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A Study on the Occupational Safety Vulnerability of Delivery Personnel for Online Orders

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Abstract: ***Objective**: As a new form of employment, society has paid insufficient attention to the occupational safety of net-delivery workers. In this regard, this study focuses on the occupational safety vulnerability of Delivery Personnel for Online Orders. It explores the influencing factors of vulnerability by constructing a three-dimensional occupational safety vulnerability theoretical framework of exposure-sensitivity-adaptability. **Methods**: Simple random cluster sampling was conducted in Hangzhou from October 2024 to February 2025, and analyzed with the help of SPSS27.0 statistical software. **Conclusion**: The occupational safety vulnerability of Delivery Personnel for Online Orders showed a positive correlation with exposure and sensitivity and a negative correlation with adaptability.*

Keywords: Delivery Personnel for Online Orders, Occupational safety, Vulnerability theory, Occupational safety vulnerability.

1. Introduction

In recent years, with the rapid advancement of technologies such as artificial intelligence, big data, and cloud computing and the booming development of the Internet economy, new forms of business, such as the online platform economy, have become new growth points for the economy. In particular, the application of Internet technology in the service industry has formed a new employment pattern of the "Internet + service industry", which has promoted the digital and informatization transformation of the takeaway industry. At the same time, with the development of the economy, the per capita disposable income continues to grow, people's consumption demand is diversified, and the demand for timely delivery of medicines, food and beverages, fresh food, and other instantaneous items is growing. Under the impetus of these two factors, "Delivery Personnel for Online Orders" as a new occupation has emerged. In this study, a delivery agent is defined as a person who receives and inspects customer orders through a mobile Internet platform and delivers the ordered items to the designated place within a certain period according to the demand of the order and according to the intelligently planned route of the platform [1]. However, along with the increase in the scale of employment, along with the increasingly serious problem of occupational safety risks of Delivery Personnel for Online Orders. The frequent occurrence of incidents such as "sudden death of a takeaway boy on the street", "conflict between riders and merchants" and "traffic accidents involving riders" has aroused social concern about the occupational safety of net-contract delivery workers The safety of Delivery Personnel for Online Orders is a major concern for the society. Delivery Personnel for Online Orders faces occupational safety problems such as traffic accidents, occupational diseases, overwork, psychological disorders, difficulties in defining work injuries, ambiguous labor relations, and oppressive algorithmic mechanisms [2]. Therefore, while the state encourages the development of the online delivery industry, how to protect the occupational safety of Delivery Personnel, resist potential risks, explore the root causes of their occupational vulnerability, and target the anti-vulnerability ideas is an urgent problem. This study aims to analyze the factors influencing the occupational safety vulnerability of net-delivery workers and provide theoretical references for improving the occupational safety level of net-delivery workers.

2. Objects and Methods

2.1 Research Design

This study mainly focuses on the occupational safety vulnerability of Delivery Personnel for Online Orders, to conduct empirical analysis, and in-depth exploration of the essential characteristics and internal laws of the occupational safety vulnerability of delivery workers, to provide support for the development of scientific and reasonable policies and interventions, to effectively improve the level of safety and security of delivery workers and reduce vulnerability.

2.2 Research Subjects

Net delivery workers working in Hangzhou from October 2024 to February 2025 were selected as the research subjects.

2.3 Questionnaire Distribution

The questionnaire was distributed through the mode of "offline distribution site distribution + online questionnaire link push". Online, the questionnaire content was entered into the questionnaire star, the questionnaire QR code was created, and the questionnaire was distributed to the research subjects through the online platform, and at the same time, the research subjects were encouraged to recruit more participants in the same way. Offline, the questionnaires were distributed through the distributor sites. Finally, a total of 444 questionnaires were retrieved, excluding unqualified questionnaires with obvious errors or irregular answers, and the total number of valid questionnaires was 411.

2.4 Theoretical Support

Vulnerability (Vulnerability) refers to the potential possibility of a system, individual, or group to suffer damage or collapse due to insufficient structural, functional, or adaptive capacity in the face of internal and external perturbations or pressures. Its core features include multidimensionality (the intersection of natural, social, and economic domains), dynamism (changes over time, space, and external conditions), and systemicity (the interaction of elements) [3]. Vulnerability theory originated in the field of natural hazards in the 1960s, initially focusing on the assessment of the resilience of natural

systems, and in the 21st century, with the emergence of the concept of sustainable development, the research has been gradually expanded to social, economic, ecological and other fields, forming an interdisciplinary theoretical framework. Vulnerability theory usually analyzes the following three dimensions (ESA framework): exposure: the frequency and intensity of external risks faced by a system or an individual; sensitivity: the degree to which a system responds to risks; and adaptive capacity: the ability of a system to cope with risks through resource allocation, institutional design, and so on [4]. As an analytical framework, it identifies key vulnerability factors and high-risk areas through the introduction of dynamic vulnerability assessment indicators to provide targeted strategies for risk prevention. The VSD vulnerability assessment system, on the other hand, not only has good compatibility but also has been widely used in social systems [5]. Therefore, this study chooses VSD vulnerability theory as the evaluation system, and builds a vulnerability model with exposure, sensitivity, and adaptability as the independent variables and vulnerability as the dependent variable, on the basis of which we analyze the occupational safety vulnerability of Delivery Personnel for Online Orders.

2.5 Questionnaire Design and Hypotheses

According to the occupational background and work characteristics of Delivery Personnel for Online Orders, the questionnaire scale was self-developed based on VSD vulnerability theory. (1) Basic information: it mainly includes age, gender, education, working years, weekly working hours of the research subjects. (2) Occupational Safety Vulnerability Scale: a total of 10 entries, using a 7-level scoring system. (3) Exposure scale: including psychological, physical, and work intensity exposure, totaling 11 entries, using a 7-level scoring system. (4) Sensitivity Scale: Including occupational safety measures, sensitivity to laws and regulations, totaling 11 entries, using a 7-point scale. (5) Adaptability scale: including occupational literacy, organizational support adaptability, a total of 11 entries, using a 7-point scale.

Based on the VSD vulnerability theory, the following hypotheses were made:

H1: Exposability has a significant positive effect on the occupational safety vulnerability of Delivery Personnel for Online Orders

H1a: Psychological exposability has a significant positive effect on occupational safety vulnerability of net delivery workers

H1b: Physical exposability has a significant positive effect on occupational safety vulnerability of net-contract delivery workers

H1c: Work intensity exposure has a significant positive effect on the occupational safety vulnerability of Delivery Personnel for Online Orders

H2: Sensitivity has a significant positive effect on the occupational safety vulnerability of Delivery Personnel for Online Orders

H2a: Occupational safety measures sensitivity has a significant positive effect on the occupational safety vulnerability of net-contract delivery workers

H2b: Sensitivity to policies and regulations has a significant positive effect on the occupational safety vulnerability of network contract delivery workers

H3: Adaptability has a significant negative effect on the occupational safety vulnerability of network delivery workers

H3a: Occupational literacy adaptability has a significant negative effect on the occupational safety vulnerability of network delivery workers

H3b: Organizational support adaptability has a significant negative effect on occupational safety vulnerability of network delivery workers

2.6 Statistical Analysis

With the help of SPSS27.0 statistical analysis software, the collected data related to the occupational safety vulnerability of Delivery Personnel for Online Orders were systematically analyzed. In the process of data analysis, a variety of statistical analysis methods are comprehensively applied. Through descriptive statistical analysis, exploratory factor analysis, validation factor analysis and other statistical methods, in-depth understanding of the interrelationship between the factors. On this basis, linear regression analysis is used to construct a regression model to reveal the mechanism and direction of the influence of the independent variable on the dependent variable, and to explain the influencing factors of the occupational safety vulnerability of distribution workers.

3. Results

3.1 Demographic Informatics Characteristics

Table 1: Demographic Informatics Characteristics of Net Delivery Workers

Name	Category	Frequency	Percentage (%)
Sex	Male	373	90.754
	Female	38	9.246
age groups	16-25 years	56	13.625
	26-35 years	306	74.453
	36-45 years	44	10.706
	46-55 years	3	0.730
	55 years and over	2	0.487
education attainment	Junior high school and below	22	5.353
	High school/vocational high school/secondary school	189	45.985
	College	192	46.715
	Bachelor degree and above	8	1.946
length of practice	Under 6 months	77	18.735
	6-12 months	187	45.499
	1-2 years	116	28.224
	3 years and above	31	7.543
Number of days worked in the past week	3 days and less	2	0.487
	4-6 days	199	48.418
	7 days	210	51.095
Hours of work per day	Less than 4 hours	2	0.487
	4-8 hours	54	13.139
	8-12 hours	334	81.265
	12-14 hours	21	5.109

A total of 411 Delivery Personnel for Online Orders were surveyed in this study. Through descriptive statistics, it was found that: 373 of them were male, accounting for 90.754%; 38 of them were female, accounting for 9.246%,; 56 of them were 16-25 years old, accounting for 13.625%; 306 of them were 26-35 years old, accounting for 74.453%; 44 of them were 36-45 years old, accounting for 10.706%; 3 of them were 46-55 years old, accounting for 0.730%; 2 of them were 55 years old and above, accounting for 0.487%; 22 people in junior high school and below, accounting for 5.353%; 189 people in high school/vocational high school/secondary school, accounting for 45.985%; 192 people in junior college, accounting for 46.715%; and 8 people in bachelor's degree and above, accounting for 1.946%. 77 people, or 18.735%, have been working in the industry for less than 6 months; 187 people, or 45.499%, have been working in the industry for 6-12 months; 116 people, or 28.224%, have been working in the industry for 1-2 years; and 31 people, or 7.543%, have been working in the industry for 3 years or more. In the past, 2 or 0.487% worked 3 days or less in a week; 199 or 8.418% worked 4-6 days; and 210 or 51.095% worked 7 days. Two people, or 0.487%, worked less than 4 hours a day; 54 people, or 13.139%, worked 4-8 hours; 334 people, or 81.265%, worked 8-12 hours; and only 21 people, or 5.109%, worked 12-14 hours. From this, it can be seen that the employees of Delivery Personnel for Online Orders are mainly male, mostly young and strong, with a generally low level of education, and the mobility of the personnel is high, and most of the Delivery Personnel for Online Orders will choose to work for a long period of time.

3.2 Reliability Analysis

The Cronbach's alpha coefficients for all data in this study were greater than 0.7, indicating a high level of reliability and good internal consistency for further analysis.

Table 2: Cronbach's reliability analysis

Variable	Dimension	Number of questions	Dimension Cronbach's alpha coefficient	Scale Cronbach's alpha coefficient
Exposure Factors	Psychological Exposability	3	0.800	0.870
	Physical Exposure	5	0.868	
	Work Intensity Exposure	3	0.791	
Sensitivity factors	Sensitivity to occupational safety measures	5	0.870	0.882
	Sensitivity to laws and regulations	4	0.858	
Adaptive factors	Professionalism Adaptation	4	0.845	0.856
	Organizational Support Adaptation	3	0.782	
Vulnerability factor		10		0.932

3.3 Linear Regression Analysis

The value of regression coefficient of exposure factor is 0.849 (t=12.325, p=0.000<0.01), which implies that the exposure factor will have a significant positive influence on the vulnerability factor. The regression coefficient value of sensitivity factor is 0.228 (t=3.616, p=0.000<0.01), which means that the sensitivity factor will have a significant positive influence relationship on the vulnerability factor. The regression coefficient value of adaptability factor is -0.284 (t=-6.888, p=0.000<0.01), which means that the adaptability factor will have a significant negative influence relationship on the vulnerability factor. In summary, hypotheses H1, H2, and H3 were verified.

Table 3: Results of linear regression analysis for each variable

	Non-standardized coefficient		Standardized coefficient	t	p	VIF
	B	standard error	Beta			
(Constant)	0.389	0.503		0.774	0.439	
Exposure Factors	0.849	0.069	0.480	12.325	0.000**	1.116
Sensitivity factors	0.228	0.063	0.143	3.616	0.000**	1.152
Adaptive factors	-0.284	0.041	-0.270	-6.888	0.000**	1.129
R^2			0.447			
Adjusted R^2			0.443			
F			F=109.518 p=0.000			

* p<0.05 ** p<0.01 Dependent variable: vulnerability factor.

3.3.1 Exposure linear regression analysis

In this study, the exposure factor was categorized into three dimensions, which are psychological exposure, physical exposure, and work intensity exposure. The regression coefficient value of psychological exposability is 0.438 (t=7.058, p=0.000<0.01), which means that psychological exposability will have a significant positive relationship on the vulnerability factor. The value of regression coefficient of physiological exposure is 0.279 (t=3.776, p=0.000<0.01), which means that physiological exposure will have a significant positive influence relationship on the vulnerability factor. The value of regression coefficient of work intensity exposure is 0.303 (t=4.830, p=0.000<0.01), which means that work intensity exposure will have a significant positive influence relationship on the vulnerability factor. This shows that hypotheses H1a, H1b, and H1c are valid. The main realizations are: firstly, under the action of multiple mechanisms such as personal factors (self-efficacy), occupational factors (algorithmic oppression), and social factors (social discrimination), the mental health of delivery workers is impacted and psychological problems such as depression, loneliness, and burnout are generated [6]; secondly, in their daily work, Delivery Personnel for Online Orders are difficult to avoid traffic accident injuries [7], and ultra-long working hours and repetitive cycling operations can trigger musculoskeletal injuries, overwork and other occupational diseases [8], and their working environment is complex, changeable and harsh, often exposed to extreme weather such as high temperature, cold, typhoons, etc., and they need to work in complex and unfamiliar city roads [9]; finally, the nature of the work leads to a large span of time and high intensity, which can also damage the physical and mental health of delivery workers.

Table 4: Results of linear regression analysis of exposure factor and vulnerability

	Non-standardized coefficient		Standardized coefficient	t	p	VIF
	B	standard error	Beta			
(Constant)	-0.307	0.371		-0.827	0.409	
Psychological Exposability	0.438	0.062	0.332	7.058	0.000**	1.374
Physical Exposure	0.279	0.074	0.181	3.776	0.000**	1.422
Work Intensity Exposure	0.303	0.063	0.223	4.830	0.000**	1.332
R^2			0.346			
Adjusted R^2			0.341			
F			F=71.696 p=0.000			

* p<0.05 ** p<0.01 Dependent variable: vulnerability factor.

3.3.2 Linear regression analysis of sensitivity

In this study, the sensitivity factor is divided into two dimensions, which are occupational safety measures sensitivity, and policies and regulations sensitivity. The regression coefficient value of occupational safety measures sensitivity is 0.214 (t=2.493, p=0.013<0.05), which implies that occupational safety measures sensitivity will have a significant positive impact relationship on the vulnerability factor. The regression coefficient value of law and regulation sensitivity is 0.335 (t=4.921, p=0.000<0.01), which means that law and regulation sensitivity will have a significant positive influence on the vulnerability factor. This shows that hypotheses H2a and H2b are valid. Sensitivity has a significant positive effect on vulnerability. The main realizations are as follows: firstly, in daily work, Delivery Personnel for Online Orders have a high probability of encountering physiological injuries and bad weather, and the lack of corresponding safety protection measures (including but not limited to safety training, the issuance and wearing of safety protection equipment, and the regular maintenance of takeaway trucks, etc.) will seriously damage the occupational safety of delivery workers and threaten their physical and mental health8; secondly, the rules and regulations related to Delivery Personnel for Online Orders (such as labor relations, occupational injury insurance, platform enterprises, etc.) are the most important factors. relationship, occupational injury insurance, platform enterprises' regulations on work content, minimum working hours, delivery routes, delivery timeframe, etc., work injury recognition and compensation, and labor union support, etc.). The lack of corresponding safety strategies and protection systems may damage the legitimate labor rights and interests of Delivery Personnel for Online Orders, making it impossible for them to avoid potential risks and difficult for them to obtain immediate and effective protection after being injured [10].

Table 5: Results of linear regression analysis of sensitivity factors and vulnerability

	Non-standardized coefficient		Standardized coefficient	t	p	VIF
	B	standard error	Beta			
(Constant)	1.925	0.407		4.727	0.000**	
Sensitivity to occupational safety measures	0.214	0.086	0.136	2.493	0.013*	1.383
Sensitivity to laws and regulations	0.335	0.068	0.267	4.921	0.000**	1.383
R^2			0.128			
Adjusted R^2			0.124			
F			F=29.962 p=0.000			

* p<0.05 ** p<0.01 Dependent variable: vulnerability factor.

3.3.3 Linear regression analysis of adaptation

In this study, the adaptability factor is divided into two dimensions, which are occupational literacy adaptability and organizational support adaptability. The regression coefficient value of occupational adaptability is -0.326 (t=-6.991, p=0.000<0.01), which implies that occupational adaptability will have a significant negative relationship on the vulnerability factor. The value of regression coefficient of organizational support adaptability is -0.108 (t=-2.086, p=0.038<0.05), which means that organizational support adaptability will have a significant negative influence relationship on vulnerability factor. This shows that hypotheses H3a and H3b are valid. The main realization is that professionalism, organizational support adaptability and vulnerability are significantly and negatively related. Strong adaptability is mainly reflected in, on the one hand, better health, strong stress resistance, able to adapt to high-intensity work and more quickly recover from injuries, high mental toughness and safety literacy, able to drive safely [11], believe that they can effectively cope with the challenges and pressures of the work, and more active and proactive communication with customers and businesses in the face of difficulties and frustrations; on the other hand, positive On the other hand, positive platform support and favorable social atmosphere can motivate delivery workers to be better qualified for their jobs and more active and relaxed in dealing with occupational safety issues [12].

Table 6: Results of linear regression analysis of adaptation factors and vulnerability

	Non-standardized coefficient		Standardized coefficient	t	p	VIF
	B	standard error	Beta			
(Constant)	6.411	0.194		32.969	0.000**	
Professionalism Adaptation	-0.326	0.047	-0.371	-6.991	0.000**	1.428
Organizational Support Adaptation	-0.108	0.052	-0.111	-2.086	0.038*	1.428
R^2			0.195			
Adjusted R^2			0.191			
F			F=49.405 p=0.000			

* p<0.05 ** p<0.01 Dependent variable: vulnerability factor.

4. Conclusion

This study explored the influencing factors of occupational safety vulnerability of Delivery Personnel for Online Orders and revealed the relationship between exposure, sensitivity, and adaptability and occupational safety vulnerability of Delivery Personnel for Online Orders. The results of regression analysis found that:

(1) Exposability has a positive effect on their vulnerability, and psychological, physical, and work intensity exposability all have a positive effect on net delivery workers.

(2) Sensitivity has a positive effect on their vulnerability, and occupational safety measures, policy and regulation sensitivity have a positive effect on network delivery workers.

(3) Adaptability has a negative effect on vulnerability, and occupational quality and organizational support adaptability have a negative effect on network delivery workers.

The results of the analysis of these indicators provide a reference for the study of occupational safety risk prevention and control of network delivery workers, and provide a certain basis for the development of related protection strategies.

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