Application of System Simulation in Mechanical Improvement of Express Processing Center

Fan Wang[1], Xiao Cui[2], Xia Hu[1]

1 *Department of Express Delivery and Logistics*
Shijiazhuang Posts and Telecommunications Technical College
Shijiazhuang, HeBei, China
2 Accounting Institute
ShiJiaZhuang Vocational College of Finance & Economics
Shijiazhuang, HeBei, China

***Abstract* — The methods of simulation and related problems are explored by combining the actual improvement of a mail processing center of EMS. The paper discusses the basic steps, research contents and modeling solutions of the express processing center simulation, shares the difficulties and corresponding solutions during the modeling, displays the conclusion through the simulation experiment and thus reflects the application value of system simulation in the express processing center.**

Keywords - system simulation; express; mail processing center; Flexsim

I. INTRODUCTION

China's express industry develops rapidly with the increasingly prosperous shopping online. In the express network, the express processing center is the dispatching center of express mails, responsible for receiving, sorting, sealing, dispatching, transferring as well as transporting express mails and playing an important role in the express chains. China's EMS network includes 168 provincial dispatching bureaus of national express mails (short for 168 bureaus) which are the hub of EMS network and whose business handling capability directly affects the operation efficiency of the entire network.

However, not all of 168 bureaus have realized the automation, even a part of processing centers does not realize mechanization at all and they still stay in the manual processing phase. When the business volume grows to a certain degree, the disadvantages of manual processing will become prominent. High labor intensity and low processing efficiency will be very difficult problems.

During the mechanical improvement, many links after the improvement should be prospectively planned as a whole, such as the layout of equipment, staff allocation, adjustment of work flow and work standards, etc. Relying on the traditional means, the managerial personnel only arrange by their experience. In this case, the deployment plan lacks of far-sight significance, generality, details supporting and data supporting, so the managerial personnel need to continuously adjust the work plan for long time; on the other hand, the staff also need some time to adapt to new equipment, new procedure and new standards, which increases the difficulty in the management to some extent. In order to solve above problems, it is necessary to introduce the logistics system simulation technology to simulate the mechanical improvement of mail processing centers.

The logistics system simulation refers that the actual or planned logistics system will be modeled on the computer and the parameters which plays a main role in the logistics system will be input into the model to keep the computer model and the main attributes of logistics system consistent; the operation result could represent the operation result of logistics system. People could use the computer simulation model to fast and economically arrive at the typical simulation result and guide the planning and management of logistics system by analyzing the simulation result.

The system simulation technology is closely related to the logistics. It plays a more and more important role in the logistics enterprises' actual operation and creates hundreds of billions of dollars of economic benefits every year. Some professional logistics system simulation software platform could provide the most basic function elements to greatly simplify the programming of simulation.

For the research on the logistics simulation software in the mail, many scholars at home and abroad have had all aspects of tries. K.PRESTON(1999) uses AutoMod to provide the help for the postal sorting simulation system developed by Lockheed Martin Corporation [1]. Liang Zhenzhen(2011) uses AutoMod to simulate a postal district center according to the modular simulation modeling solution which focuses on the reusability of models, speeds up the modeling and is good for the promotion of simulation technology [2]. Wang Yun(2003) applies QUEST to simulate push-type suspending and journal package sorting line of Urumqi postal district center [3].

However, there is no simulation for the express sorting center in lots of literatures. The paper explores methods of simulation and related problems by applying Flexsim software, combining the actual improvement of a mail processing center of EMS. The concrete process includes present situation investigation, improvement plan

investigation, simulation modeling and analysis of simulation results.

II. PRESENT SITUATION INVESTIGATION

The present situation investigation aims at understanding the working status before the improvement and precisely grasping the needs of mechanical improvement of the express processing center. The investigation results are as follow.

A. Sorting Site

The sorting site covers an area of 5263m2, stretching 81.47m east to west and 64.60m north to south; the platform of south site covers an area of 487m2, stretching 81.47m east to west and 5.98m north to south. The warehouse-in working site, warehouse-out working site and platform are set in the south of sorting site.

B. Staff Allocation

There are over 80 sorting operation staff in the processing center. The total number of people will change because of the bigger liquidity. The sorting operation staff is divided into two groups: export operation and import operation. The export operation group is responsible for sorting the taken mails in the area into 168 directions (including this city) and organizing the transportation after packaging. At present, there is 42 staff in this group, 30 of who are divided into 10 groups (receptions) and responsible for sorting. Each group is responsible for over 10 directions. The import operation group is responsible for sorting the mails from other regions and delivering the mails to the drop-off locations from 5 branches and counties in this region.

The export operation is more complex and representative, so the paper will focus on the simulation analysis for the mechanical improvement of export operation group. Without otherwise specified, the involved data later will be for the export operation group.

C. Business Volume

The export operation group normally handles about 15000 mails every day. Economic express mails account for about 1/3 while standard express mails account for about 2/3. A part of mails are transferred to the processing center in the form of scattered mails and account for about 1/3. Other mails need to be sorted after unpacking the packages. It is understood that about 1500 mailbags are unpacked every day. The collection type of business volume is as shown in Table. 1.

TABLE 1 BUSINESS VOLUME DIAGRAM OF EXPORT OPERATION GROUP

Date	Mails	Packages	Weight(KG)	Date	Mails	Packages	Weight(KG)
1st	14159	1926	16285	2nd	14963	1853	17783.23
			.....				
28th	9788	1375	12465	29th	14215	1685	15684.29

The above data is fitted with Flexsim built-in distribution fitting tool ExperFit as shown in Fig. 1. The fitting result shows that the number of handled mails every day satisfies Weibull distribution and the distribution parameter is weibull (3203.758245, 12587.159442, 4.518267).

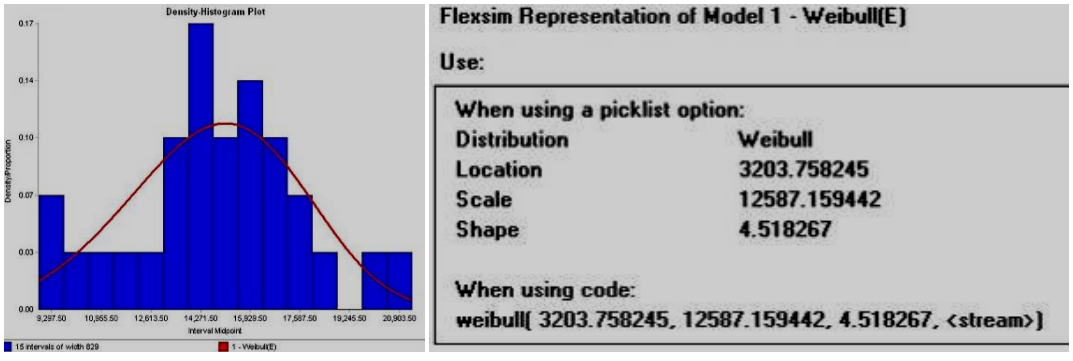

Figure 1. Business Volume Distribution Fitting Diagram of Export Operation Group.

D. Internal Processing Work Flow

The main work flow of export operation group is as shown in Fig. 2.

The mail sorting includes two steps: rough sorting and careful sorting. Rough sorting refers that the mails are given to the receptions; careful sorting refers that each reception sorts the mails to different directions and the mails are finally sorted into 168 directions.

E. Regular Mail Trucks Returning Plan

The export group is on duty at 16:00 every day and 9 regular mail trucks will return and be unloaded from 12:00 to 13:30. The export group arranges 1 or 2 staff to unload and transfer. The mails will be processed after 16:00. 25 regular

mail trucks will return and be unloaded from 18:00 to 20:00.11 regular mail trucks will be loaded and sent to 4 directions for collecting and scattering from 19:00 to 24:00. The specific returning plan is as shown in Fig. 3.

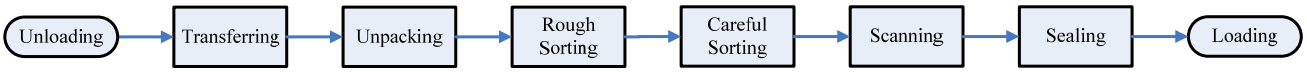

Figure 2. Main Work Flow of Export Operation Group.

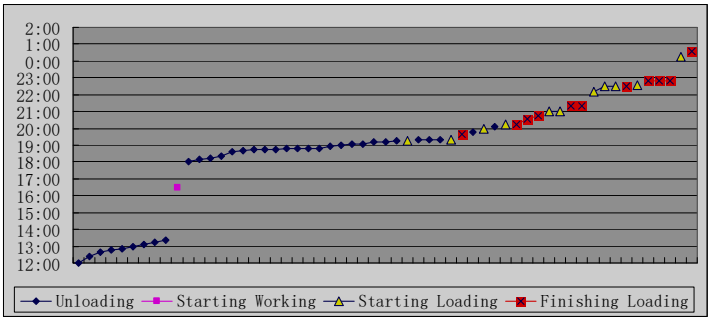

Figure 3. Regular Mail Trucks Returning Plan of Export Operation Group.

III. IMPROVEMENT PLAN

The mechanical improvement plan of export operation group should be overall understood as much as possible during the investigation, such as equipment layout plan on the site and business process optimization plan. The simulation is determined according to the importance and difficulties in the improvement plan.

A. Equipment Layout Plan

The equipment layout plan of export operation group's mechanical improvement is finally determined according to the size of site, internal structure, parameters of sorting equipment and business structure, as shown in Fig. 4.

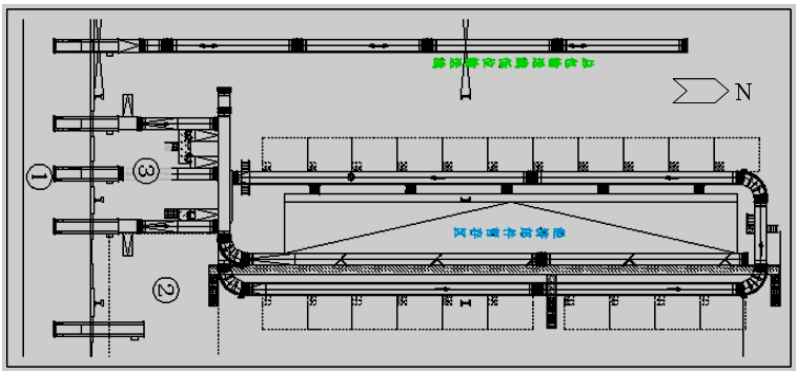

Figure 4. Equipment Layout plan.

According to the layout plan, the export group can set at most 21 sorting receptions (dotted area) and properly decrease the number of receptions for the current business volume. The west lower conveyor is used to send the sorted and sealed packages out of the sorting site for loading. The east sorting receptions need to send the packages to the lower conveyor with a long distance and moving around to the north, so in the early stage of mechanical improvement, the sorting receptions are mainly arranged at the west sorting conveyor.

In order to first sort the standard express mails, the sorting conveyor on the site is divided into upper and lower layers. The lower sorting conveyor is used to send the standard express mails to the sorting receptions and the staff sorts manually; the upper sorting conveyor is used to send the economical express mails to the temporary-storage section. When the lower sorting conveyor is available, the mails in the temporary-storage section will be sent to the lower sorting conveyor to be sorted. The lower sorting conveyor turns in an anticlockwise direction and forms a ring to make the mails not be sorted in time to return the aborting receptions again.

B. Process Optimization Plan

As shown in Fig. 5, the export group's mails processing procedure after the improvement is as follows.

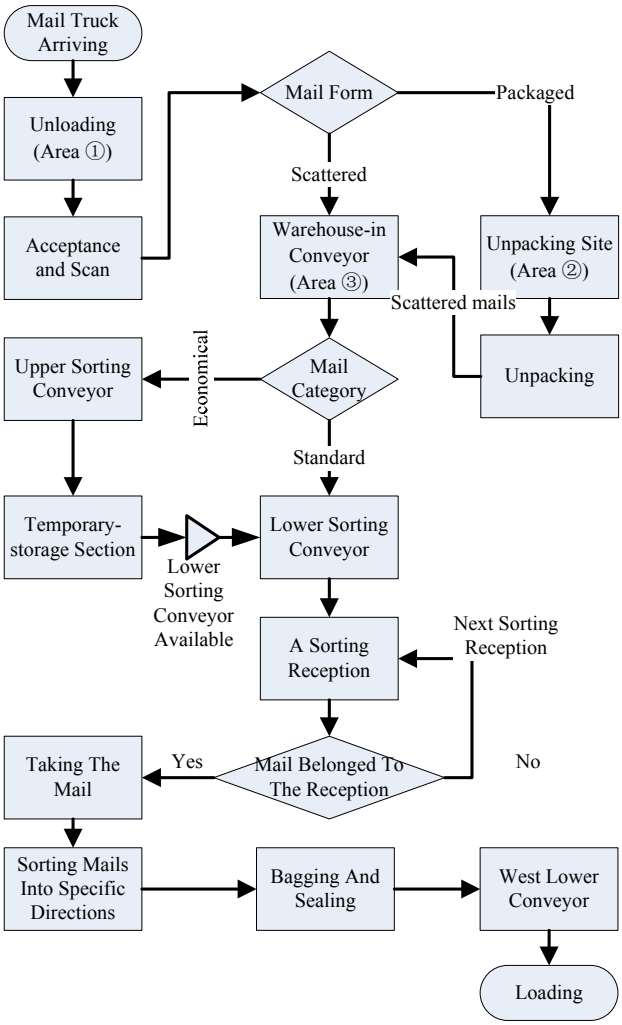

Figure 5. Process Optimization Plan.

First, the mail trucks are unloaded at the platform and the pickup staff will hand over, do the acceptance and scan. Then the unpacking staff sends the packages to the unpacking site for unpacking and puts the mails on the warehouse-in conveyor. The scattered mails will be directly put on the warehouse-in conveyor and preliminarily classified by the sorting staff. The economical express mails will be put on the upper sorting conveyor; standard express mails will be put on the lower sorting conveyor. Each sorting reception will be equipped with two sorting staff. After the lower sorting conveyor sends the mails to the sorting reception, a sorting staff takes the mails belonging to their reception and puts on their own sorting area; the other one sorts the mails into the specific directions. After the completion of sorting, the sorting staff puts the mails into the mailbag to seal. When the export mail trucks reach, they will send the mailbags to the west lower conveyor and the mailbags will be out of the warehouse and loaded onto the mail trucks.

IV. MODEL BUILDING

The simulation model will be built applied Flexsim simulation software and based on the above investigation data. The main goals of simulation include determining the best number of receptions, judging the change of employment and judging the productivity and development capacity after the improvement. The model should be kept flexible and extendible to realize the simulation for different work plans by simple operations [4,5].

First, the necessary entities including blueprint, equipment, staff, auxiliary entity and paths should be added in the model. As shown in Fig. 6, the model includes main equipment and staff on the sorting site and deploys according to four aspects in terms of the whole conception including equipment (blueprint), auxiliary, paths and staff. Equipment and staff are the entities in the reality, the auxiliary entities are to finish the operating logic of model and the paths regulate the walking paths of staff.

Second, the connection between entities should be built according to the process after the improvement. Many parameters will be set and in many cases the global table is used to help to set the parameters. At the same time, the logical relationship of model is set by the code to keep the operational status of model in line with the current situation.

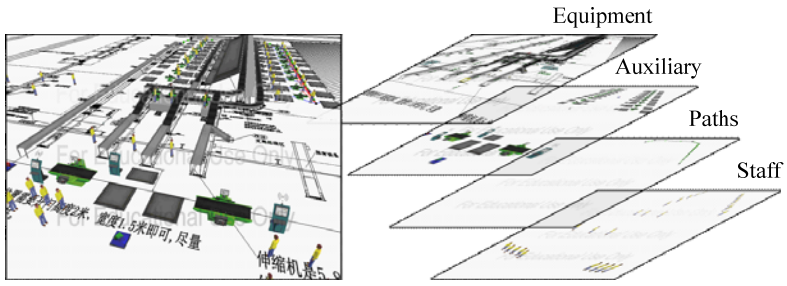

Figure 6. Hierarchical Structure of Simulation Model.

V. SETTING METHODS OF MAIN NODES

A. Source

As shown in Fig. 3, there is a strict returning time for unloading the regular mail trucks. In order to simulate the unloading time, the source will be set as the arrival schedule and the arrival times are 26. The number of mails every time is written into the global table by resetting triggers and read if necessary.

There is no need to precisely simulate the unpacking of packages and the mails in them can be seen the special scattered mails which are different from the common scattered mails in the processing time that can be set in the processor, so the procedure of unpacking the package is not simulated in the model. In order to simulate the different processing directions of scattered mails and packaged mails, the output port of source is set by percentage.

B. Lower Sorting Conveyors

The model is expected to dynamically set the sorting receptions and automatically revise the number of sorting receptions by revising the data of global table. The spare receptions are closed in the code and 168 paths are roughly evenly assigned to the receptions which are put into use.

C. Processors of Sorting Receptions

The output port 1 of processors of sorting receptions is linked to a sink which aims at clearing the spare items. In this way, the model could simulate the bagging without combiners and become simplified.

D. Regular Mail Trucks

In order to simulate the packages which need to be put into the specific regular mail truck from different directions, 11 queues should be built to simulate 11 regular mail trucks. The packages from the corresponding direction are put into the regular mail truck with the pull strategy.

VI. SIMULATION ANALYSIS

Ensure that the model can correctly reflect the current situation by operating and debugging the model. The simulation data in different plans can be obtained via the experimenter [6], from which the corresponding conclusion of simulation can be gotten.

A. Best Number of Receptions

The corresponding best number of receptions is analyzed for the current business volume, as shown in Fig. 7.

Fig. 7displays the experimental data of 5 plans and 5 times of experiments are carried out for each plan; the vertical coordinate reflects the rate of mail processing. 5 plans from left to right are set as 7, 6, 5, 4, 3 receptions. It can be observed that when 7 receptions are set, all the mails can be processed; when 6 receptions are set, about 1/6 mails without being processed are left the next day; when the number of reception decreases, there are more mails without being processed. That is to say, 7 sorting receptions can satisfy the current sorting requirements and keep the employment least, so the best number of receptions is 7.

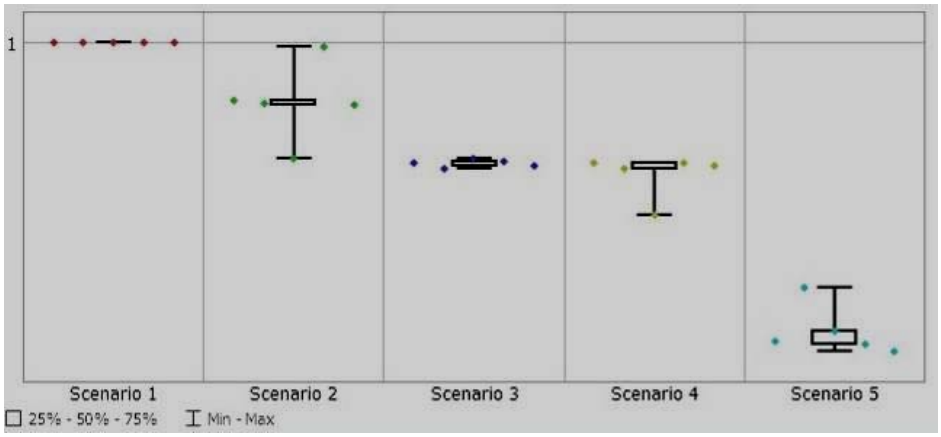

Figure 7. Computed Result of the Best Number of Receptions Experimenter.

B. Number of Employment

If the number of receptions keeps consistent with the current situation, namely, 10 sorting receptions, two staff at each sorting reception, 5 staff in charge of transferring, 3 staff in charge of scanning, 3 staff in charge of classifying of warehouse-in, 4 staff in charge of unpacking, 4 group leaders, 42 people are needed without considering the off-work rotation. 36 people are needed without considering the off-work rotation even if allocating according to 7 receptions. It is clear that the mechanical improvement cannot reduce the number of staff for the export operation group and its advantage is to decrease the staff's operating strength. In other words, that is "saving labor but not reducing the number of staff".

C. Avoid Explosive Storage

Observe the coping capacity of sorting system by increasing the business volume in the simulation model. The experiment finds that the setting of queue effectively relieves

the pressure of inadequate sites when the mails double, the mails can be placed in order and the piles of mails in the open air will not appear.

D. Development Capacity

At present, what the export operation group cares about most is the processing capacity of sorting line after the business volume doubles. According to the experiment, the situation is predicted after the business volume doubles. The result shows that when the number of receptions increases to over 10, the processing rate for mails can be assured to be higher than 98% and meets with the export operation group's actual needs. Therefore, after the export operation group's business volume doubles, the sorting line does very well against it and its processing capacity will be increased greatly.

CONFLICT OF INTEREST

The authors confirm that this article content has no conflicts of interest.

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