{cases} 1, j = n_{school} \\ j+1, else \end{cases} \quad (3)$$

While the looping occurs, the dispatch process occurs only if the current school still has an available seat for the poor student. Else, the dispatch process will not occur. In the dispatch process there are two processes, finding the candidate and allocating the candidate to the school. In the candidate finding process, the score based method is used. This process is formalized by using Eq. 4-7. In Eq. 4, the selected candidate must be a poor student has not been allocated to any school and has maximum score related to this school. In Eq. 5, it is shown that the total score includes two aspects, student's final exam score and student's home-school distance. Both aspects are weighted to accommodate the government interest in priority, academic performance or home-school distance. In Eq. 6, weight factor are floating point that ranges from 0-1. In Eq. 7, there is an ideal distance (d_{ideal}):

$$a_{cand} = a | a_{p_{econ}} = 1 \wedge \max\left(v\left(a\right)\right) \wedge a \in A \wedge a_{status} = 0 \quad (4)$$

$$v_{total}\left(a\right) = w_{exam} . a_{p_{exam}} + w_{dist} . v_{dist}\left(a\right) \quad (5)$$

$$w_{exam} = 1 - w_{dist} \quad (6)$$

$$v_{dist}\left(a\right) = \begin{cases} 100, d\left(a,s\right) \le d_{ideal} \\ \dfrac{d_{ideal}}{d\left(a,s\right)} . 100, \text{ else} \end{cases} \quad (7)$$

The ideal distance is used to change the static geographic boundary in conventional zoning system, for example as it is applied in New Zealand (Devonport, 2017). The conventional zoning system is blamed as a factor why out-zone students are difficult to be accepted because there is a static pre-determined quota for in-zone and out-zone students. By this new approach, the ideal distance can be seen as a geographic boundary but it is applied softer. Students that are inside the ideal distance can be seen as in-zone student meanwhile students that are outside the ideal distance can be seen as an out-zone student. But in this model, there is not any specific quota. As it is shown in Eq. 7, the student inside the ideal distance will get maximum distance score. Meanwhile, for the student outside the ideal distance, longer home-school distance means lower distance score. This formula is also the improvisation compared with the previous model (Kusuma, 2018). In the previous model, the demarcation between in-zone student and out-zone student is set 1 km statically. Meanwhile, in this new equation, the ideal distance is set dynamically.

After the candidate is selected, the next process is allocating this student to the current school. Processes that occur in this allocating process are shown in Eq. 8-12. In Eq. 8, it is shown that the number of available seat for a poor student in school j will decrement. Meanwhile, in Eq. 9 and 10, the number of allocated slot for poor student and the number of students that have been allocated will increment. The status of this selected applicant will be allocated or not available anymore. In Eq. 12, the selected school for this candidate is this current school:

$$s_{availpoorslot,j}\left(n+1\right) = s_{availpoorslot,j}\left(n\right) - 1 \quad (8)$$

$$n_{allocatedpoorslot}\left(n+1\right) = n_{allocatedpoorslot}\left(n\right) + 1 \quad (9)$$

$$n_{allocatedstudent}\left(n+1\right) = n_{allocatedstudent}\left(n\right) + 1 \quad (10)$$

$$a_{status} = 1 \quad (11)$$

$$a_{school} = s_j \quad (12)$$

The second method is the rank-based method. In this method, the poor student with higher academic score will be prioritized to get school earlier. Similar to round robin method, the iteration runs as long as there isan available slot for poor student and there is an unallocated poor student. This method algorithm is shown in Fig. 3. Figure 3, there are three processes inside the iteration, finding student candidate ($a_{candidate}$), finding school candidate ($s_{candidate}$) and allocating the student candidate to school candidate. The finding student candidate process is executed by using find_student candidate function. This function is formalized by using Eq. 13. Equation 13, it is shown that unallocated poor student with highest academic performance will be prioritized:

$$a_{cand} = a | a_{p_{econ}} = 1 \wedge a \in A \wedge a_{status} = 0 \wedge \max\left(a_{pexam}\right) \quad (13)$$

```
Begin
set(n_availstudent)
 set(n_poorslot)
 n_allocatedstudent← 0
 n_allocatedpoorslot← 0
 while n_allocatedstudent< n_availstudent and
n_allocatedpoorslot< n_poorslot do
 begin
  a_cand← find_studentcandidate()
  s_cand← find_schoolcandidate()
  allocate(s_cand, a_cand)
 end
end
```

Fig. 3: Rank based poor student allocation algorithm

In the school candidate finding process, the scoring method is implemented. This score includes two parameters, the student's home-school distance and school academic performance. The school academic performance is included to give incentive for the smarter student to get a favorite school while on the other side still a concern in student's home-school distance. This process is formalized by using Eq. 14-17. In Eq. 14, it is shown that the school candidate is the school that still has available slots for poor student and has maximum school total score. In Eq. 15, the school total score is depended on weighted home-school distance score and weighted school academic performance score. In Eq. 16, the distance weight and school academic performance weight (w_{ac}) are floating point that ranges from 0-1. In Eq. 17, the school academic performance score is discrete that ranges from 0-100 based on the school academic performance level. The school with higher academic performance level has less academic level and higher school academic performance score. The allocating process in the rank-based method is the same as the round robin method:

$$s_{cand} = s|s \in S \wedge s_{availpoorslot} > 0 \wedge \max\left(v_{total}(s)\right) \quad (14)$$

$$v_{total}(s) = w_{dist} \cdot v_{dist}(s) + w_{ac} \cdot v_{ac}(s) \quad (15)$$

$$w_{dist} = 1 - w_{ac} \quad (16)$$

$$v_{ac}(s) = \begin{cases} 100, s_{level} = 1 \\ \cdots \\ 0, s_{level} = n_{level} \end{cases} \quad (17)$$

After the poor student allocation process, the second process in high school admission system is nonpoor student allocation process. Based on this condition, the parameters that are used in the second process are determined by using Eq. 18 and 19. In the nonpoor student allocation process, similar to the first process, round robin method or rank based method is also can be implemented too. The differences with the first process are shown in Eq. 18 and 19:

$$a_{cand} = a|a_{status} = 0 \wedge a \in A \quad (18)$$

$$s_{availslot,j}(0) = s_{slot,j} - s_{allocatedslot,j} \quad (19)$$

RESULTS AND DISCUSSION

Implementation and analysis: This automatic high school admission model then is implemented into high school admission simulation. The environment represents a virtual city with the size is 25 km width and 25 km long. There are 2 thou. applicants and on the other side there are 10 schools. The quota of every school is 100 seats. The quota for the poor student is only 20%. The schools are grouped into 3 clusters based on their academic performance, level 1-3. Level 1 is the school group with the highest academic performance. The final exam score ranges from 60-100.

In this simulation, he observed parameters include student's average home-school distance and average applicant's final exam score. The average student's home-school distance is analyzed because this aspect has been one important aspect in designing admission system (Devonport, 2017; Ewing *et al*., 2004). Meanwhile, final

Table 2: Relation between distance weight and observed parameters in round robin method

		Average final exam score		
w_{dist}	Average distance (km)	Level 1	Level 2	Level 3
0.1	5.6	90.1	90.0	90.6
0.2	4.8	88.8	89.7	89.1
0.3	3.8	86.8	87.5	86.7
0.4	3.0	86.1	86.0	84.7
0.5	2.6	83.5	84.0	82.2
0.6	3.0	82.0	81.9	82.9
0.7	2.6	81.4	81.5	80.9
0.8	2.7	80.6	80.4	80.8
0.9	2.6	80.1	80.4	80.3

Table 3: Relation between distance weight and the observed parameters in rank based method

		Average final exam score		
w_{dist}	Average distance (km)	Level 1	Level 2	Level 3
0.1	8.8	97.1	89.4	82.5
0.2	9.1	96.7	90.5	84.0
0.3	8.0	97.6	90.9	84.2
0.4	7.4	95.4	90.7	84.5
0.5	6.5	94.3	90.8	85.3
0.6	7.9	94.4	89.5	85.6
0.7	6.3	92.9	90.1	88.7
0.8	6.3	92.3	89.4	89.5
0.9	6.0	89.6	91.0	90.0

exam score distribution is concerned about developing equality among schools (Devonport, 2017). In this context, students are students that are accepted in this admission process. The average final exam score is grouped based on the academic performance level of the school. The adjusted parameters include, distance weight, ideal distance and school academic performance score. In this simulation, the performance of both methods is compared to each other. The first test is evaluating the relation between distance weight and the observed parameters. The distance weight ranges from 0.1-0.9. The step size is 0.1. In this test, the ideal distance is set 3 km and the distribution of the school academic performance based on their level is {100, 80, 60} consecutively. The result is shown in Table 2 and 3.

Table 2 when round robin method is used when the distance weight increases, the average final exam score and average home-school distance decrease. In the beginning, the decreasing process is fast and then gets slower. When the distance weight is more than 0.3, the average home-school distance is stable with small fluctuation. The average final exam score among school levels are similar. In Table 3, when the rank based method is used, when the distance weight increases, the average home-school distance decreases. In the final exam score aspect, the average final exam score in the first level school is the highest while in the third level school is the lowest. When the distance weight is small, the average final exam score is wide. When the distance weight is high, the average final exam score is low.

The second test is evaluating the relation between ideal distance and the observed parameters. The ideal distance ranges from 0.5-5 km. The step size is 0.5. In this test, the distance weight is set 0.5 and the distribution of the school academic performance based on their level is {100, 80, 60} consecutively. The result is shown in Table 4 and 5. Table 4, when the round robin method is used when the distance weight increases, the observed parameters value decrease. When the ideal distance is 2 and 2.5 km, the observed parameters reach their lowest value. Then, the value of the observed parameters increases. The average final exam score among school levels is similar. In Table 5, when the rank-based method is implemented, the average home-school distance tends to decrease with a small slope and small fluctuation. When the ideal distance is low, the average final exam score gap between the highest and the lowest school level is wide. The increasing of the ideal distance makes this gap narrower.

Table 4: Relation between average ideal distance and the observed parameters in round robin method

		Average final exam score		
d_{dist} (km)	Average distance (km)	Level 1	Level 2	Level 3
0.5	4.4	88.1	87.7	88.0
1.0	3.7	84.8	85.9	86.7
1.5	2.9	83.9	84.1	84.3
2.0	2.7	83.1	83.3	83.9
2.5	2.7	82.9	82.6	83.2
3.0	2.8	83.0	83.9	82.8
3.5	3.2	84.1	84.4	83.7
4.0	3.2	84.4	85.0	86.0
4.5	3.3	85.8	87.2	85.4
5.0	3.6	85.3	86.6	86.8

Table 5: Relation between average ideal distance and the observed parameters in rank based method

		Average final exam score		
w_{dist}	Average ideal distance (km)	Level 1	Level 2	Level 3
0.5	8.6	98.6	92.3	84.3
1.0	8.2	97.4	90.9	84.2
1.5	7.5	95.8	90.2	85.0
2.0	6.7	95.9	89.9	85.8
2.5	6.5	95.4	89.4	85.8
3.0	7.0	95.1	89.6	85.2
3.5	6.8	93.5	89.1	85.3
4.0	6.9	94.0	89.4	85.3
4.5	6.6	95.2	91.5	85.5

Table 6: Relation between the school academic score distribution and the observed parameters

School score	Average final exam score			
distribution	Level 1	Level 2	Level 3	Average distance (km)
100-90-80	95.3	90.2	88.0	7.1
100-80-60	96.2	91.1	86.0	7.0
100-70-40	95.6	89.7	85.2	7.0
100-60-20	97.0	90.4	82.9	7.8
100-50-0	96.8	90.4	83.8	7.2

The third test is evaluating the relationship between the academic score gap between school group level and the observed parameters (Table 6). The academic score gap is symbolized as $\{v_{ac,1}-v_{ac,3}\}$ from the first level until the third level consecutively. In this test, the distance weight is set 0.5 and the ideal distance is 3 km. This test is only for rank-based method. The result is shown in Table 6. Based on the result in Table 6 when the inter-school score gap increases, most of observed parameters fluctuate. Meanwhile, the average final exam score in the third level school group decreases. It means that the inter-school score gap gives significant impacts in the schools with the lowest academic performance.

The next analysis is comparing the performance of these models with models in previous research (Kusuma, 2018). The first comparison is the comparison between round robin model and previous models (Kusuma, 2018) in average student's home-school distance. This current model performs a little bit better than full round robin-total score model (Kusuma, 2018). It also performs better enough than the semi round robin-total score model (Kusuma, 2018). It performs much better than the exam score prioritized-semi zoning model or national exam score prioritized-clustered school combined model (Kusuma, 2018).

The second comparison analysis is comparing the rank-based model with the previous models (Kusuma, 2018) in average student's home-school distance aspect. This current model performs worse than the full round robin-total score model (Kusuma, 2018) or semi round robin-total score model (Kusuma, 2018). Meanwhile, this rank-based model is competitive compared with the previous national exam score prioritized-clustered school combined model or exam score prioritized-semi zoning model (Kusuma, 2018).

As an automatic admission system, similar to the automatic admission system in our previous research (Kusuma, 2018) by using this current model, all applicants will be accepted successfully as long as there is any available slot in the system. It is shown logically in the algorithm both in round robin model Fig. 2 or rank based model Fig. 3. The improvement is that in this current model as it is shown in Fig. 1, poor applicants are allocated before non-poor applicants. This method is different from the previous research (Kusuma, 2018) where there is not any difference between poor applicants and non-poor applicants.

CONCLUSION

Based on the explanation above, it is shown that the proposed model has been developed and has been implemented into the automatic high school admission system. This model is accommodates stakeholder's interest, appreciating student's academic performance, reducing equality among schools, prioritizing student near the school and accommodating the poor student with special allocation. By using the automatic method, applicants do not need to determine their preferred school but the system will dispatch student to his suites school. This model also has introduced a new method in reducing explicit discrimination between the in-zone student and the out-zone student. Based on the test, round robin based method performs better than rank-based method in creating equality among schools and in maintaining the home-school distance low. In the other side, rank based method performs better than round robin method in appreciating student's academic performance. Meanwhile, in the rank-based method, the gap among schools can be reduced by increasing the distance weight.

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