

Application of Human Factors Engineering in the Design of Logistics Systems

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Abstract: This paper explores the critical application of human factors engineering in logistics system design. As the core of modern supply chain management, the design quality of logistics system directly affects efficiency, cost and customer satisfaction. This paper firstly gives a brief introduction to the concept, characteristics and composition of logistics system. Secondly, it analyzes the important role of human factors engineering in logistics system design. Next is the main part of this paper, which details the application of several important parts of human factors engineering in logistics system design.

Keywords: Human Factor Engineering; Logistics System; Application Design.

1. Introduction

In the modern globalized and highly competitive business environment, effective logistics system design is critical to operational efficiency and market competitiveness. With the rapid changes in technological advances and market demands, how to optimize the logistics system to adapt to these changes has become a core challenge in today's logistics management. As an interdisciplinary field focusing on the interaction between human and technological environments, human factors engineering is increasingly attracting attention and application in the logistics industry.

Human factors engineering not only focuses on improving work efficiency and reducing operational risks, but also looks at how to optimize workstation design, reduce human errors, and improve employee job satisfaction. Reasonable application of human factors engineering in logistics system design can significantly improve operational efficiency and accuracy, which will have a positive impact on the overall supply chain management.

The purpose of this paper is to explore the practical application of human factors engineering in logistics system design. Through this study, we can gain an in-depth understanding of the potential of human factors engineering in enhancing the quality and sustainability of logistics system design, and provide valuable references and practical experience for logistics managers and researchers.

2. Logistics System Overview

2.1. The Concept of Logistics System

The logistics system refers to a certain time and space, by the materials to be transported and including the relevant equipment, conveyor tools, storage equipment, personnel and communication links and a number of mutual constraints on the dynamic elements of the composition of the organic whole with a specific function. It involves all activities from the supply of raw materials to the delivery of final products, including logistics planning, procurement, production, inventory management, transportation, warehousing, distribution and other links.

2.2. Characteristics of the Logistics System

2.2.1. Diversification

The logistics system involves many different types of logistics activities, such as procurement, production, transportation, warehousing, etc., involving multiple links and participants.

2.2.2. Integral

The logistics system combines all links and elements together organically to form a whole, with interdependence and influence on each other.

2.2.3. Dynamic

The logistics system is in a state of constant change and development, affected by market demand, technological progress, supply chain changes and other factors, the need for timely adjustment and optimization.

2.2.4. Comprehensive

The logistics system needs to take into account the needs and interests of suppliers, manufacturers, distributors, customers and other parties to coordinate the various links to achieve the overall optimization effect.

2.3. Composition of Logistics System

A logistics system is a whole formed by a number of components that are interrelated and interact with each other. The following are the main components of a logistics system:

2.3.1. Supply Chain Management

Supply Chain Management is the core of the logistics system, covering the logistics and information flow between suppliers, manufacturers, distributors and final customers. It includes activities such as supplier selection, procurement management, supplier coordination, supply chain planning and collaboration to ensure smooth logistics processes and efficient supply chain operations.

2.3.2. Purchasing and Supply Management

Purchasing and supply management is an important link in the logistics system, which involves the procurement of raw materials and products, supplier management, contract management, supplier evaluation and so on. Through effective procurement and supply management, it can ensure the timely supply of required materials and reduce the inventory holding cost and supply uncertainty.

2.3.3. Production and Manufacturing

Production and manufacturing are a key link in the logistics system, covering the processing of materials, the organization and management of the production process, quality control and so on. In the production and manufacturing process, the transformation and processing of materials into final products, providing the basis for subsequent logistics processes.

2.3.4. Warehousing and Inventory Management

Warehousing and inventory management involves the storage, management and distribution of materials and products. It includes the planning and layout of warehouse facilities, inventory management, classification and storage of goods, inbound and outbound operations, order picking and so on. Effective operation of warehousing and inventory management can ensure the smooth flow of logistics and inventory cost control.

2.3.5. Transportation and Distribution

Transportation and distribution are an important part of the logistics system, involving the transportation and delivery of materials and products. It includes the selection of appropriate mode of transportation (such as road, rail, air, water, etc.), transportation route planning, transportation cost control, cargo tracking and distribution services. Effective transportation and distribution can ensure on-time, safe and efficient logistics activities.

2.3.6. Information Management and Technical Support

Information management and technical support is the key support part of the logistics system. It includes the construction and application of logistics information system, order processing, inventory tracking and visualization, supply chain collaboration platform and so on. Effective use of information management and technical support can improve the visibility, coordination and decision-making effectiveness of logistics processes.

2.3.7. Human Resource Management

Human resource management involves recruitment, training, performance evaluation and motivation of personnel in the logistics system. Through appropriate human resource management, it can ensure that the logistics system has the right talents and skills, and improve the efficiency and satisfaction of employees.

3. The Importance of Human Factors Engineering in the Design of Logistics Systems

Human factors engineering is a science based on psychology, physiology, anatomy, anthropometry and other disciplines to study how to make the design of human-machine-environment system in line with human physiological and psychological characteristics, in order to achieve the best match between human, machine and environment, so that people can work and live safely, healthily, effectively and comfortably. In logistics system design, human factors engineering has an important role and value, which is mainly reflected in the following aspects:

3.1. Improve Work Efficiency

Human factors engineering can improve work efficiency by reducing the motor and cognitive load on operators through optimizing workstation design, equipment HMIs and workflow. Proper workstation design and human-machine interfaces can reduce the number of operator actions and

errors, and improve the accuracy and speed of operations, thus speeding up the completion of logistics tasks.

3.2. Reducing the Risk of Errors and Accidents

Ergonomics reduces the risk of operator errors and accidents by taking into account human physiological and psychological characteristics and designing ergonomic working environments and tools. For example, appropriate table heights and angles, easy-to-understand indicators and signage, and user-friendly operator interfaces can reduce errors and accidents caused by misuse and operator error.

3.3. Improve the Working Environment

Human factors engineering can optimize the working environment of the logistics system to provide safe, comfortable and humane working conditions. Appropriate workstation height, good lighting, comfortable work chairs, etc. can reduce operator fatigue and discomfort, improve job satisfaction and health.

3.4. Reduce Physical Labor and Health Risks

logistics systems usually involve a large number of handlings, loading and unloading and transportation work, human factors engineering can reduce the operator's physical labor and health risks through reasonable workstation design, auxiliary loading and unloading equipment and personnel training. For example, the use of conveyor belts, forklifts and other equipment to reduce the operator's physical labor, while providing appropriate training and guidance to reduce the risk of injury at work.

3.5. Improve Employee Satisfaction and Work Quality

Reasonable logistics system design can improve operator job satisfaction and work quality. Comfortable working environment and working conditions can increase employees' motivation and enthusiasm, and reduce the impact of fatigue and anxiety on work quality.

In summary, the importance of human factors engineering in logistics system design is to optimize work efficiency, reduce the risk of errors and accidents, improve the work environment, reduce physical labor and health risks, and improve employee satisfaction and work quality. By considering human needs and capabilities, human factors engineering can realize human-machine synergy in logistics systems and improve overall operational effectiveness and management benefits.

4. Specific Application of Human Factors Engineering in Logistics System Design

4.1. Application of Human Factors Engineering in Logistics Transportation and Distribution

The application of human factors engineering in logistics warehousing and inventory management covers a wide range of aspects, with the main objective of improving the efficiency, accuracy and employee satisfaction in warehousing and inventory management by optimizing the work environment, process design and human-computer interaction.

4.1.1. Vehicle Human-machine Interface Design

Human factors engineering can optimize the design of the vehicle's human-machine interface so that the driver can operate the vehicle more conveniently and safely. For example, ergonomically designed seats and maneuvering devices ensure driver comfort and ease of operation; rational layout of instrument panels and control panels reduce the cognitive load on the driver.

4.1.2. Vehicle Internal Layout

Ergonomics can optimize the layout of vehicle internal space and improve the efficiency of cargo storage and loading/unloading. Reasonable cargo storage area and shelf design can reduce the time and effort of handling and picking, and reduce the physical burden of the operator.

4.1.3. Design of Loading and Unloading Equipment and Tools

Human factors engineering can help design loading and unloading equipment and tools suitable for logistics and transportation systems, improve loading and unloading efficiency and reduce the physical labor of personnel. For example, the design of ergonomic cargo handling tools, such as carts, forklifts, etc., to reduce the operator's physical burden and reduce operational risks.

4.1.4. Route Planning and Navigation Systems

Ergonomics can improve route planning and navigation systems in logistics and transportation systems, providing accurate and easy-to-use navigation guidelines. Reasonable planning of transportation routes and provision of real-time traffic information can reduce the driver's navigational problems and reduce travel time, thus improving transportation efficiency.

4.1.5. Driver Training and Training Tools

Human factors engineering can be used to design driver training and training tools to help drivers quickly acquire operational skills and improve safety awareness. Through the use of interactive training tools and simulators, drivers can practice their driving skills and cope with different scenarios in a virtual environment to improve driving skills and safety.

4.1.6. Driver Working Time and Rest Management

Human factors engineering can be involved in the development of driver working time and rest management strategies to ensure driver safety and health. Reasonable working time arrangement and rest planning can reduce fatigue driving and improve driver's concentration and reaction ability.

4.1.7. Distribution Time and Timing Management

Human factors engineering can participate in the development of distribution time and timing management strategies to ensure the timeliness and accuracy of distribution. Reasonable delivery time arrangement and optimized delivery route planning can reduce stopover time and improve delivery efficiency.

4.2. Application of Human Factors

Engineering in Logistics Warehousing and Inventory Management

The importance of human factors engineering in logistics warehousing and inventory management is not only reflected in the improvement of efficiency and accuracy, but also concerns the health and safety of employees, as well as the sustainability of long-term development of enterprises. By considering the physiological and psychological needs of

people and designing a reasonable working environment and system, it can bring significant economic and social benefits to the enterprise.

4.2.1. Workstation Design

Ergonomics can optimize the design of storage workstations, so that operators can work in a comfortable and safe environment. Reasonable height and angle of the workstation, ergonomic chair, adequate lighting, etc. can reduce operator fatigue and discomfort, improve work efficiency and comfort.

4.2.2. Goods Storage and Layout

Ergonomics can help optimize the storage and layout of goods in the warehouse to improve storage density and loading and unloading efficiency. Reasonable cargo classification, labeling and storage methods can reduce the time and effort of handling and picking, and reduce the physical burden on the operator.

4.2.3. Warehouse Equipment and Tool Design

Human factors engineering can be used to design equipment and tools suitable for the storage environment to improve the efficiency of handling and loading and unloading of goods. For example, the design of ergonomic carts, cargo transportation equipment, picking tools, etc., to reduce the physical burden on the operator and reduce operational risks.

4.2.4. Warehouse Layout and Process Optimization

Human factors engineering can optimize warehouse layout and process to improve the efficiency of logistics activities and reduce errors. Reasonable goods flow path planning, picking area settings, warehouse facilities layout can reduce the operator's walking distance and reduce the occurrence of picking errors.

4.2.5. Marking and Navigation System

Human factors engineering can improve the marking and navigation system in the warehouse environment, providing accurate and easy to recognize information and guidance. Reasonable setup of goods marking, position marking and navigation marking reduces operator search time and improves picking accuracy.

4.2.6. Inventory and Goods Scheduling

Human factors engineering can optimize the inventory and goods scheduling process to improve the efficiency and accuracy of inventory management. Reduce inventory time and labor through reasonable inventory planning and processes; use appropriate goods scheduling tools and algorithms to improve the accuracy and speed of goods scheduling.

4.3. Application of Human Factors Engineering in Logistics Information Management

The significance of human factors engineering in logistics information management is to enhance operational efficiency, reduce costs, improve working conditions and employee satisfaction by optimizing the interaction between people and the system, and at the same time, enhance the stability and security of the system, so as to comprehensively improve the efficiency and quality of logistics information management.

4.3.1. User Interface Design

Human factors engineering can optimize the user interface design of logistics information management system to make it easy to operate and understand. Through reasonable information display and interaction design, the cognitive load

of users can be reduced, and the usability and user satisfaction of the system can be improved. For example, the use of intuitive charts, logos and instructions to provide clear operational guidance to reduce user errors and time waste.

4.3.2. Data Visualization

Human factors engineering can help design the way of data visualization in logistics information management systems so that users can better understand and analyze the data. Through reasonable charts, graphs and visualization tools, complex data is transformed into an easy-to-understand form to help users quickly access key information and insights.

4.3.3. Information Layout and Organization

Human factors engineering can optimize the information layout and organization of the logistics information management system to improve the findability and accessibility of information. Through reasonable information categorization, search function and navigation structure, it reduces the time and effort of users to find and access information in the system.

4.3.4. Information Input and Output

Human factors engineering can improve the information input and output methods in the logistics information management system, making it more efficient and accurate. Through reasonable data entry interface design and automated data collection technology, manual input errors and time costs are reduced. Meanwhile, reasonable information output methods, such as reports, notifications and reminders, help users acquire and process information in a timely manner.

4.3.5. User Feedback and Improvement

Human factors engineering can help collect user feedback and make system improvements. Through user surveys, observations and user experience tests, we can understand users' needs and problems of the system in order to optimize the system design and functions and improve user satisfaction and system usability.

5. Conclusion

This study demonstrates the importance of optimizing interface design, improving the working environment and enhancing operational efficiency by analyzing the application of human factors engineering in logistics system design. The results of the study show that the rational application of ergonomic principles can significantly reduce the error rate during operation and improve the overall efficiency of the logistics system. In particular, by designing ergonomic work environments, not only does it enhance employee job satisfaction, but also effectively improves efficiency and

productivity. However, further research and exploration of new design strategies are needed to cope with the increasingly complex and rapidly changing logistics environment. Future work could focus on gaining a deeper understanding of the impact of technological developments and market demands on the design of logistics systems, and further optimizing the application of human factors engineering in this area for more efficient and sustainable logistics management. In summary, the application of human factors engineering in logistics system design has significant potential and importance, providing valuable lessons and insights for future research and practice.

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