The Meaning and Usefulness of Simulation Method for Business Process Reengineering

- Focused on the Korean Supreme Court BPR Project (1994 – 2003) -

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ABSTRACT

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Simulation is used to reduce a risk involved in the new project and decision-making in an organization and to save cost and time by forecasting different situations. The objectives of this research are to acknowledge the need of simulation through the real life sample and to encourage the use of the simulation method in the future consulting project by continuously making the necessary improvements.

This research analyzed the effectiveness of the simulation based on the sample use of simulation method in 1994 and 1997 for the BPR project of certification issuance process at the Supreme Court. In order to evaluate the value of the proposed simulation model, we examined the gap, which existed between the simulation result and the operational data collected by visiting the actual sites where AROS (Automated Registry Office System: automation system developed by LG-EDS Systems) is being utilized. We also identified the causes for the existing gap. According to the analysis result, (1) the gap came from the status change of thinking that the concentration of certification issuance request has eased after the computerization, (2) the gap existed in the operational process because they failed to consider the situational factors of each registry office in the simulation model, and (3) lastly the gap came from the difficulty of formulating the mathematical model for predicting the complex and diverse behavior

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pattern of individuals requesting the certification issuance.

In order to narrow the existing gaps, we made a proposal to improve the certification issuance process where software of certification issuance vending machine was upgraded in order to help the people to use the service conveniently, more part time workers were hired when there was a overload of certification issuance request, and the quality of the certification issuance vending machine is improved.

In this research, we examined an efficient way of resource allocation based on the simulation conducted in 1994 and 1997. By reflecting changes since the simulation of 1994 and allocating the clerk and machine based on the predicted results of the simulation, we maximized the efficiency of the certification issuance process.

In conclusion, this research examined the future usability of simulation method based on the analysis result and identified the key issues to consider when using the simulation method in the future consulting project.

1. The meaning and usefulness of simulation method

1.1. The usefulness of simulation method

To understand how modeling and simulation can be used in the business world, we need to understand the "Business" itself first. Business is a system and network composed by independent structures and channels connecting those structures. For example, a change in marketing strategy can have an impact on sales activities and a modification in product design can cause an alteration of production process.

A model in "Business" is a logical and functional representation of the systems. A simulation is an imperfect imitation of the business systems and a dynamic representation by which the result of 'what if~' scenario can be quickly verified in a cost-effective way.

Michael Hammer, an expert of "BPR (Business Process Reengineering)", said that the success rate of reengineering projects was merely at 30 %. One of the main reasons for this low success rate was that an analysis of the performance forecast was limited by the analysis level of using the flowchart and spreadsheet.

The analysis using the flowchart and spreadsheet can give an answer only to "what", not to "How," "When," and "Where." Recent business processes are so complex and dynamic that they cannot be comprehended just by analyzing the flow charts and spreadsheets. From that perspective, simulation method can be a very useful tool to visualize the comparison of alternative proposals.

Through the simulations, we can reduce the risks involved in the implementation of the projects and save the cost and time at the same time. In short, the usefulness of simulation method is based on the effects of 'prediction' and 'optimization'.

1.2. The objectives and methods of research

This research is conducted to redefine the meaning and usefulness of simulation method and to promote a continuous application of simulation method to other consulting projects.

We will analyze the effectiveness of the simulation method used in the Korean Supreme Court BPR project for Real Estate Registration. The first simulation method was used in 1994 to analyze the effectiveness of certification issuance process of the Supreme Court, which adopted the new information system, and it was used again for the same project in 1997 at the completion stage of the AROS (Automated Registry

Office System: Automation system developed by LG-EDS Systems) development. In the next chapter, this report will briefly explain the background of the BPR project for the registration process of the Supreme Court and examine various simulations used during the project. In chapter three, we make a comparison of actual values collected from actual site visits with predicted values of simulated operation and identify its causes. Lastly, we will examine the future applicability of the simulation method and other considerations.

2. Simulation Case Analysis

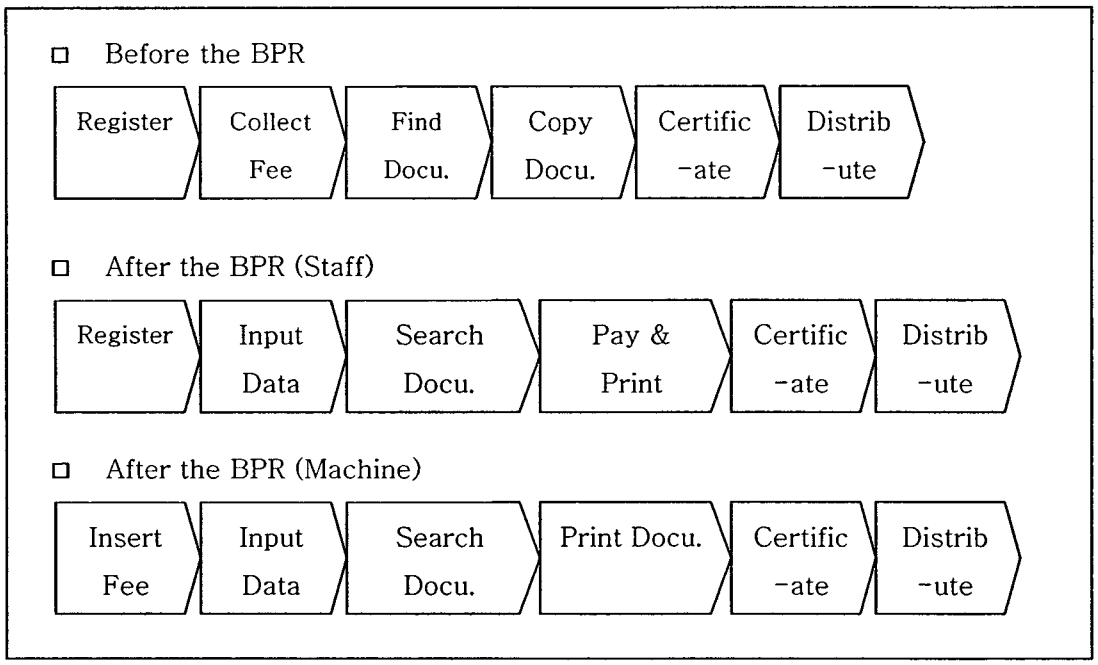
2.1. Introduction

LG-EDS Systems has been conducting the 'Supreme Court Real Estate Registration Project' since 1994 with the goal of completing the project by 2003. This project aimed to convert all the documentations related to real estate registration since 1945 to digital forms and to automate current registration process, which previously has been handled manually.

In fact, automation systems (AROS), which support the new real estate registration process, has been already developed and implemented at 60-70% of all Korean registry offices. This implementation project is expected to be completed by 2003.

The main purpose of the project is to improve the effectiveness of processes for printing real estate registration documents (certificates). Simulation method was used to examine the current processes that consist of submission, distribution, and printing tasks. Prior to the project, applications were processed in batches. But the new systems will process it separately. Figure 1 shows the old and new processes of certification issuance.

< Figure 1. Process change >



The BPR simulation has been conducted twice in 1994 and 1997. First simulation in 1994 was to test the feasibility of newly developed model. Best way of testing the new model is making the evaluation after waiting for some time since the implementation of the model.

However, the evaluation of the model might not be feasible due to time-consuming tasks and high costs involved. Therefore, we used the SIMAN as simulation language where the simulation was conducted based on the probability situational model

Second simulation in 1997 since there was a requirement for new study which supports the rationalization of registry office structure and improves its operational efficiency. The development of AROS, which started in 1994, ended in 1997. Thus, pilot test was conducted in August 1997. And the system was expected to expand to every real estate registry offices from 1998 to convert the old documents into digital format. In this study, field research and interviews have been conducted to collect data, which was used as raw data for the simulation. At this time, the simulation was not computer-based. Both the real data and forecasted data were used in the mathematical model. The simulation examined the correlation between the simulation results and assumptions of the BPR in 1994.

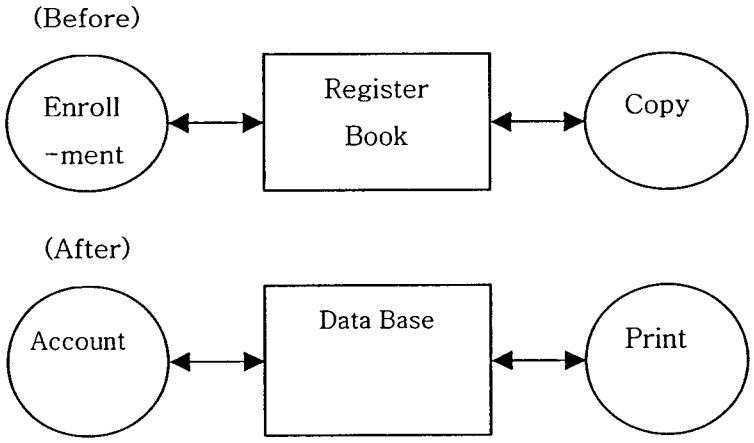
2.2. Simulation in 1994

2.2.1. Simulation model

Before the automation of the certificate issuance process, applicants submitted the certificate issuance application/request at the service desk. Staff who worked at the certificate issuance service desk processed the request by transferring the request to another staff, who is in charge of sorting and searching. Then, this staff found the original certificate document and asked a person who is responsible of copying duties to photocopy the document. Then the copied document is returned to the staff who is responsible of sorting and searching. And finally the photocopied document got back to the staff at the service desk. And this staff at the service desk issued the document with certification to the applicant. The overall process involved a team of 3 staffs, each handling different roles.

As shown in Figure 2, in the new system, applicants can use the vending machine, which prints out the certificate documents by themselves after collecting the basic applicant information and can also make a service request to the staff at a service desk. Print jobs are sent upon verifying the request information and matching the searched information in case of the vending machine.

< Figure 2. The comparison of workflow >



As previously mentioned, certification theoretically can be issued in three ways; using vending machine only, using staff only, and using both vending machine and staff. Simulation model explains these three alternatives.

- ✓ Mixed Model: Issuance request is processed by both the vending machine and staff.
- ✓ Staff Model: Issuance request is only processed by staff.
- ✓ Vending Machine Model: Issuance request is only processed by vending machine.

2.2.2. Assumptions for simulation

<Assumption 1> Peak Time and Concentration

Concentration is the rate of work processed at a given time over total amount of work processed in a day. For example, suppose that 100 cases are processed in a day, among them 30 cases are handled in two hours say between 14:00 and 16:00, then the level of concentration in that time frame is 30%. In fact, the level of concentration is reaching 40 to 50% between 14:00 and 16:00 in a day at the most registry offices. Second highest concentration rate is observed from 11:00 to 12:00 and 13:00 to 14:00 and 16:00 to 17:00. Considering this situation, we divided work hours into three time zones; 9:00 to 14:00, 14:00 to 16:00, and 16:00 to 18:00 and regarded the time zone from 14:00 to 16:00 with the average concentration rate of 40% ~ 50% as the peak time

<Assumption 2> Probability Model Approach

Applicant arrival intervals are quite irregular and service times are quite different by applicants. A probability distribution model fairly reflects this situation. The previous report used the exponential distributions with different parameters for inter-arrival times and service times, respectively.

The assumption that arrival interval or service time has probability distribution has usually one pre-condition, which suggests that there is no exogenous variable except time. But this condition did not apply to our case in which applicant arrival was only concentrated in the specific time zone. In other words, we have time zone as another exogenous variable. If we only consider the average arrival interval ignoring the concentration by time zone, waiting time at busiest time zone might be overestimated. For an accurate test, we need a combined model, which computes the applicant arrival rate for each time zone. However, it is impossible to interpret this combined model mathematically. Therefore, we need to reflect the practical situation and simultaneously conduct the mathematical analysis. Moreover, to examine the applied model, it should be taken account that the real estate registration is the service

provided to the public, which means any applicant has the equal right to receive standardized quality service from the registration office regardless of his or her arrival time.

Taking an account of this situation, it is most desirable for the model to focus on the busiest time zone in a practical sense. By maintaining a certain level of service quality in the peak time, they can also provide the standardized service in other time zones. Simulation in 1994 was conducted based on demand at peak time. This test might suggest the optimum capacity at peak time while work overload at non-peak time might bring opportunity cost. We will discuss the issue in more detail in section 4.2

<Assumption 3> Number of Issuance

Every applicant makes a request for different number of issuance and the employees of judicial scrivener usually requests tens of issuance at one time while an individual calls for one or two. We use an exponential distribution model for solving this unequal demand per applicant. We assume this different number of issuance request per applicant causes the difference in service time.

<Assumption 4> The standard time for work processing

The standard time for work processing is the sum of average time consumed at each process from the point of applicants making a request to releasing the certificate to the applicant at the service desk or from the point of inserting fee to printing out the documents in case of the vending machine. We assumed that the standard processing time is 37 seconds for staff assisted service while 63 seconds for machine assisted service.

<Assumption 5> Maximum waiting time for an applicant

Before the automation of the system, an applicant should wait 40 to 60 minutes on average to get the certificate document, which caused many complaints. The automation targeted to reduce the waiting time at least to 15 minutes, which was acceptable to many. Therefore, the simulation model regarded the 15 minutes as the maximum waiting time.

<Assumption 6> The number of Queue

Before the automation of the system, only a single queue existed. Since then, automation allowed two queues using vending machine. Simulation in 1994 assumed that the length of queue was equal. The reason is that an applicant always moves over to the

shorter line after comparing the two queues. He/she was assumed to shift continuously to shorter line between the two queues. It was presumed that an applicant cannot feel the service difference between the machine and staff. This assumption might be used unless an applicant actually realizes the difference.

<Assumption 7> Key Parameter

Before the automation, an applicant arrival seemed to concentrate on the specific time zone as previously mentioned. Apparently, high concentration resulted in a long waiting time and total number of requests decided the overall waiting time as well. Therefore, key parameters for our simulation model are concentration and total number of daily request.

2.2.3. Result of Simulation

The simulation in 1994 was intended to observe the relationship between waiting time and concentration and between total demand and concentration and to determine whether the capacity meets the demand in each case: vending machine and staff service The purpose of 1994 simulation was summarized as below

- To confirm the time effectiveness brought by the automation
- To determine whether the capacity meets the demand in each case

The simulation showed the results as below:

<Sim. 1.1>

✓ Goal

To find the proper time to deploy or allocate additional staffs and machines in order to maintain the processing time of 15 minutes in cases of the concentration rate of 40% and 50%.

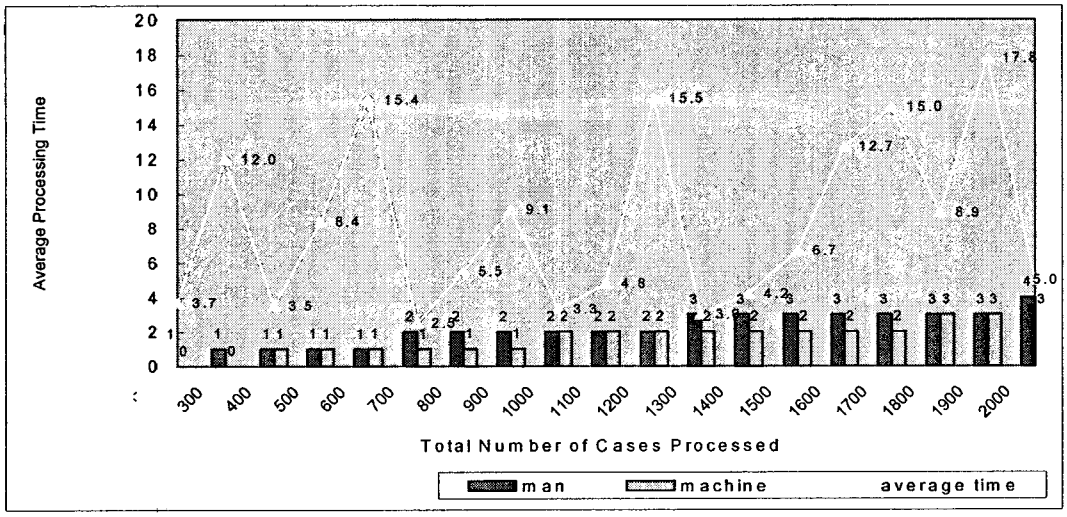
✓ Method

Increasing the number of applications by 100 from 300 applications per day to 2100 applications per day relatively at the concentration rate of 40% and 50% and allocate additional staffs and machines to maintain the 15 minutes waiting time. Staff is allocated first and then the machine in the sequential order of each one at a time.

✓ Result

To keep the processing time under 15 minutes, the mixed model requires one additional machine and staff at every 700 applications at 55% concentration rate and at every 900 applications at 40% concentration rate. The staff model requires one additional staff at every 600 applications at 40% concentration rate. For the 55% concentration rate, the result is shown in Figure 3.

<Figure 3. Processing times for mixed model with 55% concentration and 300~2100 daily request>



<Sim. 1.2>

✓ Goal

To identify the total number of processed applications with average processing time of 15 minutes at 40% concentration rate and 50% concentration rate.

✓ Method

Mixed model fixed the number of vending machine and staff as one to achieve the goal mentioned above while the staff model used one employee and the vending machine model used one machine in order to achieve the same goal.

✓ Result

8.4 minutes was needed to process 600 cases of work on average at 55% concentration rate in a given day while 15.4 minutes was needed for 700 cases of work at same concentration level. 12.6 minutes was need to process 900 cases of work at

40% concentration level while it took 15.8 minutes to process 930 cases of work on average. Therefore, only 700 or less cases of work can be processed within in 15 minutes at 55% concentration rate while 900 cases of work or less can be processed within 15 minutes at 40% concentration rate. Please refer to Table 1 for the staff/vending machine model results.

<Sim. 1.3>

✓ Goal

To find the total number of cases processed within 15 minutes at 40% concentration rate and 50% concentration rate.

✓ Method

The processing time could exceed over 30 minutes. In this case, we need to find the total number of works processed in which 99% of works could be done within 15 minutes. To figure out the number, we conduct the simulations in the forms of mixed, staff alone, and machine alone at the concentration rate of 55% and 40%.

✓ Results

On average, 12.4 cases consumed over 30 minutes under the circumstance where the total number of daily processed case was 800 and concentration rate was 40% in a mixed model. It was three times higher than the average processing time of the peak time. Under the similar conditions of the mixed model, more than 99% of the cases were processed within 14 minutes when the total of 700 cases are processed in a given day. The detailed results are as below.

< Table 1. Summary of simulation results in 1994 >

		Model	The Degree of Concentration	Total No. of Cases Processed	Results
Sim. 1.1	1.1.1	Mixed	55%	300-2100	One increase of Staff & Machine by 700 cases (works)
	1.1.2		40%		One increase of Staff & Machine by 900 cases
	1.1.3	Staff	55%		-
			40%		One increase of Staff by 600 cases
Sim. 1.2	1.2.1	Mixed (Staff 1, Machine 1)	55%	700	8.4 Min. consumed on average for 600 cases 15.4 Min. consumed on average for 700 cases → Maximum cases: 700

			40%	930	12.6 Min. consumed on average for 900 cases 15.8 Min. consumed on average for 930 cases → Maximum cases: 930
	1.2.2	Staff (1)	55%	405	10 Min. consumed on average for 385 cases 14.9 Min. consumed on average for 405 cases → Maximum cases: 405
			40%	580	9.1 Min. consumed on average for 525 cases 15 Min. consumed on average for 580 cases → Maximum cases: 580
	1.2.3	Machine (1)	55%	240	15.5 Min. consumed on average for 240 cases → Maximum cases: 240
			40%	330	14.4 Min. consumed on average for 330 cases → Maximum cases: 330
Sim. 1.3	1.3.1	Mixed (Staff 1, Machine 1)	55%	800	-
			40%		99% of the cases processed under 30 min. (Average service time in concentrated time: 8.9 Min)
			40%	700	99% of the cases processed under 14 min. (Average service time in concentrated time: 4.6 Min)
	1.3.2	Staff (1)	55%	400	99% of the cases processed under 30 min. (Average service time in concentrated time: 12 Min)
			40%		99% of the cases processed under 12 min. (Average service time in concentrated time: 3.3 Min)
	1.3.3	Machine (1)	55%	300	-
			40%		19% of the cases processed over 30 Min. (Average service time in concentrated time: 16 Min)

2.3. Simulation in 1997

2.3.1. Simulation Model

After the automation, certification issuance can be processed in both the mixed and simple method. In the mixed method a staff prints out the certificate document and

receives the next application simultaneously while in the simple method, a staff performs the tasks in sequence from its previous step. Simulation in 1997 was performed based on the mixed method.

2.3.2. Key Assumptions

<Assumption 1> Peak Time and Concentration

According to the research results, concentration rate reached 34% from 14:00 to 16:00 in a given day at most registry offices. Considering this trend, it is reasonable to assume from 14:00 to 16:00 is the peak time.

<Assumption 2> Probability Model Approach

Similar to the first simulation, an exponential distribution model was applied to the simulation in 1997.

<Assumption 3> Number of Certificate Issuance

A single certification issuance request is consisted of three parts: details on the number of different application type, the number of certificate copies requested, and the number of real estate involved. We estimated the composition rate to identify the standard processing time required for each case of work. The estimation results using the data from year 1995 are as follows.

Definition

Number of application : the unit of application (request) form submitted by applicants
Number of Sojaejibeon : the number of different real estates in a single application
Number of real estate : the total number of real estate included in a single application (land and building are separately calculated)
Number of issuance : the number of certification issuance in a single application

Raw data used in 1995

Total number of application : 21,729,787
Total number of issuance : 49,703,961

Estimation and Assumption

Number of Sojaejibeon / Number of applications: 1.2
Number of real estate / Number of Sojaejibeon: 1.6

Number of issuance / Number of real estate: 1.2

The Combination rate of work per a single application

Number of Sojaejibeon: 1.2

Number of real estate: 1.2 x 1.6 = 1.9

Number of issuance: 1.2 x 1.6 x 1.2 = 2.3

<Assumption 4> Standard time for work (case) processing

We assumed the standard time for work (case) processing was 138 seconds for staff while it is 215 seconds for vending machine. This standard time largely increased compared with that of 1994. The reason for this increase was that there were many activities (ex., instant TP call or loading time for printing out) which were not captured because it was before the AROS implementation. In 1994, we assumed the printing time for average of 1.5 pages was 3 seconds while it was 4 seconds for 4 pages in 1997.

✓ Staff

After a test with AROS Ver 1.0 based on assumption 3, we estimated that the average processing time by staff per application is 131.4 seconds. From that, we decided that the average processing time by staff is 138 seconds, considering additional 5% of reserve time.

✓ Vending Machine

When the processing time for vending machine was assumed to be same with that of staff and taking account of the skill level of each staff, the standard processing time was 199.5 seconds on average for vending machine based on our observation. However, the variance of processing time for machine is larger than that of staff. Thus, we assume that the average processing time of machine is 215%, considering additional 8% slack.

<Assumption 5> Maximum waiting time for an applicant

The simulation model sets the 15 minutes as the maximum waiting time as suggested from BPR project at the Supreme Court in 1994 for service during the peak time.

<Assumption 6> Queue

There was no particular mentioning about the length of queue, however, we used same assumption applied in 1994.

<Assumption 7> Key Parameter

Apparently, high concentration brought a long waiting time, and total number of processed cases affects the waiting time as well. Therefore, key parameters for our simulation model are concentration and total number of daily processed cases.

<Assumption 8> Rate of demand increase

An average of 10% increase per year was estimated until 2003. This estimation was based on the 6 year data from 1990 to 1996.

2.3.3. Results of simulation

The simulation in 1997 was intended to determine whether capacity meets the demand in each case; vending machine, staff service, and mixed service. The level of needed capacity for each case is as follows:

<Sim. 1.1> Mixed Process

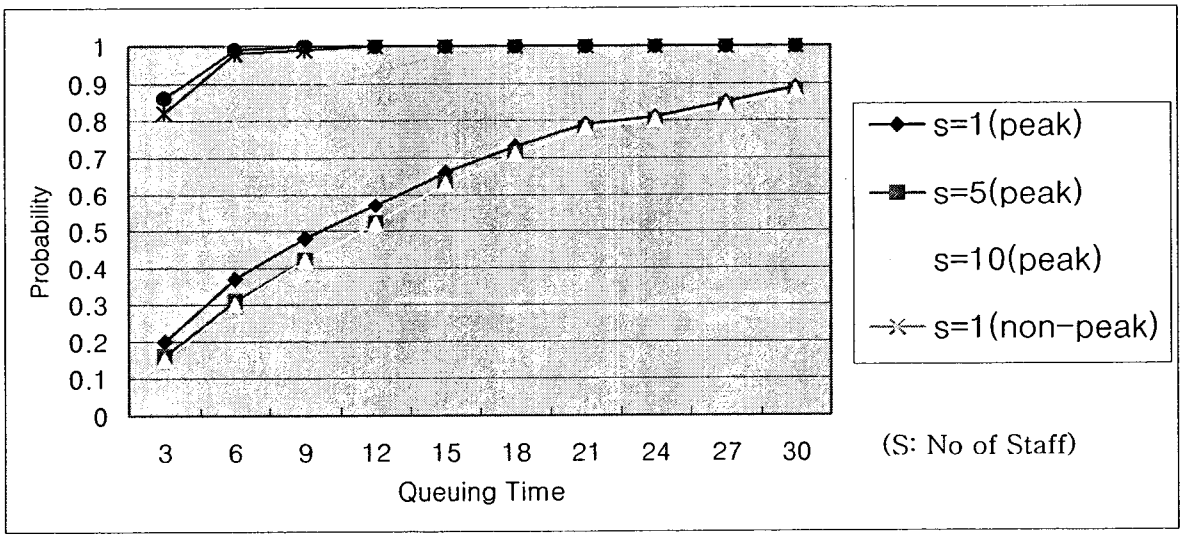
In order to keep the average waiting time under 15 minutes during the peak times, the mixed process has to increase a number of staff by one for every 240 cases of application on a daily basis. Under such circumstance, only about 65% of applicants could receive the standard service which consumes 15 minutes for issuance during the peak time. And roughly 90 % will receive within 30 minutes during the peak time. However, 10 minutes is enough to provide service during the non-peak time. The detailed simulation results are summarized in Table 2 and displayed in Figure 4.

<Table 2. The upper limit of daily issuance and the average waiting time at the peak, depending on the number of staff>

	No. of Staff							
	1	2	3	4	5	10	15	20
Queuing time before printing[1](Min.)	13.514	14.084	14.079	14.191	14.269	14.290	14.207	14.264
Queuing time for printer(Min.)	1.406	1.001	0.882	0.832	0.807	0.773	0.768	0.767
Total queuing time (Min.)	14.92	15.085	14.961	15.023	15.076	15.063	14.975	15.031
Customers serviced in a day (No./Day)	213	454	694	934	1,174	2,374	3,574	4,775

♦ 1) Queuing Time = Service Time + Waiting Time

<Figure 4. The transition of cumulative probability at the peak and non-peak time, depending on service time>



<Sim. 1.2> Vending machine process

To keep the waiting time under 15 minutes, the mixed process has to increase the number of machines by one for every 100 cases of application on a daily basis. Please see Table 3 for specific results.

<Table 3. The upper limit of daily issuance and the average waiting time, depending on the number of machine>

		No of Machine							
		1	2	3	4	5	7	9	10
Machine Service Rate (No of Applicants / Min.) [1]		0.279	0.558	0.837	1.116	1.395	1.953	2.512	2.791
Peak Time	Applicants Average Queuing Time (Min.) [2]	15	15	15	15	15	15	15	15
	Applicants Arrival Rate (No of Applicants/Min.) [3]	0.212	0.487	0.764	1.041	1.319	1.876	2.433	2.712
Daily Average (The Number of Applicants / Day.) [4]		75	175	275	375	475	675	875	975
Non-Peak Time	Applicants Average Queuing Time (Min.)	0.140	0.321	0.504	0.687	0.871	1.238	1.606	1.790
	Applicants Arrival Rate (No of Applicants/Min.)	7.194	5.361	4.658	4.299	4.092	3.871	3.761	3.727
Average on the day	Applicants Average Queuing Time (Min.)	0.159	0.365	0.573	0.781	0.989	1.407	1.825	2.034
	Applicants Arrival Rate (No of Applicants /Min.)	8.333	6.267	5.361	4.858	4.549	4.195	4.000	3.938

: The value is calculated considering the standard time of business process and the level of public service

1) The service rate of vending machine by the min.: the number of machine × (1 / the process time of machine by the work 3.6 Min.)

2) Average waiting time on the level of public service: 15 Min.

3) The upper limit of arrival rate by the min. to maintain an average waiting rate at the peak by the maximum 15 min.

4) The upper limit of processing cases on a daily basis for maintaining an average waiting rate at the peak under 15 min.: the arrival rate at the peak (per min.) × 120 min. (2~4 o'clock) × 3 (concentration rate at the peak: 34%)

<Sim. 1.3> Combined case

To determine the optimum resource allocation at each level of customer service, the simulation was performed using different allocation rates of 2:1, 3:1, and 4:1 between staff and machine. Please refer to Table 4 for results.

<Table 4. Mix of staff and machine>

One machine per two staffs			One machine per three staffs			One machine per four staffs		
Cases	Staff	Machine	Cases	Staff	Machine	Cases	Staff	Machine
215	1	0	215	1	0	215	1	0
455	2	0	455	2	0	455	2	0
530	2	1	696	3	0	695	3	0
770	3	1	770	3	1	935	4	0
1,010	4	1	1,010	4	1	1,010	4	1
1,110	4	2	1,250	5	1	1,250	5	1
1,350	5	2	1,490	6	1	1,490	6	1
1,590	6	2	1,590	6	2	1,730	7	1
1,690	6	3	1,830	7	2	1,970	8	1
1,930	7	3	2,070	8	2	2,070	8	2
2,170	8	3	2,310	9	2	2,310	9	2
2,270	8	4	2,410	9	3	2,550	10	2
2,510	9	4	2,650	10	3	2,790	11	2
2,750	10	4	2,890	11	3	3,030	12	2
2,850	10	5	3,130	12	3	3,130	12	3
3,090	11	5	3,230	12	4	3,370	13	3
3,330	12	5	3,470	13	4	3,610	14	3
3,430	12	6	3,710	14	4	3,850	15	3
3,670	13	6	3,950	15	4	4,090	16	3
3,910	14	6	4,050	15	5	4,190	16	4

3. Investigation and analysis of certification issuance process in 2001

3.1. Overview and analysis

There was no radical process change in the year 2001 in comparison with BPR in 1994. In the normal certification issuance process, an applicant enters the registry office and completes the request slip and waits in line with a ticket number. Then, when it is his or her turn, the person makes the service request at the service desk as the number of next available service desk lights up on the digital board. Using the vending machine, as soon as users insert fees and enters the required information, a certification gets printed out immediately.

The site visits of the registry office where computerization is completed revealed that combination system of staff-assisted and vending machine is used in most cases. Further, they were managing the operation in a parallel mode where the application cases were processed at the same time printing and certifying tasks were being handled We conducted field observation, interviews and data analysis to evaluate the current certification issuance process. First of all, we not only interviewed the persons in

charge of previous simulation experiment to collect the detailed information, we also analyzed the data gathered at the time and reviewed the related report. In addition, we selected two registry offices in Seoul with highest issuance rate and conducted on-site investigation. Through on-site investigation, we measured waiting time and processing time in certification issuance process for staff-assisted case and vending machine case by distinguishing the peak time and non-peak time. We collected and analyzed the data related to current status of certification issuance in the registry offices in Seoul from March 2000 to August 2001.

3.2. On-site investigation of registry office

Concentration rates of 40% and 55% are assumed in the simulation model in 1994. Thus registry office for site investigation was selected from large cities where a high concentration rate could be expected. As a result, registry office A and registry office B with the highest rate of certification issuance among registry offices in Seoul were selected for site visits. The results of on-site investigation are as follows (see Table 5):

<Table 5. The results of observation on the registry offices>

Comparison		Registry office A	Registry office B
Date of observation		August 21~22, 2001	August 21, 23, 2001
Status	Staff	6	7
	Machine	3 (2 broken, 1 operating)	3 (1 broken, 2 operating)
Total Issuance	Average (8.18~8.22)	2392	3100
	On the day of observation	2553	3673
Peak Time		4~6 (p.m.)	11 (a.m.), 4 (p.m.)

Registry office A had low concentration and the workload of a staff was not higher than expected. We found the cases were processed under 15 minutes around 4 pm which was assumed peak time. In contrast, we observed that there was much higher concentration in registry office B than in registry office A and the number of applicants soared in a short time as well. Although the staff handled work without any break time due to increasing number of applications, the number of applicants who waited over 15min. was still high and there were many cases where it took a longer time to receive the service.

In case of registry office B, they deployed public service members to assist the people who were not experienced with using the vending machine when the concentration was high in certain time. As a result, registry office B was able to reduce the waiting time. But this was an exceptional case. We found that in both registry office A and registry office B, there always were people who come from judicial scrivener office or real estate agency to request certification issuance as part of their job responsibilities. The process involved a person making certification issuance request at the service desk and using the vending machine and another partner taking the issued certifications periodically when the documents accumulate in stock.

Not only did they show excellent abilities to utilize the vending machine compared with the general applicants, they also helped the applicants who were not familiar with using the vending machine.

3.3. Comparison between simulation and current status

3.3.1. Comparison between simulation assumptions and current status

There are some discrepancies between current status of certification issuance in the year 2001 and the assumptions applied in the year 1994 and 1997. Although it was assumed the 2pm~4pm was the peak time in the simulation model, we observed the real peak time was 11am and 4pm. It revealed that the standard work handling time in current status is longer than it was assumed in the simulation. The assumption that the queue lengths of staff-assisted service desk and vending machine are same is not appropriate because it was revealed that applicants showed complex and various arrival pattern in real situation. The results of comparing each simulation assumption and current status were presented in Table 6.

The difference between simulation results and current status results stemmed from the discrepancies between simulation assumption and real situation. In section 3.4, the reasons for the discrepancies will be discussed in more detail.

<Table 6. The comparison of the assumptions of Simulations and the real situation>

		1994	1997	2001
Assumption 1	Peak Time	2~4 (p.m.)		11 (a.m.), 4 (p.m.)
	The degree of concentration	40%, 55%	34%	Concentration rate is alleviated.
Assumption 2	The application of probability model	Assuming the arrival rate of customers as following an exponential distribution		Following the assumption of an exponential distribution
Assumption 3	The number of issuance on an application	Unclear	2.3 on the average	The individual variance is high
Assumption 4	The standard time of business process in issuing	Staff : 37 sec. Machine : 63 sec. (assuming an exponential distribution)	Staff : 138 sec. Machine : 215 sec. (assuming an exponential distribution)	The time is taken longer than estimations in 1994, 1997
Assumption 5	The upper limit of waiting time	15 min.		Adopting as a guide line of the Supreme Court
Assumption 6	The length of Queues on line of machine and staff	Assumed to be same	No comment (estimated to be same)	The variance is high. The activity patterns of customers are somewhat unpredictable.
Assumption 7	Key Parameter	Key parameters (concentration rate, total number of works)		The concentration rate and the total number of works still works, but the concentration rate of each registry office is not so different.

3.3.2. Comparison between simulation results and current status

*** Are the number of vending machine and service staff reasonable based on the total number of processing cases and the level of concentration?**

As we conduct on-site investigation of registry office A and registry office B, we can consider its appropriateness. It was impossible to compare current resource deployment with the suggested resource deployment in the year 1994 because the number of issuance per application was not clearly stated. However it is possible to compare current resource deployment with the simulation results in the year 1997. Although both of the registry offices currently have more number of service staff and vending machine than the number suggested in the year, there was a large difference in terms of the level of public service. Registry office A processed most of certification issuance applications in 15 minutes but registry office B didn't. This result showed that the resource deployment as suggested in the year 1997 was not appropriate. The

reasons for the results obtained will be discussed in section 3.4.

*** Is the average processing time under 15 min.?**

The Table 7 presents the average processing time which is the sum of applicants' waiting time and service time. In case of registry office A, both service staff and vending machine processed the certification issuance within 5~6 minutes. In case of registry office B, the processing time by service staff was over 15 minutes whereas it was over 8 minutes using the vending machine. Consequently, this observation showed the relatively higher processing time was required for registry office B than in registry office A. We did not separate non-peak time and peak time because actual peak time was observed around 11am and 4pm for a short time only.

<Table 7. The average processing time by each registry office>

		Office A		Office B	
		Non-peak	Peak	Non-peak	Peak
Staff	Average Service Time	284.6 sec.		866.8 sec.	
	Standard Deviation	220.7 sec.		353.9 sec.	
Machine	Average Service Time	334.2 sec.		502.8 sec.	
	Standard Deviation	171.9 sec.		360.1 sec.	

*** Was 99% of total number of certification issuance in a given processed within 15 min.?**

In case of registry office A, most of the certification issuance was processed within 15minutes. In case of registry office B, although 80% of applicants waited for less than 15minutes, 40% of applicants had to wait for more than 15minutes, until the certificate was issued. This meant that the total service time took more than initially expected. However, we found that vending machine processed the certification issuance more efficiently than service staff so vending machine guaranteed better results than service staff. Table 8 shows the ratio of waiting time and total service time under 15 minutes for registry office A and registry office B.

<Table 8. The ratio of processing time within 15 minutes>

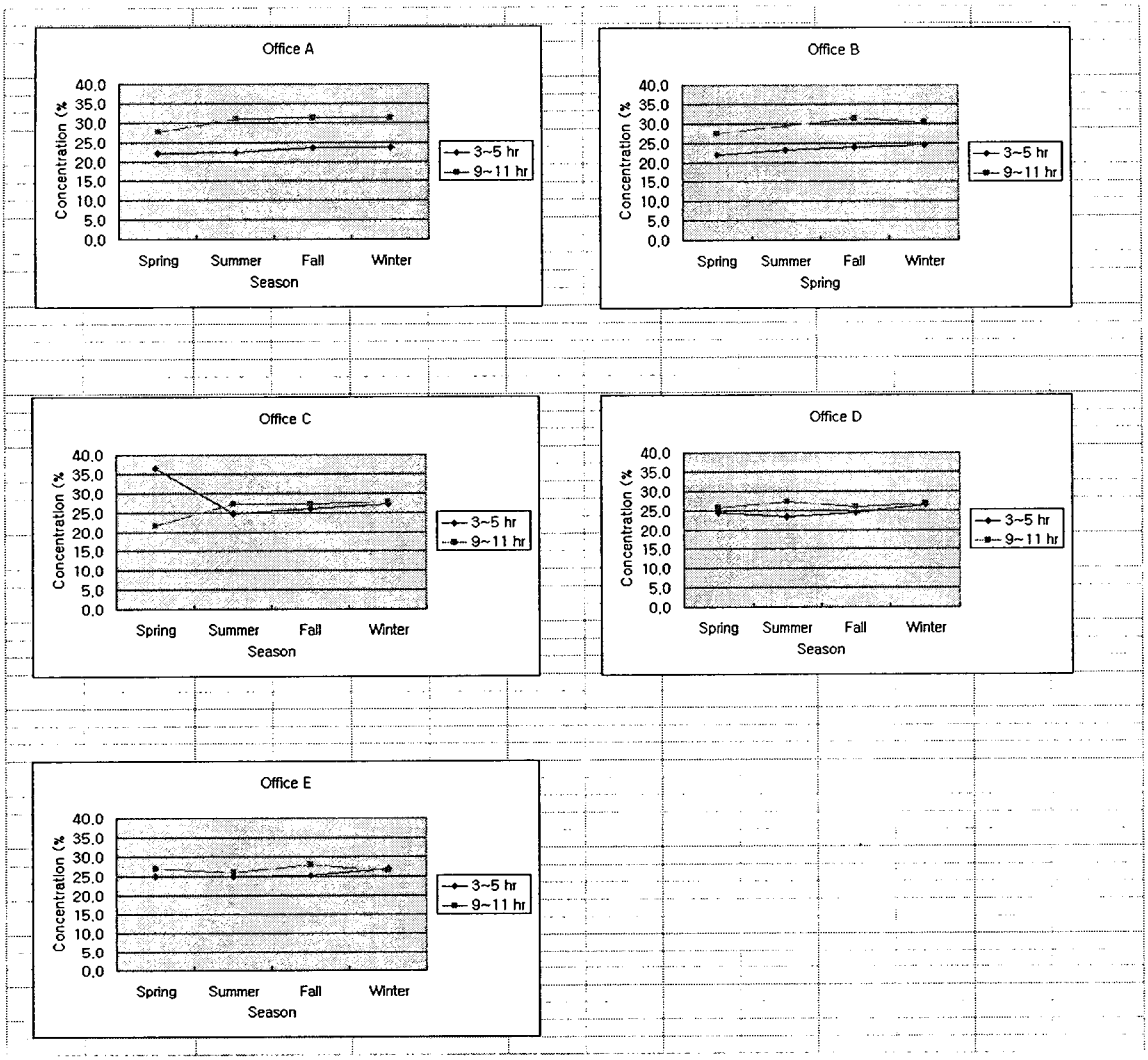
		Office A		Office B	
		Non-peak	Peak	Non-peak	Peak
Staff	Waiting Time	100%		80.0%	
	Queuing Time (Waiting + Service)	97.3%		60.0%	
Machine	Waiting Time	100%		92.5%	
	Queuing Time (Waiting + Service)	100%		87.5%	

3.4. Root-cause analysis: the analysis on the difference between simulation and status quo

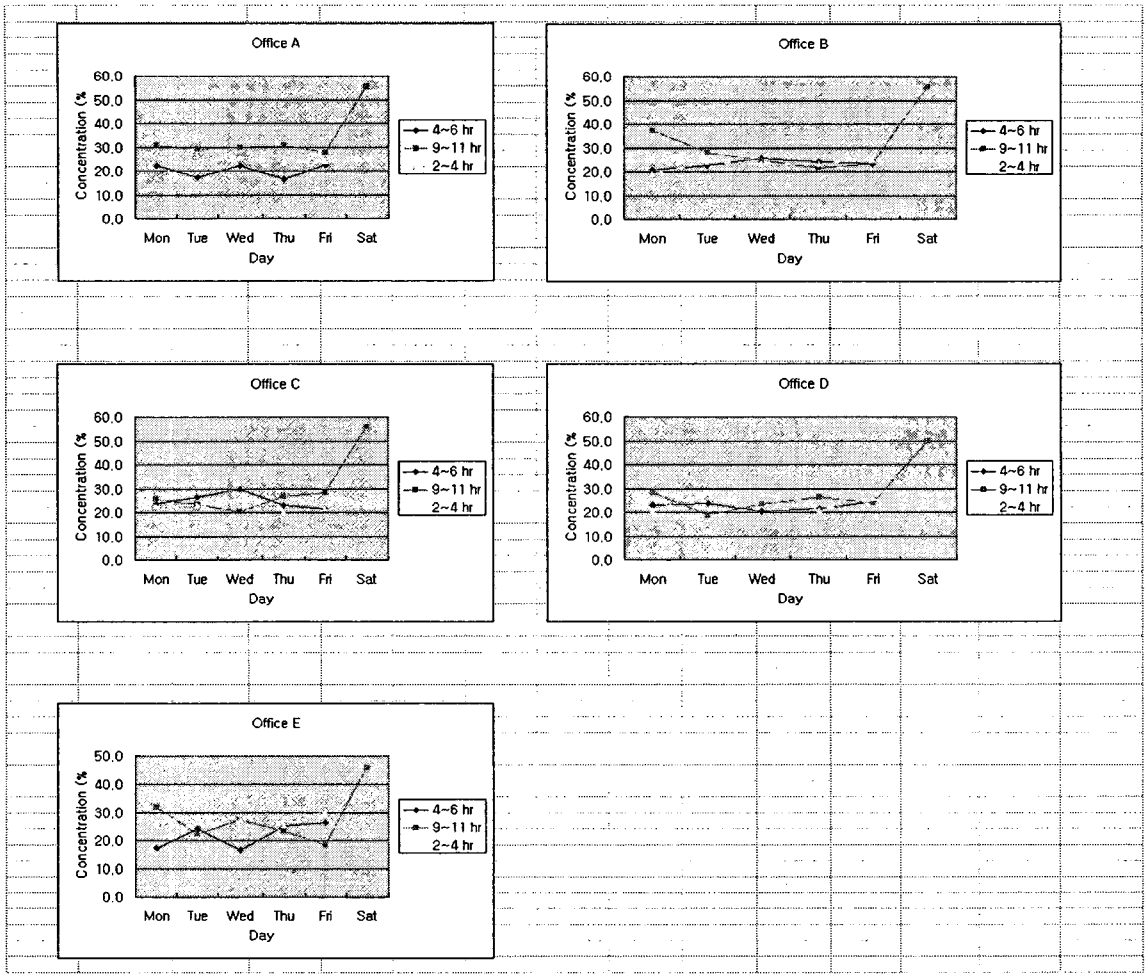
3.4.1. <1> The difference occurred after the computerization

Less concentration: The simulation in the year 1994 set the range at maximum of 55% and minimum of 40%. However, observing the number of issuance data from March 2000 to August 2001, analysis showed less concentration. When analyzed by season, as shown Figure 5 there was a certain level of concentration regardless of time period. When analyzed by day, there was constant concentration ranged from 20% to 30% except Saturday where the concentration occurred in the morning time as shown Figure 6. Despite the fact that the concentration of applicants was observed, there wasn't actual concentration considering the data based on the number of issuance.

<Figure 5. The change in the rate of concentration by season>



<Figure 6. The change in the rate of concentration by day>



The main reason for the above results is the process improvement after the computerization. In other words, when there was a high concentration, waiting time increased due to the time required to process an application. But after the computerization, certification issuance process became more efficient as the processing time decreased per application and the waiting time decreased as well due to the better traffic management with the use of vending machines.

3.4.2. <2> The difference in actual operation process

Inefficient resource deployment without considering unique situation of each registry office: From March 1, 2000 to February 28, 2001, registry office A and registry office B issued 2,343 per day and 2,816 per day respectably. The difference between registry office A and registry office B was 473 per day. Let's make a comparison with the

simulation results in the year 1994. The simulation results of the year 1994 suggested to input 1 human resource and 1 machine per 900 cases at 40% concentration rate. But as there is no clear assumption about the number of issuance per application, it is impossible to make a direct comparison by using the number of issuance. However, assuming that the number of issuance per application was 2.3 in 1997, it became possible to make the necessary comparison. By extracting the data related with registry office A and registry office B in Table 9, the relevant comparison of simulation results can be made in the year. According to the simulation results in the year 1997, it was suggested that 4 service staffs and 1 vending machine in registry office A and 5 service staffs and 1 vending machine with 3:1 ratio of service staff vs. vending machine. Actually, registry office A placed 6 service staffs and 3 vending machines and registry office B 6 service staffs and 3 vending machines. This resource allocation was more excessive than the suggested number from the simulation in the year 1997.

<Table 9. The mix of staff and machine>

One machine per two staffs				One machine per three staffs			
Works	Issuances	Staff	Machine	Works	Issuances	Staff	Machine
1,010	2323	4	1	1,010	2323	4	1
1,110	2553	4	2	1,250	2875	5	1

However, assuming that the resource deployment was appropriate, the workload of employee at each registry office was observed. We observed that the employee in registry office A processed an issuance task with ease and took a break and then moved on to next issuance task. Nevertheless, registry office A processed almost 100% of issuance cases within 15 minutes. In contrast, the staff of the service desk in registry office B worked without any break. However, the ratio of issuance cases processed within 15 minutes was significantly lower than in registry office A. This means that registry office A has a surplus of resource and registry office B has resource shortage.

In another perspective, we observed that the total number of issuance per day in registry office A was 2,553 which meant that there was not much difference between average number of issuance per day and per year. However in the same day, the total number of issuance per day in registry office B was 3,673. This means that there were 800 issuance difference in comparison with the average number of issuance per year.

In calculating the right number of staff and machine, the variance of issuance also needs to be considered with the average number of issuance per day. To allocate the resources in a registry with large variance, we need to secure more resources in

reserve to prevent a shortage of resources.

Inefficient resource utilization (frequent breakdown of vending machine) : Both registry office A and registry office B had three vending machines. However the only one vending machine worked in registry office A and two vending machines worked in registry office B. The president of registry office also complained about the frequent breakdown of vending machine. The frequent breakdown of vending machine is one of the reason for increasing concentration because this caused work overload at the service desk thereby increasing the average waiting time.

3.4.3. <3> The difference caused by the difficulty in designing a mathematical model

Applicants' complex and diverse behavior pattern: One of the important assumptions in the year 1994 was that the total length of line was same regardless of the system. This assumption states that the applicants join the line, which has less people waiting regardless of using the service desk or vending machine for service when they arrive at registry office. We made observations which supported this assumption. While some applicants pulled a number ticket for receiving the service at the service desk but they actually stood in line in front of the vending machine. Then they moved to the faster line. This is one of factors that made the line length remain equal. In this situation, a thrown number ticket was reused by other customers arriving late and this violated the "FIFO" assumption of receiving the service.

In contrast, we can easily observe the situation that results in different line length. Regardless of the waiting line length, the difference in the level of familiarity with vending machine and its acceptance has influenced some group of applicants to prefer one form of service to the other. For example, we observed that elderly applicants would not use vending machine and the line of service desk was significantly increasing even though there less people waiting in line for using the vending machine. The fundamental reason for this inefficiency is the applicants, who have previous experience of using service desk and vending machine, didn't move to the line for using the vending machine just because the waiting line length was short. In other words, applicants did not consider waiting line length but total service time so they joined the line that they were serviced as soon as possible.

As a result, the model should be modified to reflect this situation. Despite the problem, it is hard to consider all the complex and diverse behavior patterns in simulation model and this produce the difference between simulation model and real

situation inevitably.

3.5. Recommendation for improving issuance process and further considerations

Assure the quality of vending machine: We found frequent breakdown and mal-function of vending machine in both registry offices. In case of registry office A, only one vending machine among three was working properly. In case of registry office B, two vending machines among three were working and last one was out of order. The reasons for breakdown are mal-functioning of touch-screen and printer and so forth. Registry office employees complained about frequent breakdown of vending machine and addressed the need for quality improvement.

Software upgrade: Although the program installed in the vending machine provided satisfactory interfaces, it still required the complex process for the user who were not familiar with the computer. We frequently observed that many applicants made a minor mistake in typing address so they had to move back to previous screen and re-type. In this situation, it is desirable that users are allowed to select accurate category by suggesting another similar address. By improving the interfaces, it is possible to reduce the time required to certification issuance using the vending machine.

Allocate more part-time employees under the concentration situation: Registry office B utilized public service members to assist applicants who want to use vending machine but are not accustomed to when there is extreme concentration and traffic. In this situation, it is more effective to deploy part-time employees than regular service staffs.

4. The evaluation and suggestion on simulation method

4.1. The effectiveness and evaluation of simulation method

After examining the effectiveness of simulation method used in the computerization project of the Supreme Court, we made some evaluation on the project.

First of all, as mentioned in the beginning of this report, the meaning of simulation is to forecast the need of future and optimize the usage of resources. The computerization project of registry offices is a huge project requiring enormous time and money in computerizing data accumulated before the establishment of Korean government

This is such an unprecedented case that nobody can be sure what problems might arise and how much resources and manpower are required in the project. In such circumstance, the commencement of the project with rough estimate without using simulation could lead to numerous trial and errors and end at predetermined inefficiency Thus, simulations used in 1994 and 1997 should be regarded as a good trial to prevent those possible inefficiency and waste of resources.

Secondly, the two registry offices observed in this research are in the high level of issuance rate in Seoul. As shown in the table 10, the issuance number of the registry office B office is far greater than that of other major offices.

<Table 10. The annual number of issuance of major registry offices> (200.3 - 2001.2)

Registry Office	Office B	Office A	Office C	Office D	Office E
No. of Issuance	844,816	702,950	613,988	508,974	457,009

Considering the business of those registry offices, it is very encouraging that 80% of applicants record the maximum 15 minutes in waiting and 60% of applicants complete their business less than 15 minutes. The other registry offices are supposed to be in better condition than those business registry offices. Thus, allocating staff and machine as suggested in the simulation results seems to maximize the efficiency of issuance process.

Thirdly, the computerization project of the Supreme Court has taken so long time that the simulation conducted additionally in 1997 was appropriate to reflect various changes occurring during the project. The simulation in 1997 implemented the unexpected changes of business process incurred by the development of AROS system and improved the modeling by clarifying ambiguous assumptions in 1994. Consequently, the simulation in 1997 could be more suitable to real situations and secure more accurate results than in 1994.

4.2. The suggestion on the use of simulation method in the future

Up to now, the computerization project of the Supreme Court is the only case of utilizing the simulation at LG-EDS Systems. The reasons for rare use of simulation are as follows.

- Customer's satisfaction level is not high despite the huge expense incurred in developing a complicated mathematical model and making an experiment.
- More simple the modeling is, more easier the results are. If the modeling is easy, it is hard to reflect the real situations and clients easily challenge it. On the other hand, if the modeling is complicated, it is difficult to analyze and calculate results. Such being the case, it is hard to take a balanced approach.

In spite of these hardships, the simulation method can secure more accurate and reliable estimates than the spreadsheet and flowchart in modeling complicated and dynamic business processes. Therefore, there is a strong need for continuing to use and develop the simulation method.

Firstly, the objective of simulation should be set in the initial stage of the project. The list of problems to be solved has to be defined in advance and the measurement criteria for results should be available as well.

Secondly, communication with decision makers has to be conducted efficiently. It is required to confirm the right selection of problems and the fitness of modeling with decision makers. Without this confirmation, an impractical model can be applied even though it is valid in a technical sense. The model might not be realistic when used in making a decision and solving a problem. The example of registry office A reflects on this issue.

In registry office A, the waiting time in non-peak time was very short and the level of customer satisfaction was high even in peak time. Thus, there was a need to examine whether excessive resources are allocated in registry office A. Even though the objective of public affairs is to focus on public service, an abuse of resource causes a burden on people.

To solve this resource allocation problem, we can divide the service time into peak-time and non-peak time then differentiate the allocation of machines and service staffs depending on the time selection. In the peak time, we can employ student workers or public agents serving for national service duty to enhance the quality of service. Also, we can reduce the whole expenses without compromising the quality and sustain the level of quality in the peak time as in the non-peak time.

However, unforeseen variances could happen. For example, agents from judicial scrivener offices or real estate agencies can apply a great quantity of register papers in the non-peak time. If we did not forecast a sudden increase in issuance and decrease the number of machine and staff in the non-peak time, we could not prevent a severe concentration. Such being the case, our attempt to reduce cost with maintaining certain

level of customer satisfaction could lead to an amplification of customer dissatisfaction. The balancing between the enhancement of service quality and the reduction of expenses comes down to the issue of resource allocation and eventually to maximizing the efficiency of decision making.

Thirdly, to utilize simulation, a good knowledge of simulation method and probability/statistics is required. Conducting simulation based on the knowledge of simulation package only is so risky. To perform a simulation analysis, a thorough knowledge of simulation method is requisite. Namely, the understanding of the validity of modeling, the probability distributions of input variables, and the design of simulation are requested. Furthermore, the knowledge of probability and statistics is needed.

Fourthly, the complexity of model has to be controlled. The common mistake in simulation process is to devise a model so complicatedly to heighten the adaptability of model to real situations. We need to start a model in an appropriate level of complexity and elaborate it in each level with examination of professionals and decision-makers. The case in which all sides of system need to be considered is scarce. It is also restricted by time and money to work out a complicated model.

Fifthly, it is important to extract key parameters of systems. In the process of modeling business processes, we need to figure out key elements of the system and collect data. In the simulation reviewed in this paper, it seems to be appropriate to choose the concentration rate and the total number of issuance as key parameters. The concentration rate and the total number of issuance have a critical impact on the waiting time and the total processing time for customers.

Sixthly, the arrival interval of customers and the service processing time are not to be fixed. The usual mistake in simulation modeling is using an average value of certain time without using an appropriate probability distribution in consideration of system randomness. For example, assuming that there is a queue system with single service staff and the average arrival interval is one min. and the average service time is 0.99 min., the two parameters follow an exponential distribution. Then the average number of cases in waiting for service is about 98. On the contrary, when the parameters do not follow an exponential distribution and the number is fixed as constant value of 1 and 0.99, the number of cases in waiting for service is zero. This might be an unusual example, but it is a common mistake.

Finally, it is important to select an appropriate probability distribution. Simulation performers commonly assume a normal distribution for task processing time. However most of real cases do not follow normal distributions. In the preceding example, the arrival interval of customers is skewed to one side. If this is overlooked and a normal

distribution is assumed, then the number of people in waiting in the queue would be underestimated. Thus, it is advisable to observe real data and assume an appropriate distribution in order to conduct a fitness test and perform the simulation.

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