Article

Modeling and Simulation of Passenger Flow Distribution in Urban Rail Transit Hub Platform

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Abstract: Urban rail transit hub platform is the most important area for passenger flow distribution. In order to calculate passenger flow volume in platform and evaluate platform service level during rush hours, this paper presents a method for modeling and simulation of passenger flow distribution in platform. Passenger flow distribution model (PFDM) is proposed based on the basic analysis and the superposition principle of passenger flow. Simulation design for PFDM is proposed by Anylogic, which contains simulation process and simulation model. Experiment results show that PFDM and simulation design are effective and accordant with the reality scenario, and the simulation precision is comparatively ideal. This research could provide a beneficial reference for train scheduling and operation management under the viewpoint of traffic safety and service level.

Keywords: passenger flow distribution model; simulation design; performance evaluation; passenger flow volume; service level; urban rail transit hub platform

1. Introduction

In recent years, urban rail transit has become the main mode to ease traffic congestion. For an urban rail transit hub, the platform is the most important area for passenger flow distribution. Passenger flow volume in platform is the fundamental and crucial data for train scheduling and operation management under the viewpoint of traffic safety and service level. In order to calculate passenger flow volume in platform and evaluate platform service level during rush hours, this paper tries to present a method for modeling and simulation of passenger flow distribution in platform.

In summary, there were two sides to the related research on passenger flow distribution in urban rail transit, one side was the research on modeling and simulation of passenger flow distribution, the other side was the research on application of passenger flow distribution. The research purpose is to improve passenger traffic service quality and reliability. According to the hierarchy of modeling and simulation, passenger flow model contains macroscopic model, mesoscopic model and microscopic model. Early research mainly focused on the correlation among traffic flow, speed and density, research findings represented by Fruin J. J. [1] were adopted as an effective macroscopic analysis approach for passenger traffic in the US Highway Capacity Manual [2]. As the representative of mesoscopic model, lattice gas model was firstly proposed to passenger flow simulation by Muramatsu. M., et al. [3]. With the rapid development of computer technology, microscopic model was proposed and applied to simulation, which mainly included magnetic model [4], benefit cost cellular model [5], queuing network model [6], social force model [7] and cellular automata model [8,9]. On the other hand, application of passenger flow distribution mainly focused on traffic system planning, operation organization design, facility performance evaluation, emergency evacuation and so on.

Aiming at the research on passenger behavior analysis, passenger individual behavior model was firstly built by Gipps. P. G., et al. [5], and a simple route choice model was proposed with the short circuit law of passenger movement. Helbing. M. [10] proposed social force model to clarify the complex

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characteristic of passenger flow. Xiong. H., et al. [11] proposed a continuous-time random walk model to simulate the walking behavior of passenger flow. Lu. L. L., et al. [12] explored the effects of different walking strategies on bi-directional pedestrian flow in the channel with cellular-automata formulation. Daamen. W., et al. [13,14] analyzed the interrelation between passenger path-finding behavior and interlayer facility layout, experiment results showed that passenger flow crowd degree of interlayer facility was the key factor affecting route choice behavior directly. Duive. D. C., et al. [15] proposed the state-of-the-art crowd motion simulation models to explain the different phenomena of crowd motion such as lane formation, stop-and-go waves, faster-is-slower effect, turbulence and zipper effect. Guillermo H. G. [16] built a mathematical model of the formation of lanes in crowds of pedestrians moving in opposite directions. Bandini. S., et al. [17] improved the traditional floor field cellular automata model to simulate the negative interaction among pedestrians of high density.

Especially, aiming at the research on passenger flow distribution and service levlel in urban rail transit station, Seriani. S., et al. [18] explored the pedestrian traffic management of boarding and alighting in metro stations, obtained the management criteria of platform and metro doors by micro-simulator and laboratory experiments, results showed that service level, service time and passenger flow density could provide reference for pedestrian traffic management in metro systems. Zhang. Q., et al. [19,20] proposed a cellular automata-based alighting and boarding micro-simulation model, and a grid-based micro-simulation model for passengers in Beijing metro stations, simulation experiments with different alighting and boarding group sizes and ratios were developed for model verification, results indicated that efficiency evaluation of transfer stations should consider integrated effects of passenger flow volume, facility attributes and train timetable. Yang. Y. D., et al. [21] proposed a method for passenger flow simulation of subway entrance by Anylogic. Wang. G. and Gao. S. S. proposed passenger flow model in subway platform [22,23]. Wang. S. W. [24] built congestion index of transit station based on passenger flow simulation and gray clustering evaluation. Zhao. H. [25] proposed the service level of pedestrian facility and obtained the corresponding value range of passenger flow density in urban rail transit hub. Furthermore, there was the research on passenger dwell time. Schelenz. T., et al. [26,27,28] proposed an agent-based simulation method for calculating passenger dwell time and analyzing passenger preferences with different vehicle layout designs, results proved that the number of vehicle doors had a direct effect on passenger dwell time.

From the above research, it could be found that kinds of models and methods were widely used to explore passenger flow characteristic and behavior in urban rail transit station. However, there were little research on the passenger flow distribution during rush hours in hub platform under the viewpoint of traffic safety and service level. Therefore, the objective of this research is building an effective method for modeling and simulation of passenger flow distribution with different train headways during rush hours in hub platform, expected results could provide a beneficial reference for train scheduling and operation management.

2. Passenger Flow Distribution Model

2.1. Basic Analysis

(1) Passenger flow classification and distribution process

In urban rail transit hub platform, passenger flow could be divided into boarding passenger flow and alighting passenger flow according to passenger flow direction; furthermore, it also could be divided into transfer passenger flow and non-transfer passenger flow according to transfer demand inside. Passenger flow classification is shown in Figure 1, PF-i refers to the corresponding passenger flow, i=1,2,3,4.

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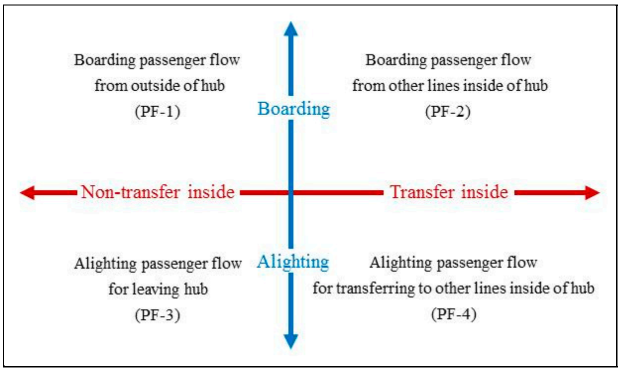


Figure 1. Passenger flow classification in hub platform

In urban rail transit hub platform, passenger flow distribution process refers to the traffic behaviors of passenger group dynamics influenced by platform facilities and train scheduling. Passenger flow distribution morphology is regularly changed with train headway. Passenger flow distribution process is shown in Table 1.

Table 1. Passenger flow distribution process in urban rail transit hub platform

Passenger flow classification	Passenger flow distribution process
PF-1	hub entrance → hub platform → train
PF-2	other lines inside of hub → hub platform → train
PF-3	train → hub platform → hub exit
PF-4	train → hub platform → other lines inside of hub

From Table 1, it could be concluded that there is a same target attribute to PF-3 and PF-4 in hub platform, which is to leave the platform. Therefore, PF-3 and PF-4 could be combined into the alighting passenger flow (PF-5).

Furthermore, during train dwell time, especially after opening train door, the process of passenger flow getting on or off the train includes two phases: alighting phase and boarding phase, as shown in Figure 2, "▲" refers to alighting passenger flow, and "●" refers to boarding passenger flow.

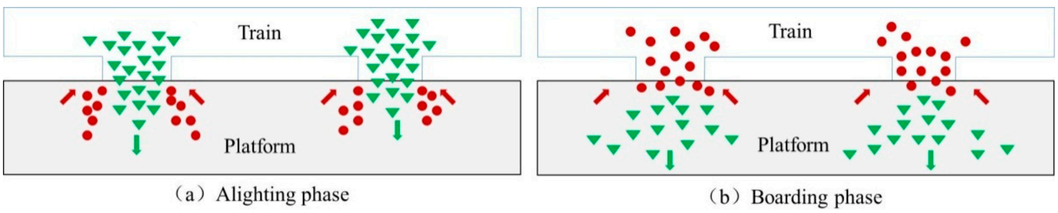


Figure 2. Alighting phase and boarding phase of passenger flow

(2) Influence factors of passenger flow distribution

Based on the relationship between interaction agents, influence factors of passenger flow distribution are derived from platform and train, which are shown in Table 2.

Table 2. Influence factors of passenger flow distribution

Interaction agents	Influence factors
platform	platform available area passage traffic capacity stairs traffic capacity escalator traffic capacity
train	train type train formation train headway train dwell time

2.2. Basic Definition and Assumption

(1) Island-type platform is selected for this research, which has been the most widely applied in urban rail transit hub in reality. As shown in Figure 3, for the platform of line k or line m, "+" refers to up direction, and "-" refers to down direction. And then, PF-1^{+} and PF-2^{+} refer to boarding passenger

flow for up train; PF-5$^+$ refers to alighting passenger flow from up train; similarly, PF-i$^-$ refers to the corresponding passenger flow for (or from) down train.

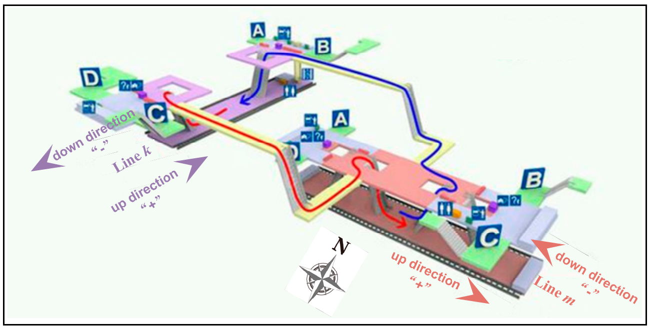


Figure 3. Structure schematic of island-type platform in urban rail transit hub

(2) Train headway is defined as the time interval between adjacent trains leaving platform in the same direction.

(3) During train headway, it is assumed that all of boarding passengers in platform could get on the train, and all of alighting passengers could leave the platform.

2.3. Passenger Flow Distribution Model

Based on the basic analysis above, it could be concluded that passenger flow distribution morphology in platform is regularly changed with the different train headway. Therefore, the sub-objectives of building passenger flow distribution model in platform are as follows:

(1) Setting up the change rule of passenger flow distribution morphology in platform during train headway.

(2) Calculating the maximum passenger flow volume and passenger flow density value gathered in platform.

(3) Analyzing the dynamic loads of platform facilities, and then evaluating the service level of platform.

During train headway, variation curves of passenger flow distribution in hub platform could be shown in Figure 4. Where, Δt refers to train headway, *s*; t_0 refers to the time when the prior train leaves hub platform, *s*; t_a refers to the time when alighting passenger flow from the prior train leaves the hub platform completely, *s*; t_b refers to the time when the current train door opens, *s*; t_c refers to the time when boarding passenger flow begin to get on the current train, *s*; $t_0+\Delta t$ refers to the time when the current train leaves hub platform, *s*; $t_0+2\Delta t$ refers to the time when the next train leaves hub platform, *s*. Furthermore, Δt^+ refers to train headway for up train, *s*; t_0^+, t_a^+, t_b^+ and t_c^+ refer to the corresponding time for up train, *s*; Δt^- refers to train headway for down train, *s*; t_0^-, t_a^-, t_b^- and t_c^- refer to the corresponding time for down train, *s*.

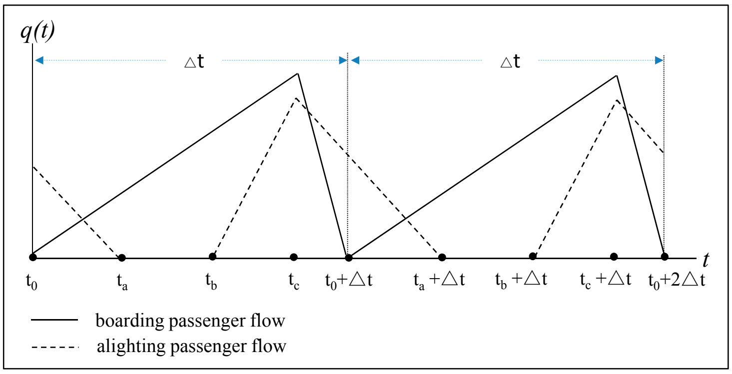


Figure 4. Variation curves of passenger flow distribution in hub platform

Firstly, passenger flow volume of PF-1$^+$ at time *t* is shown in Formula (1):

$$q_{(PF-1)}(t)^+ = \begin{cases} v_0^+ \cdot (t_c^+ - t_0^+) & t \in [t_0^+, t_c^+) \\ -v_1^+ \cdot (t_0^+ + \Delta t^+ - t_c^+) & t \in [t_c^+, t_0^+ + \Delta t^+] \end{cases} \tag{1}$$

And:

$$v_0^+ = \frac{Q_0^+}{T_0} \tag{2}$$

$$v_1^+ = \frac{v_0^+ \cdot \Delta t^+}{t_1^+} \tag{3}$$

Where, $q_{(PF-1)}(t)^+$ refers to passenger flow volume of PF-1$^+$ at time t in platform, p; v_0^+ refers to average arrival rate of PF-1$^+$ in period T_0, p/s; Q_0^+ refers to passenger flow volume of PF-1$^+$ in period T_0, p; T_0 refers to the rush hour, 3600s; v_1^+ refers to average boarding rate of PF-1$^+$, p/s; t_1^+ refers to boarding time of PF-1$^+$, $t_1^+ = t_0^+ + \Delta t^+ - t_c^+$, s. Because $\Delta t^+ > t_1^+$, so, $v_1^+ > v_0^+$. Similarly, passenger flow volume of PF-1$^-$ at time t could be defined and calculated.

Secondly, passenger flow volume of PF-2$^+$ at time t is shown in Formula (4):

$$q_{(PF-2)}(t)^+ = \sum_1^k \left[q_{transfer}^k(t_0^+)^+ + \int_{t_{k_1}^+}^{t_{k_2}^+} v_k^+ dt - \int_{t_c^+}^{t_0^+ + \Delta t^+} v_{2,k}^+ dt \right] \quad t \in [t_0^+, t_0^+ + \Delta t^+] \tag{4}$$

And:

$$v_k^+ = \frac{Q_k^+}{T_0 \cdot (\frac{1}{\Delta t_k^+} + \frac{1}{\Delta t_k^-}) \cdot (t_{\max}^k - t_{\min}^k)} \tag{5}$$

$$v_{2,k}^+ = \frac{v_k^+ \cdot \Delta t^+}{t_1^+} \tag{6}$$

Where, $q_{(PF-2)}(t)^+$ refers to passenger flow volume of PF-2$^+$ at time t in platform, p; $q_{transfer}^k(t_0^+)^+$ refers to passenger flow volume among PF-2$^+$ transferring from line k at time t_0^+ in platform, p; $t_{k_1}^+$ refers to the time when the first passenger among PF-2$^+$ arrives at platform from line k, s; $t_{k_2}^+$ refers to the time when the last passenger among PF-2$^+$ arrives at platform from line k, s; v_k^+ refers to average arrival rate of passenger flow among PF-2$^+$ transferring from line k in period T_0, p/s; Q_k^+ refers to passenger flow volume among PF-2$^+$ from line k in period T_0, p; Δt_k^+ refers to train headway of up train in line k, s; Δt_k^- refers to train headway of down train in line k, s; $t_{\max}^k$ refers to the maximum walk time from line k, s; $t_{\min}^k$ refers to the minimum walk time from line k, s; $v_{2,k}^+$ refers to average boarding rate of passenger flow among PF-2$^+$ transferring from line k, p/s. Similarly, passenger flow volume of PF-2$^-$ at time t could be defined and calculated.

Thirdly, passenger flow volume of PF-5$^+$ at time t is shown in Formula (7):

$$q_{(PF-5)}(t)^+ = \begin{cases} -v_4^+ \cdot (t_a^+ - t_0^+) & t \in [t_0^+, t_a^+] \\ 0 & t \in [t_a^+, t_b^+] \\ v_3^+ \cdot (t_c^+ - t_b^+) & t \in [t_b^+, t_c^+] \\ -v_4^+ \cdot (t_0^+ + \Delta t^+ - t_c^+) & t \in [t_c^+, t_0^+ + \Delta t^+] \end{cases} \tag{7}$$

And:

$$v_3^+ = \frac{Q_3^+ \cdot \Delta t^+}{T_0 \cdot t_3^+} \tag{8}$$

$$v_4^+ = \frac{Q_3^+ \cdot \Delta t^+}{T_0 \cdot t_4^+} \tag{9}$$

Where, $q_{(PF-5)}(t)^+$ refers to passenger flow volume of PF-5$^+$ at time t in platform, p; v_3^+ refers to average alighting rate of PF-5$^+$, p/s; v_4^+ refers to average rate of PF-5$^+$ for leaving platform, p/s; Q_3^+ refers to passenger flow volume of PF-5$^+$ in period T_0, p; t_3^+ refers to alighting time of PF-5$^+$,

$t_3^+ = t_c^+ - t_b^+$, s; t_4^+ refers to the walk time PF-5$^+$ for leaving platform, $t_4^+ = t_a^+ + \Delta t^+ - t_b^+$, s. Because $t_4^+ > t_3^+$, so, $v_3^+ > v_4^+$. Similarly, passenger flow volume of PF-5$^-$ at time t could be defined and calculated.

Therefore, based on the research above and the superposition principle for passenger flow, passenger flow volume in hub platform at time t is shown in Formula (10):

$$Q(t)=Q(t)^+ + Q(t)^-, \quad t \in [t_0, t_0 + \Delta t] \tag{10}$$

And:

$$\begin{cases} Q(t)^+ = q_{(PF-1)}(t)^+ + q_{(PF-2)}(t)^+ + q_{(PF-5)}(t)^+ & t \in [t_0^+, t_0^+ + \Delta t^+] \\ Q(t)^- = q_{(PF-1)}(t)^- + q_{(PF-2)}(t)^- + q_{(PF-5)}(t)^- & t \in [t_0^-, t_0^- + \Delta t^-] \end{cases} \tag{11}$$

Where, $Q(t)$ refers to passenger flow volume in hub platform at time t, p; $Q(t)^+$ refers to passenger flow volume for up train in hub platform at time t, p; $Q(t)^-$ refers to passenger flow volume for down train in hub platform at time t, p.

3. Simulation Design and Case Study

3.1. Simulation Design

(1) Simulation process

Anylogic is a professional simulation environment for virtual prototyping based on UML-RT, Java and differential equation. It is efficiently used for the simulation of complex systems which contain discrete system, continuous system and hybrid system [29]. So far, Anylogic is widely applied to the dynamic simulation in traffic. In this research, pedestrian library and rail library in Anylogic are adopted to design the simulation environment. Simulation process design of passenger flow distribution in hub platform by Anylogic is shown in Figure 5.

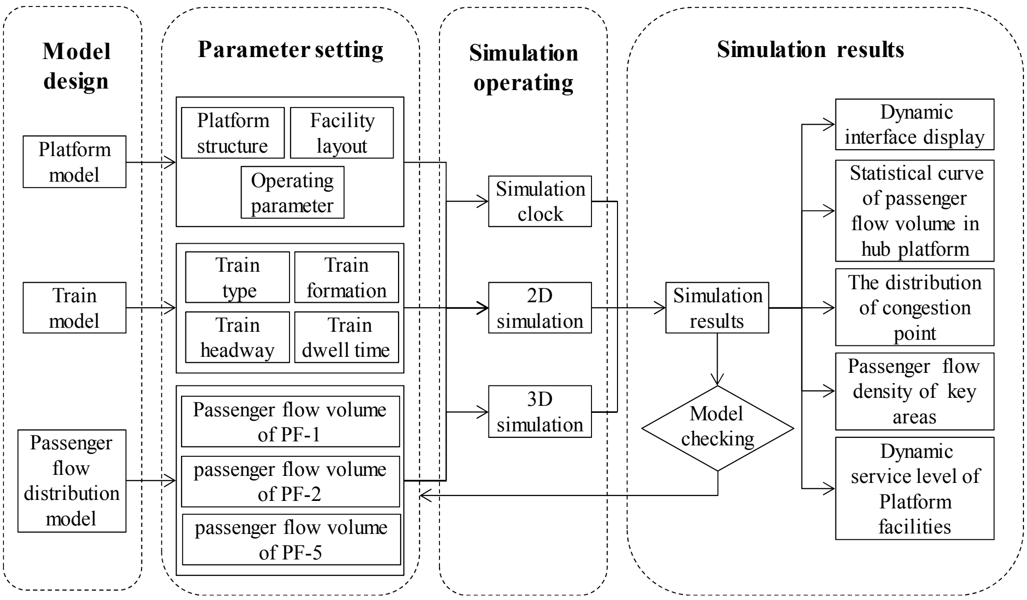


Figure 5. Simulation process design of passenger flow distribution in hub platform by Anylogic

(2) Simulation model

Firstly, simulation model of platform could be proposed according to platform structure and facility layout, and the scale of simulation model could be set as 10.5 pixels per meter, as shown in Figure 6.

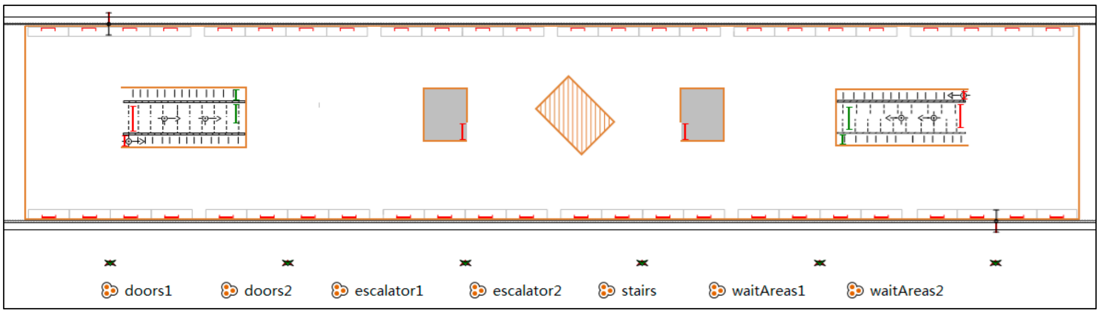


Figure 6. Simulation model of platform

Secondly, simulation model of train could be proposed according to rail library, as shown in Figure 7.

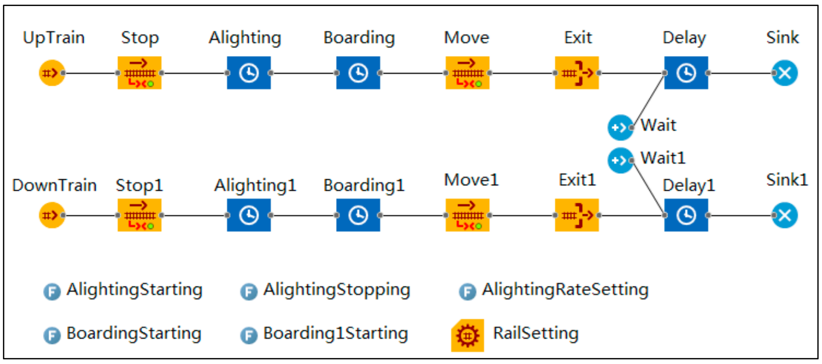


Figure 7. Simulation model of train

Thirdly, simulation model of passenger flow could be proposed according to pedestrian library, as shown in Figure 8.

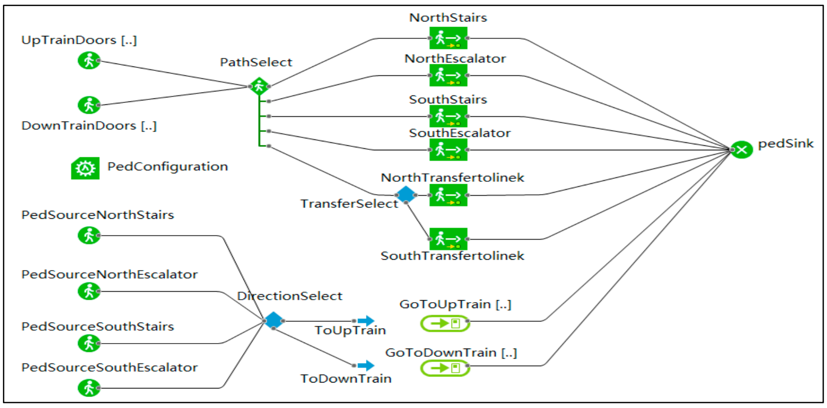


Figure 8. Simulation model of passenger flow

3.2. Case Study

(1) Experiment scenario and data

As an urban rail transit hub, Beijing South Subway Station contains subway line 4 and line 14, which is located in the underground of Beijing South Railway Station. It is convenient for passenger transfer among the different traffic modes such as high-speed railway, urban rail transit and urban public bus. The structure schematic of Beijing South Subway Station is shown in Figure 9. In this paper, subway line 4 platform is selected for case study.

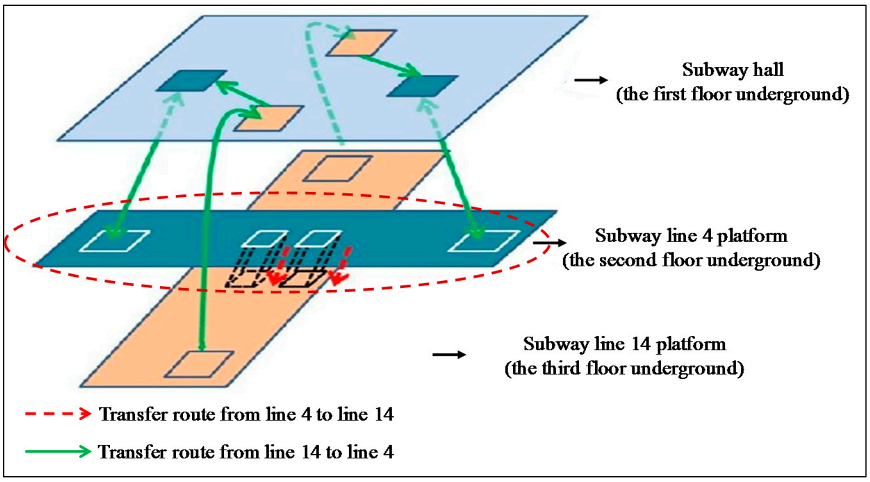


Figure 9. Structure schematic of Beijing South Subway Station

According to the practical investigation from June 6 to June 12, 2016 and data processing, parameters values of platform and train are listed in Table 3, parameters values of passenger flow distribution model are listed in Table 4.

Table 3. Parameters values of platform and train

Interaction agents	Parameter	Value	Unit
platform	available length of platform	115	*m*
	available width of platform	17	*m*
	available area of platform	1600	m^2
	available length of escalator	15.5	*m*
	available width of escalator	1	*m*
	the number of escalator	4	-
	available length of stairs	15.5	*m*
	available width of stairs	2.5	*m*
	the number of stairs	4	-
train	train type	type B	-
	train formation	6	-
	train length	115	*m*
	train width	2.8	*m*
	the number of doors	24	-

Table 4. Parameters values of passenger flow distribution model in rush hours

Rush hour	Symbol	Value	Unit	Symbol	Value	Unit
07:30-08:30	Q_0^+	6650	*p*	Q_0^-	950	*p*
	Q_k^+	2100	*p*	Q_k^-	300	*p*
	Q_3^+	4590	*p*	Q_3^-	1800	*p*
	v_0^+	1.85	*p/s*	v_0^-	0.26	*p/s*
	v_1^+	9.53	*p/s*	v_1^-	1.21	*p/s*
	$v_{2,k}^+$	22.56	*p/s*	$v_{2,k}^-$	2.94	*p/s*
	v_3^+	26.27	*p/s*	v_3^-	14	*p/s*
	v_4^+	2.39	*p/s*	v_4^-	1.08	*p/s*
	v_k^+	4.38	*p/s*	v_k^-	0.63	*p/s*
12:30-13:30	Q_0^+	2300	*p*	Q_0^-	650	*p*
	Q_k^+	800	*p*	Q_k^-	180	*p*
	Q_3^+	1500	*p*	Q_3^-	2050	*p*
	v_0^+	0.64	*p/s*	v_0^-	0.18	*p/s*
	v_1^+	3.30	*p/s*	v_1^-	0.84	*p/s*
	$v_{2,k}^+$	8.60	*p/s*	$v_{2,k}^-$	1.77	*p/s*

	v_3^+	8.58	*p/s*	v_3^-	15.94	*p/s*
	v_4^+	0.78	*p/s*	v_4^-	1.23	*p/s*
	v_k^+	1.67	*p/s*	v_k^-	0.38	*p/s*
	Q_0^+	5850	*p*	Q_0^-	3350	*p*
	Q_k^+	1000	*p*	Q_k^-	1800	*p*
	Q_3^+	2000	*p*	Q_3^-	5400	*p*
	v_0^+	1.63	*p/s*	v_0^-	0.93	*p/s*
18:30-19:30	v_1^+	8.39	*p/s*	v_1^-	4.34	*p/s*
	$v_{2,k}^+$	10.71	*p/s*	$v_{2,k}^-$	17.50	*p/s*
	v_3^+	11.44	*p/s*	v_3^-	42	*p/s*
	v_4^+	1.04	*p/s*	v_4^-	3.23	*p/s*
	v_k^+	2.08	*p/s*	v_k^-	3.75	*p/s*
	$t_1^+ = t_0^+ + \Delta t^+ - t_c^+$	20	*s*	$t_1^- = t_0^- + \Delta t^- - t_c^-$	30	*s*
	$t_3^+ = t_c^+ - t_b^+$	5	*s*	$t_3^- = t_c^- - t_b^-$	5	*s*
	t_4^+	55	*s*	t_4^-	65	*s*
07:30-08:30	$t_a^+ - t_0^+$	30	*s*	$t_a^- - t_0^-$	30	*s*
12:30-13:30	$t_b^+ - t_a^+$	48	*s*	$t_b^- - t_a^-$	75	*s*
18:30-19:30	$t_{\min}^k$	120	*s*	$t_{\max}^k$	140	*s*
	Δt^+	103	*s*	Δt^-	140	*s*
	Δt_k^+	300	*s*	Δt_k^-	300	*s*
	T_0	3600	*s*			

(2) Results analysis

Based on the research above, during the rush hours, the values of passenger flow volume in hub platform are calculated, as shown in Figure 10; probability density values of passenger flow volume in hub platform are calculated, as shown in Figure 11; and then, statistical results of passenger flow volume and density in hub platform are calculated, as shown in Table 5 and Table 6.

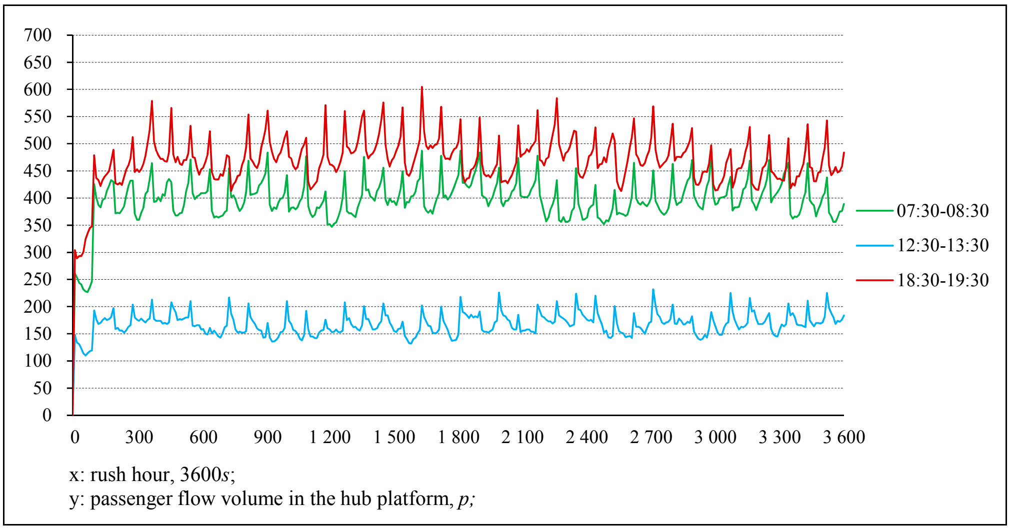


Figure 10. Statistical curves of passenger flow volume in hub platform

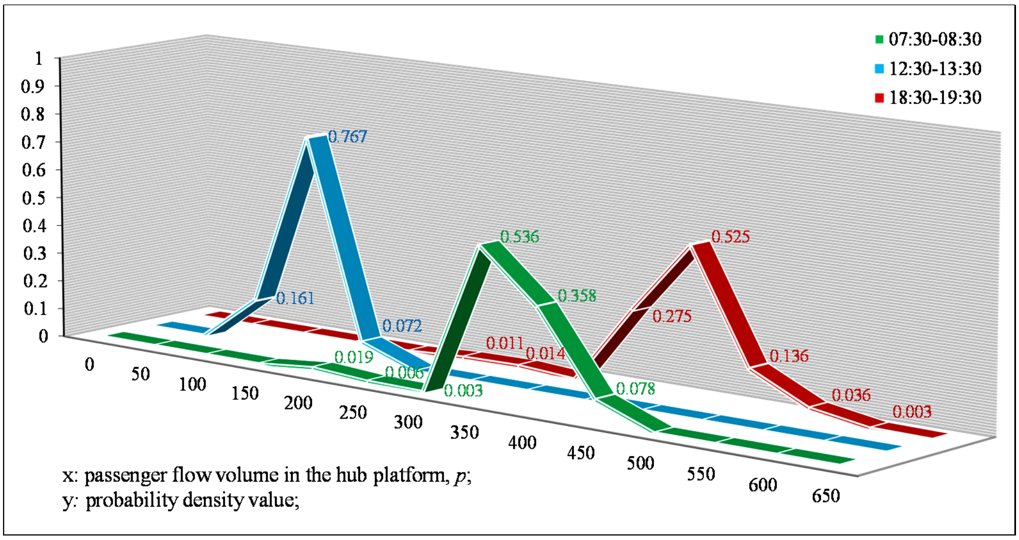


Figure 11. Probability density curves of passenger flow volume in hub platform

Table 5. Statistical results of passenger flow volume in hub platform

Rush hour	Numerical simulation		Actual statistic		Average error
	Maximum value	Average value	Maximum value	Average value	
07:30-08:30	487	396	473	379	
12:30-13:30	238	167	245	171	2.33%
18:30-19:30	605	468	612	467	

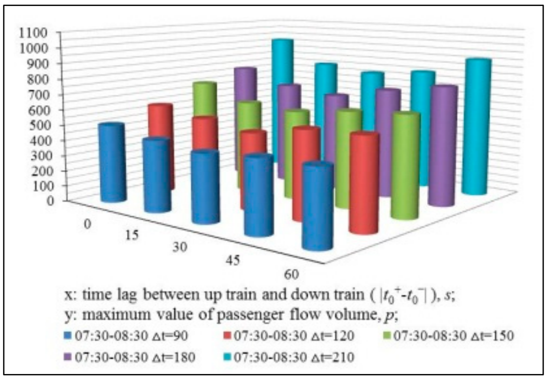
Table 6. Statistical results of passenger flow density in hub platform

Rush hour	Numerical simulation		Actual statistic		Service level of platform
	Maximum value	Average value	Maximum value	Average value	
07:30-08:30	0.30	0.25	0.30	0.24	C
12:30-13:30	0.15	0.10	0.15	0.11	A
18:30-19:30	0.38	0.29	0.38	0.29	C

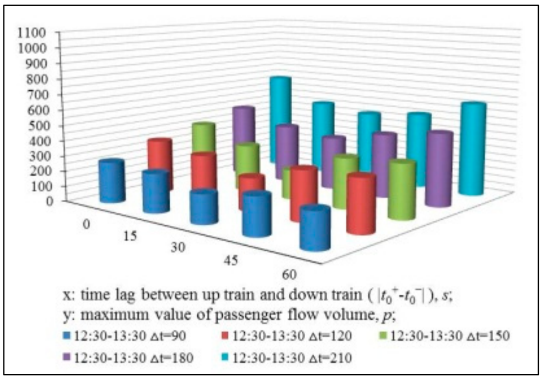
Furthermore, during the rush hours, with different train headways ($\Delta t = 90,120,150,180,210, s$) and different time lags between up train and down train ($\left|t_0^+ - t_0^-\right| = 0,15,30,45,60, s$), more experiments could be developed. The maximum values of passenger flow volume with different Δt and $\left|t_0^+ - t_0^-\right|$ during the rush hours are calculated, as shown in Table 7 and Figure 12.

Table 7. Maximum values of passenger flow volume with different train headways and time lags in hub platform

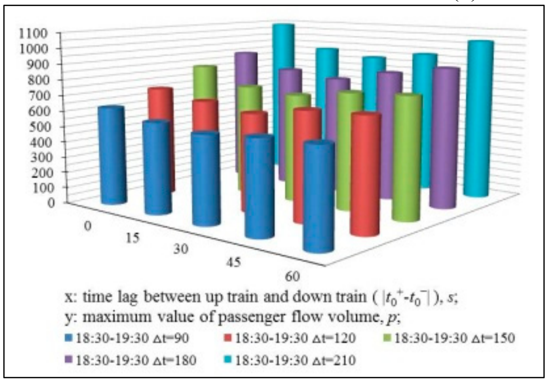
Rush hour	Train headway (Δt , s)	Time lag between up train and down train ($\left|t_0^+ - t_0^-\right|$, s)				
		0	15	30	45	60
07:30-08:30	90	506	456	427	455	463
	120	588	540	493	560	573
	150	701	599	578	620	642
	180	773	678	642	712	767
	210	963	801	763	798	908
12:30-13:30	90	266	251	187	239	223
	120	348	300	212	320	333
	150	408	306	194	327	349
	180	480	385	349	419	474
	210	670	508	470	505	615
18:30-19:30	90	625	574	548	575	587
	120	708	660	621	680	693
	150	826	715	693	743	760
	180	893	798	762	832	887
	210	1086	920	880	925	1032



(a) 07:30-08:30



(b) 12:30-13:30



(c) 18:30-19:30

Figure 12. Statistical histograms of the maximum passenger flow volume with different train headways and time lags in hub platform

Examining these tables and figures above, the following statements could be drawn:

(1) In Table 5, the average error of passenger flow volume between numerical simulation and actual statistic is 2.33%, it could be indicated that the simulation precision is comparatively ideal, passenger flow distribution model proposed in section 2 and simulation design proposed in section 3 are effective and accordant with the reality scenario.

(2) In Figure 10, Figure 11 and Table 5, it is shown that the maximum value of passenger flow volume from 18:30 to 19:30 (605, 18:30-19:30) is greater than any other maximum value in each rush hour (487, 07:30-08:30; 238, 12:30-13:30).

(3) In Table 6, the maximum value and average value of passenger flow density are less than $0.40p/m^2$, it could be indicated that the service level of hub platform during rush hours is reliable.

(4) In Table 7 and Figure 12, the minimum value among the maximum values of passenger flow volume with different train headways and time lags in each rush hour could be obtained as Δt=90 and $|t_0^+ - t_0^-| = 30$, which could provide a beneficial reference for train scheduling under the viewpoint of traffic safety and service level.

4. Conclusion

For an urban rail transit hub, hub platform is the most important area for passenger flow distribution. Passenger flow volume of hub platform has become the fundamental and crucial data for hub capacity design, operation management and train scheduling. In this paper, in order to research the dynamic variation regularity of passenger flow distribution and calculate the passenger flow volume of hub platform, a method for modeling and simulation of passenger flow distribution is proposed, and some conclusions are obtained as follows.

(1) Passenger flow distribution model is built based on the basic analysis and the superposition principle of passenger flow. Simulation design for passenger flow distribution model is built based on Anylogic, which contains simulation process and simulation model.

(2) Subway line 4 platform in Beijing South Subway Station is selected for case study, experiment results show that passenger flow distribution model and simulation design are effective and accordant with the reality scenario, and the simulation precision is comparatively ideal. Furthermore, more

experiments are developed with different train headways and time lags, which could provide a beneficial reference for train scheduling under the viewpoint of traffic safety and service level.

In this research, because of the basic definition and assumption, it is not free of mistakes and limitations. Future research could be conducted to improve the performance of passenger flow distribution model, and focus on the reality application.

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