Quantitative Assessment Methods for the Needs of Airline Safety Management Personnel

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Abstract. Safety managers are responsible for recognizing and controlling safety risks in the operation process, monitoring safety performance and implementing safety training. It is very necessary to evaluate safety manager quantity needed for different parts of the safety management system under the current running state. In this study, a calculation model of airlines' demands for safety managers was constructed. The routine safety management duties were determined and information about unconventional management duties was collected. Moreover, some factors were considered in this model, including leave, fatigue, extra working hours, personnel quality, office automation degree, and so on. Based on this model, an airline company was chosen for case study and data of normal working hours of safety managers was collected. The safety manager demands under the current running conditions were evaluated. Research conclusions provide references for companies to evaluate human resource demands.

Keywords: Safety Managers · Personnel Demand · Workload · Effective Working Hour

1 Purpose and Background

Safety is the bottom line of enterprise production and management. Safety managers are vital to safety of civil aviation and they are responsible for recognizing and controlling safety risks in the operation process, monitoring safety performance and implementing safety training. Determining the at least number of safety managers for the safety management of the company is an important premise for continuous safety operation of airlines. Laws and regulations regulate setting of safety production management organizations and equipments of full-time or part-time safety production managers, but there's no regulation on number of safety managers. In many industrial fields including construction, hazardous chemicals, electric power, road transport, metallurgy, building materials, mechanical engineering and light industry, the equipment proportion of safety managers of relevant enterprises has been refined. In the civil aviation, it only regulates to establish a safety management system and have safety managers to meet needs of safety management. In practical situation, there's no regulation on how to equip safety managers in accordance of enterprise scale and no model of safety manager demands of enterprise has been established. Determining safety manager demands based on experiences

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might lead to inadequate safety managers and increase safety risks of civil operation. Elen et al. [1] studied correlation among human resource management shrinkage, working worsening, and safety and security risks in business aviation, and concluded that human resource management shrinkage increased safety and security risks through the worsening working environment through a model test. It is pointed out in the evaluation report of expert configuration demands in the aviation system related with facility maintenance of United States Federal Aviation Administration (FAA) that understaffing will affect performance, increase inherent risks in the system and create potential risks within the system through overtime level, pressure accumulation and use of shortcut. For current running conditions, some problems still have no explicit solutions, such as whether personnel workload is over saturated, whether excessive workload may influence safety state of enterprises, whether it is necessary to increase personnel, and how many personnel has to be added.

Hence, to prevent adverse safety influences caused by cost minimization, this study aims to measure safety manager demands of enterprises according to needs and determine the at least quantity of safety managers under the premise of safety running.

2 Current Situation Analysis of Personnel Demand Assessment

2.1 Study on Ordinary Personnel Demands

At present, the efficiency-based personnel allocation method is used the most extensively. Production personnel with explicit production quota calculates workloads according to product yield or task load and norm of working hours per unit product or task. In the field of health human resource allocation, the World Health Organization (WHO) issued the health manpower configuration method (WISN) based on workload index. The key steps include estimation of available working time (AWT), definition of workload, formulation of activity standard, establishing workload standard, and calculation of adjustment factor and personnel demands [2]. Qu Xiangdong [3] used the average trial time for various tasks in a single case as the workload and calculated the quantity of judges according to the ratio between trial tasks and trial working time.

On this basis, many scholars have improved the formula to some extent during application to adapt to their studies. Some scholars calculated working hours of temporary tasks thoroughly. Moreover, the allowance time determined by relaxing ratio was added [4]. According to characteristics of posts, some scholars considered the adjustment coefficient produced by different alpine environment in plateau and allocation of production force [5]. Some scholars weighted physical time for work by using working environment and labor intensity.

2.2 Safety Manager Demands of Civil Aviation

Studies on personnel allocation calculation in civil aviation mainly focus on employees of frontline business departments. Lin Qiang et al. [6] reviewed duties of ground officials and calculated workloads of duties one by one, formulated the airport ground service system. Duan Zhezhe [7] calculated personnel of airport ground service department by using the efficiency-based personnel allocation method through the total production tasks in the planning period and per capita efficiency hours. Dong Ziliang [8] calculated demands of controlling officers by using the post-based personnel allocation method and compared the calculation results based on number of posts and number of personnel per post with the calculation results based on number of needed working hours of a post and working hours per employee on duty. He found that the later calculation of personnel structure was relatively reasonable.

Based on above research status and estimation model of personnel demands, it found that research objects can be divided into two types: one is frontline pure operators who have single structure of job content and high repeatability. The other type is non-pure operators, such as judges and workers in health institutions. Research object of this study chooses safety managers. Compared with judges and workers in health institutions, the job contents of safety managers are more diversified, accompanied with more complicated working structure and lower frequency of occurrence of duplicate tasks. As a common calculation method of personnel quota and allocation, the efficiency-based personnel allocation method can calculate the needed personnel accurately by measuring the workload. For scientific and accurate determination of safety manager quantity of enterprises, the research idea of efficiency-based personnel allocation method was chosen and the quantity of safety managers was determined through labor hours and legal working hours. On this basis, the safety manager allocation of civil aviation was studied.

3 Construction of the Safety Manager Demands Evaluation Model

Personnel allocation was calculated through labor hours and legal working hours in this study. Labor hours refer to the time needed to finish tasks in a period and it is determined by number of task executions and time per unit task. The number of task executions is determined by practical situations. Nevertheless, time per unit task differs significantly and only a statistical analysis on time for various tasks can be carried out. Time per unit task is surveyed or measured through questionnaire survey and field measurement. The statistical analysis results were used as the estimated basic data directly. The data accuracy was higher and the calculation results were closer to situations of the company.

Based on above personnel allocation, the safety manager quantity was calculated by the ratio between time for workload in the period and effective working hours of personnel: $N = P/T$, where N is the number of safety managers, P is the safety management workload, and T is effective working hours of personnel. Since some safety management is carried out by years, the model calculation used years as the calculation period. Specifically, safety management workload can calculate normal working hours of conventional job and temporary job. Combining with studies of various personnel,

personnel demands might be influenced by personnel quality, job content and office conditions. These influencing factors were added into the formula as adjustment coefficient when calculating effective working hours of personnel to calculate personnel demands under different influencing factor levels.

3.1 Safety Manager Demand Evaluation Model

The calculation formula of quantity of safety managers can be expressed as:

$$\mathrm{N} = \frac{P}{T} = \frac{\sum_{i=1}^{m} s_i t_i + \sum_{j=1}^{n} f_j h_j}{T_1(1-\alpha)(1-\beta)(1+\gamma)ab} \tag{1}$$

Based on the above model, the safety management workload and effective working time of personnel which are applicable to organization institutions, operation scale, job contents and working atmosphere of research objects can be gained. As a result, the safety manager demands could be calculated specifically. Based on the calculated results, workload can be divided through responsibility-based personnel allocation method, which is conducive to arrange various tasks reasonably.

3.2 Calculation of Safety Manager Workloads

Except for route acts have to be made daily in safety management, there are unconventional jobs like temporary meeting, conferences and administrative responsibilities may occupy working hours. Therefore, the calculation of safety management workload was divided into conventional workload and temporary workload, which were expressed in working hours. The total working hours of this task were calculated by number of work tasks in a period and norm of working hour of this task. Therefore, the calculation formula of safety management workload was:

$$P = \sum_{i=1}^{m} s_i t_i + \sum_{j=1}^{n} f_j h_j \tag{2}$$

where I = 1,2,3, i, …, m——set of the ith conventional responsibilities of safety managers;

J = 1,2,3,…,n——set of the jth unconventional responsibilities of safety managers, including temporary tasks, conference, working records and other administrative jobs;

s_i——operation frequency of the ith conventional responsibility, i ∈ I;
t_i—— normal time to finish the ith conventional responsibility, i ∈ I;
f_j—— operation frequency of the jth unconventional responsibility, j ∈ J;
h_j——normal time to finish the jth unconventional responsibility, j ∈ J.

3.3 Estimation of Effective Working Time

Except legal working days, absences caused by personal leave, sick leave, annual leave and training all may decrease working time and working days shall be calculated by actual attendance. The daily legal working hours is not equal to effective working hours. Some company may require overtime and not all of working hours are effective working hours. Due to factors like psychology and psychology, working efficiency of employees in a day fluctuates to some extent. Hence, fatigue allowance time shall be considered. Besides, personnel quality level and office conditions of companies also can influence effective working hours of employees. With comprehensive considerations to above factors, the calculation formula of effective working hours of personnel was:

$$T = Tl\ (1 - \alpha)\ (1 - \beta)\ (1 + \gamma)ab \tag{3}$$

where Tl is the annual legal working hours;

α——absence rate, expressed by the ratio between annual absent days for personal leave, sick leave, annual leave and training and annual legal working days;
β—— fatigue allowance, expressed by the ratio between weekly fatigue allowance time and legal working hours;
γ—— overtime rate, expressed by the ratio between weekly overtime and legal working hours.
a—— personnel quality level, determined by education background and business-related skills.
b—— office automation degree, determined by the degree that job can be completed by automatic software or system.

4 Implementation Process

With full considerations to the premise that enough safety managers are needed to complete safety management tasks and guarantee operation safety of enterprises, allocation of safety managers in an enterprise can be performed according to following steps. According to efficiency-based personnel allocation method, the above safety manager allocation model was used as the basis and the basic framework to study safety manager allocation was established.

4.1 Determine Safety Management Programs

In this study, job contents of safety managers referred to Safety Management Manual (Doc 9859) of International Civil Aviation Organization and requirements in legal standards, such as requirements of safety management system construction of air operators, airports and air traffic control unit. Besides, working status of real safety management department was surveyed and the basic safety management responsibilities were determined preliminarily from 12 elements, four pillars of the safety management system. On this basis, the safety management task list was adjusted according to expert interview. The final safety management task list is shown in Table 1.

Table 1. Final safety management task list.

Pillars	Elements	Job contents	workloads
Safety policy and objectives	Safety responsibility	Issue rewards and punishment list	18
	Appoint core safety personnel	Materials of Security Commission	120
	Coordinate formulation of emergency plans	Emergency rehearsal, evaluation effect, follow-up of emergency plan rectification	30
	Safety management system document	Revision of safety management system document	60
Safety risk management		Risk source database management, risk evaluation report, implementation of risk measures	432
Security assurance	Safety performance management	Monitor safety performance index, issue the note of rectification, track and verify implementation and effects of measures, review and revise safety performance index	216
	Safety inspection	Formulate inspection plan, formulate inspection list, issue note of rectification, track and verify implementation and effects of measures, identify problems and analyze data in safety inspection	1200
	Event survey	Implement survey, form survey report, issue note of rectification, track and verify implementation and effects of measures	540
	Safety report	Safety information data analysis, issue note of rectification, track and verify implementation and effects of measures	1460

(*continued*)

Table 1. (*continued*)

Pillars	Elements	Job contents	workloads
	SMS review	Formulate review scheme, document review and field review, write review report, issue note of rectification, track and verify implementation and effects of measures	30
	Flight data analysis	Analyze flight data, issue note of rectification, track and verify implementation and effects of measures	576
	Safety information comprehensive analysis and management	Collect external safety information, comprehensive analysis of various safety information, issue note of rectification, track and verify implementation and effects of measures	120
	SMS management review	SMS management review report, SMS management review meeting, track implementation and effect of management review decision	14
Safety promotion	Safety training and education	Formulate safety training plan, implement safety training and evaluate effect, establish and perfect safety training files of workers, carry out safety education activities	40
	Safety information exchange	Carry out safety information communication activities and evaluate effect	72

4.2 Data Acquisition and Processing

Respondents. In civil aviation enterprises and institutions, safety management is characteristic of systematic and diversified. Management structure in enterprises also tends to be flattening. In this study, personnel allocation covered all employees responsible for safety management as much as possible, and their workloads were quantized. This improved accuracy of really needed safety manager quantity which was estimated by the personnel allocation model. Hence, the survey objects of this study were all workers exclusive for safety management in enterprises.

Survey Contents. Based on the above personnel allocation model, information which had to be collected in questionnaire included time of safety managers of a post to complete various safety responsibilities and working frequency; time of leave and return; time of annual leave, personal leave and sick leave; scores of personal quality level and scores of office automation. To calculate consistency of data in computation, time indicators except the ratio indicator all used days as the unit.

Data Acquisition. Before implementation of survey, we communicate with respondents fully to interpret the research goal and investigate meanings of items. During field survey, doubts of respondents to the questionnaire were solved and inappropriate places of the questionnaire were adjusted timely. Moreover, missing times were supplemented and amended timely. The reality, reliability and usability of questionnaire data were improved.

Data Processing. Monthly data and annual data in the questionnaire were surveyed uniformly. The monthly data was adjusted into annual data according to 12 months in a year, which was convenient for the next calculation processing of data. This was also consistent with annual effective working hours.The time and frequency of route job items were multiplied and workloads of all routine jobs of all respondents in the calculation period were organized. Moreover, time of all unconventional jobs of all respondents in the calculation period were organized. Workloads of safety management of an enterprises were calculated according to Eq. (2).The absent days for annual leave, personal leave and sick leave, working hour data for rest adjustment, average overtime, personnel quality level and office automation degree were brought into Eq. (3) to calculate the effective working hours.Combining with Eq. (1), ratios of above results were used as safety manager demands which were calculated according to existing workloads.

5 Case Study

To verify feasibility of the model, Airline A was chosen as the research object. Combining with practical operation conditions and safety managers, safety manager demands were further evaluated by the model. Now, Airline A has 20 employees in the Department of Safety Supervision, including 6 in the safety supervision sector, 8 in the safety management sector and 6 in the flight quality monitoring sector. The annual workload of each safety manager in Airline A was collected through field survey and questionnaire survey, including annual frequency of a task and average time per implementation. Workloads of all employees involved in each job were summarized. It concluded that the total workloads of safety managers were 5005 man-day and the workloads results are shown in Table 1.

According to questionnaire survey, the average weekly fatigue allowance of safety managers in Airline A was 4.85 h, the annual absence time was about 19.15 days, and the weekly average overtime was 4.95 h. The personnel quality level and office automation degree were both industrial average levels, so their adjustment coefficients were both 1. The above data were brought into Eq. (3), thus getting the annual effective working hours per person of about 227.95 days. It calculated from the evaluation model of safety manager demands that the safety manager demands of Airline A were 21.96. Compared with existing personnel, 2 safety managers shall be added to meet existing job contents and strength. This can decrease working pressure of existing safety managers to some extent and guarantee safety operation of flights.

6 Conclusions

Safety managers assume the important safety management responsibilities. They recognize operation risks and control them at an acceptable level through risk management, performance monitoring and control, safety communication, and safety training. To guarantee safety operation of flights, the safety managers in accordance to current development stage and operation scale shall be evaluated. In this study, a quantitative evaluation method of safety manager demands is established to estimate workloads of safety management in a period and effective working hour. The proposed method can get actual demands of safety managers accurately and provide theoretical references to further evaluate existing labor sources in airlines.

References

1. Paraschi, E.P., Georgopoulos, A., Papanikou, M.: Safety and security implications of crisis-driven austerity HRM practices in commercial aviation: a structural equation modelling approach. Saf. Sci. **147**, 105570 (2022)
2. World Health Organization. Workload indicators of staffing need: user's manual. Geneva: World Health Organization (2010)
3. Xiangdong, Q.: Model estimation of case-based personal allocation and judge quota. Modern Law Sci. **38**(03), 160–180 (2016)
4. Yibin, W., Guohua, F., Tao, S., Ming, X., Xianfeng, H.: Research on flexible determination of posts for the pump station project in the Jiangsu section of east route of the south-to-north water transfer project. Water Conservancy Cconomy **36**(03), 39–44+79 (2018)
5. Zeqian, Z., Kexin, Z., An, Y.: Discussion on labor allocation standards for the railway engineering system in high-altitude and complicated dangerous mountainous areas. Railway Energy-saving, Environ. Protect. Saf. Health **11**(04), 37–42 (2021)
6. Qiang, L., Xin, G., Huibin, J.: Application of method study in personnel allocation in airport ground services. J. Tianjin Univ. (Soc. Sci.) **15**(05), 406–410 (2013)
7. Zhezhe, D.: Operator allocation model in ground service department of China's civil aviation and its applications —— an empirical study based on ground service department of airport a. J. Nanchang Hangkong Univ. (Soc. Sci.) **18**(01), 60–67 (2016)
8. Ziliang, D.: Calculation methods of controlling officers in civil airport planning and construction. Build. Tech. Dev. **44**(17), 16–17 (2017)