METHODS OF ACCOUNTING AND WAREHOUSING IN EXTREME CONDITIONS

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Abstract. The relevance of the study is determined by the need to ensure fault tolerance of warehouse logistics in extreme conditions (the Far North, remote infrastructure projects), where the use of standard digital management systems (WMS, ERP) is either inefficient or impossible due to infrastructural, climatic, and resource constraints. Under these conditions, the key source of losses becomes the human factor — errors caused by cognitive overload and deficits of attention and memory among personnel.

The subject of the study is an integrated system of non-automated inventory management methods (FBSI, REDI, APLA, HASS, RTP-Dispatch, 5S) aimed at minimizing operational errors.

The scientific novelty of the work lies in a paradigmatic shift from technological automation to cognitive-ergonomic optimization of warehouse processes. For the first time, a comprehensive model is proposed and theoretically substantiated. In this model:

1. Procedural discipline (RTP-Dispatch) and principles of spatial organization (HASS, APLA) compensate for the absence of digital control.

2. The non-conflict nature and synergy of the methods are demonstrated: tactical control FBSI (buffer) and strategic REDI (ranked inventory) are integrated into the annual

operational cycle; macro-optimization HASS (by turnover) and micro-optimization APLA (prevention of stock mixing and mislabeling) form a unified storage topology.

3. Logistics operations are directly linked to cognitive psychology. The study substantiates that the root cause of errors is not negligence, but the cognitive limits of the operator.

4. The theoretical basis (the Baddeley-Hitch working memory model, the effect of spaced repetition) validates the effectiveness of cyclic inspections (FBSI/REDI) as a method for consolidating professional memory.

5. An applied toolkit has been developed — a set of neurocognitive exercises (including Landolt rings and schematic analysis) for the targeted development of job-specific cognitive functions of personnel (attention, differential perception, visuospatial memory).

The practical significance lies in the proposal of an economically efficient, ready-to-implement system of resilient logistics. The model makes it possible to radically reduce losses from stock misclassification and accounting errors, increase transparency and accountability (RTP-Dispatch), and ensure operational resilience of the warehouse under conditions of high uncertainty, relying not on vulnerable equipment, but on a procedurally disciplined and cognitively trained operator.

Keywords: warehouse logistics, extreme conditions, inventory management, cognitive ergonomics, human factor, cognitive training, working memory, non-automated warehouse management, inventory methods, APLA (prevention of stock misclassification), FBSI / REDI

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INTRODUCTION

In the era of global challenges and the need to search for new resource bases, logistics and supply chain management in extreme conditions acquire strategic importance for key sectors of the economy. The Far North is not only a geographical zone, but also a unique laboratory for innovation, where traditional approaches to warehousing, inventory management, and material distribution fail due to low temperatures, limited infrastructure, and seasonal constraints.

Based on extensive expertise accumulated over 10 years of working with various inventory categories, it can be concluded that most warehouse errors occur not only due to the absence of standardized work procedures, but also due to the human factor most often caused by insufficient levels of attention and its stability, underdeveloped concentration and visuospatial memory. Warehouse personnel are required to simultaneously perceive multiple objects, rapidly switch between tasks, and maintain high concentration under monotonous and stressful workload conditions. Among typical human-factor-related errors, the following can be identified: stock mix-ups, inaccurate accounting, and failure to identify defects. These are often the result of insufficiently developed attention properties. This is precisely why the implementation of adapted inventory control methodologies (FBSI, REDI, APLA, HASS, RTP-Dispatch, and 5S) compensates for this imperfection.

These methodologies emerged from the need to solve both complex tasks (optimization of the entire warehouse operations cycle — from receiving and placing materials to issuing and accounting for them) and specific problems (for example, accelerating inventory without stopping production, reducing stock mix-ups, preventing misuse). They may be applied as an integrated system or selectively, depending on the goals of a particular enterprise. Under extreme climate conditions, where temperature drops to -50°C and logistics depends on seasonal routes, traditional automated systems (ERP, WMS) are often inaccessible due to energy shortages, lack of stable connectivity, and shortage of qualified personnel.

In such circumstances, even an annual inventory may turn into a serious challenge that threatens operational performance and the financial stability of the organization. The methodologies presented in this document go beyond solving the narrow task of inventory counting.

They form a comprehensive system of resilient logistics for industries operating in remote and challenging regions: energy, infrastructure construction, mineral extraction, humanitarian missions. For example, FBSI and REDI provide daily control of active inventory, APLA and HASS minimize stock mix-ups and optimize placement, RTP-Dispatch ensures transparency, and an adapted 5S system builds a culture of work and increases personnel discipline.

The accuracy of accounting is directly linked to cost savings for the organization. The delivery of each kilogram of cargo to northern regions costs two to three times more than transportation within the central part of the country. Incorrectly purchased or unused materials typically remain on site, since reverse transportation is economically impractical. Errors and stock mix-ups at the warehouse stage lead to significant additional costs. Even with accurate procurement calculations, losses are unavoidable if accounting and issuance in warehouses are performed inaccurately.

The scalability of these approaches is manifested in their universality: they do not depend on expensive automation and are applicable in any regions with limited resources — from the Arctic to remote territories in other countries. In the global context, where world logistics is striving for resilience and loss reduction, such methodologies contribute to resource savings and improved safety.

This document describes the essence, application, and results of the methodologies, including training stages, and cognitive aspects confirmed by scientific research. These are not merely tools for warehousing, but constitute an innovative paradigm for industries in which the reliability of logistics determines success.

CHAPTER 1. WAREHOUSE STOCK CONTROL METHODS

Within the chapter, the specific features of adapting logistics operations to operation under conditions of high uncertainty, resource scarcity, and limited technological support (absence of WMS, unstable communication) are examined. The methodologies presented (FBSI, REDI, APLA, HASS, RTP-Dispatch, 5S) form a system that encompasses both procedures of tactical verification of accounting data and physical stock levels, and strategic approaches to the rationalization of storage. Within the chapter, cognitive-ergonomic aspects of minimizing operational errors (APLA), principles of hybridization of location-based storage on the basis of turnover analysis (HASS), as well as mechanisms for building a transparent, accountable system for issuing material assets (RTP-Dispatch) and for forming a resilient production culture (5S) are examined. Thus, the chapter establishes a conceptual foundation for constructing a warehouse accounting system that functions primarily through procedural discipline and the development of professional competencies of personnel in environments with high operational risks.

1.1 FBSI methodology

FBSI (Fast Buffer Stock Inspection – buffer reconciliation) focuses on daily reconciliation of the buffer zone (the most active items). Repeated observation of the key items helps develop visuospatial working memory, which in turn helps the operator become familiar with warehouse nomenclature and maintain accounting accuracy. The storekeeper reconciles the summary and the actual availability of materials every day: this activates the area of the prefrontal cortex responsible for working memory and attentiveness.

The essence of the methodology: ensuring primary control of warehouse accounting without the need to suspend its operation (the work has just been launched in a new area; there are discrepancies in the documents; there is no time and no resources for a full stock check; there is a shortage of personnel) [1, 2].

Application: the FBSI methodology is especially effective at the start, when the warehouse has only received its first deliveries and the accounting system is still unstable. Or when the warehouse has been operating in a chaotic mode for a long time and a large number of problems have accumulated.

Result: the methodology makes it possible to control accounting without overloading personnel. Also, its use leads to a significant reduction in errors in the active stock zone and to an increase in staff discipline, since personnel appreciate the convenience of systematic placement and the general accessibility of items.

Case: On one of the projects, which involved large-scale construction of an infrastructure facility, a classic problem emerged: chaos in material storage and in accounting. Due to the lack of stable connectivity and the inability to implement automated systems, accounting was maintained in Excel tables, which led to constant discrepancies and the absence of up-to-date information on stock. In conditions where it is impossible to carry out a full inventory and to stop issuing material and technical resources even for one day, let alone for weeks. This method is similar to daily till reconciliation in a retail store and does not require significant time expenditure or additional human resources. After 10–14 days, the employee begins to form a virtual warehouse map.

1.2 REDI methodology

REDI (Ranked Everyday Inventory) is a methodology of ranked micro-reconciliation based on turnover. After stabilization of the basic accounting using the FBSI method, a more advanced control system is introduced: REDI. All items in the warehouse are classified by turnover rate: active, medium-active, passive.

The essence of the methodology: full inventory requires temporary freezing of the warehouse operations and the involvement of a large number of employees, while REDI makes it possible to distribute control throughout the entire year without interrupting daily operations. This method addresses the need for an effective approach to preparing for the annual inventory and organizing this process. It is especially useful in the absence of information regarding the extent of discrepancies between the physical and documented stock. With continuous application, it shortens the duration of the inventory and reduces the workload on personnel [3, 4].

Application: performed over 3–4 months (a period of logistical pause) before the annual inventory, once every two weeks in the active and medium-activity zones. It should be performed once a month in passive / illiquid zones, or these zones should be sealed after reconciliation. The inspection is carried out manually, at the end of the shift, based on a pre-created database. That is, a double full inventory takes place — without stopping warehouse operations.

Result: the documented stock is aligned with the physical stock, and the workload on personnel is reduced. Furthermore, due to the establishment of order based on the criterion of demand the time spent interacting with the warehouse zone is also reduced, making it possible to achieve correct allocation between the dynamic zone and the long-term storage zone.

Case: in the conditions of the Far North this method is in the highest demand — it does not require a high level of process automation. The duration of a full inventory in a typical warehouse environment is reduced from two months to, on average, three weeks.

1.3 APLA Methodology

APLA (Anti-Persort Logistics Algorithm – algorithm for minimization of item misplacement) is focused on the development of differentiated perception. APLA makes it possible to distinguish visually similar items and to perform subtle differentiation based on external attributes.

The essence of the methodology: creation of a situation in which all items from the risk group are assigned a storage location that is physically separated from items similar in external characteristics, even if they belong to the same product group, in order to avoid errors. The placement is indicated in the storage layout in the WMS system or in Excel. Through the use of bright markings and color codes, a mnemonic system is created to facilitate memorization of the relationships between the type of materials and the corresponding labels.

Application: during issuance, groups of inventory items with increased risk of misplacement are identified. These are items similar in physical external appearance, packaging, or labeling (for example, filters, gaskets, nuts, tires of similar size).

Result: as a result of training aimed at error prevention (error-based learning), the warehouse operator not only learns to see differences, but also to predict where the next error may occur.

Over time, visual sensitivity is formed: the operator notices a problematic situation before they become consciously aware of it. This facilitates work in the absence of automation tools, since personnel develop visual memory and correctly build associations map [5, 6].

Case: problems often arise under conditions of insufficient time for issuing goods due to poor climatic conditions and peak workload. After the implementation of the methodology, a reduction in item misplacement and confusion was achieved, since similar goods were placed far from each other, which led to optimization. The number of errors in placement and issuance of similar items was reduced by up to 90%.

1.4 HASS Methodology

HASS (Hybrid Addressable Storage System – hybrid storage system) assumes combined storage: dynamic for active items, static for non-liquid items.

The essence of the methodology: the entire warehouse is divided into two main zones according to the principle of material movement. The zones consist of a dynamic storage zone for fast-moving items (frequently requested inventory items) and a static storage zone for slow-moving or non-liquid items. When a new batch of materials arrives, items with high turnover (consumables, commonly used spare parts) are identified and placed closer to issuing points. If the items are new, analogous items are used to forecast which materials will be requested. Non-liquid goods, rarely used materials, and reserve stock are moved to remote rows or to specially designated zones. Placement is carried out manually, based on analysis of item movement: simple marking schemes or Excel tables are used, without WMS systems or scanners.

Purpose: to minimize the time needed to locate and issue required materials, to organize storage so that the warehouse is logically structured by activity level rather than by receipt date or a random principle. It is also intended to ensure convenience for employees working under high workload and in extreme conditions (low temperatures, poor visibility, the need to work within limited time).

Result: ensuring effective operation in extreme conditions while maintaining high turnover speed [7, 8].

Case: through the implementation of the system in the warehouse, correct placement was achieved for thousands of items with varying demand levels, which is especially important in conditions of unstable connectivity, absence of data collection terminals, and lack of constantly available ERP systems. A reduction of 40% in the time required to issue inventory items was achieved, since the most important items were located in the active zone.

1.5 RTP-Dispatch Methodology

RTP-Dispatch (Regulated Targeted Purpose Dispatch – regulated targeted issuing) assumes controlled dispatch based on a normative-target principle.

Essence: dispatch is carried out only upon an official request with mandatory indication of the purpose of use. The process is structured according to the following logic:

Request submission: in the case of spare parts, the mechanic prepares a defect report (in written form). The request specifies: the name of the part, the quantity, and the specific purpose, for example, replacement of the filter on the Ural tractor unit, description of malfunction – wear.

Verification: the warehouse checks the correctness of the request and the availability of the requested inventory items. Upon confirmation, an invoice and a work order are issued.

Issuing: materials are released strictly according to the request. The recipient signs for each item. Exceptions are possible only in the event of a threat to the operation of residential facilities (for example, urgent issuance of oil for a diesel power plant or a water pump for a water truck), with subsequent documentary confirmation.

Accounting: each movement is recorded in an Excel log and then transferred to the central 1C system. Inventory items are linked to a specific machine or facility. For this, a table with the Consumption tab is used, indicating which piece of equipment each item was written off to.

Control: if consumption exceeds the norms, the recipient is required to provide an explanatory note and photographic documentation. All documents are stored centrally.

Purpose: to create a transparent and protected system of inventory issuing, in which any movement is documented, tied to a machine or repair activity, and does not create difficulties during inventory audits or employee offboarding. The methodology simplifies the work process not only for the warehouse operator, but also for accounting, procurement, and responsible persons [9, 10].

Case: before the implementation of RTP-Dispatch, requests were rarely prepared, and inventory was issued simply against invoices, which employees accumulated themselves. This led to situations in which one person could have stock with a significant monetary value (the equivalent of hundreds of thousands of US dollars) assigned to their account, which showed no movement and had no physical presence. In addition, upon termination of employment, part of the inventory had long since been used but not written off. Accounting could not close the month due to missing documents, which initiated a lengthy and unsuccessful search for information.

Result: established document flow, timely reporting, and control of balances held by responsible persons. Any request for materials is recorded in the accounting system, which improves control over it. Losses due to disappearance and theft were reduced, which is especially relevant for fuel and lubricants, whose consumption may exceed initial norms.

In addition, this is particularly significant in the case of unique spare parts, the loss of which may be critical in conditions where warehouse facilities are located in the Far North, that is, under constraints related to logistics and access to these facilities. This method makes it possible to reduce costs even during periods without internet access through centralized data collection and transfer. All write-offs are carried out under documented control, which increases the level of employee accountability.

1.6 5S Methodology

5S is the adaptation of methodologies through the Japanese system to conditions of isolation for the formation of a culture of work within the team.

Essence: the 5S concept is based on five principles:

– Seiri (整理) sorting (necessary/unnecessary) – clear separation of items into necessary and unnecessary and disposal of the latter;

– Seiton (整頓) orderliness (neatness) – organized and precise arrangement and storage of necessary items, which allows them to be found and used quickly and easily;

– Seiso (清掃) cleanliness (cleaning) – maintaining the workplace in a clean and orderly state;

– Seiketsu (清潔) standardization (establishment of norms and rules) – a necessary condition for the implementation of the first three rules;

– Shitsuke (躾) improvement (self-discipline) – cultivation of the habit of precise execution of established rules, procedures, and technological operations.

The methodology makes it possible to work under conditions of high turnover, fatigue, poor weather, and personnel shortage.

Purpose: to create a culture of order, responsibility, and transparency in the warehouse under conditions of isolation, unstable connectivity, unstable power supply, minimal staffing, and high operating speed. To ensure the possibility of warehouse operation without excessive fatigue, stress, sabotage, and destructive errors, especially during peak delivery periods.

Result: improvement in organization and the overall emotional climate within the team [11, 12].

Case: practical implementation eliminated the need to search for who is to blame. Chaotic behavior in all standard operations decreased. Issuance of inventory items became clear, predictable, and transparent. New employees adapt within 10 days and the habit is formed within 2.5 months. Independence increased: employees themselves monitor tags, cleanliness, and templates.

CHAPTER 2. COMPARISON, EVALUATION, COMPATIBILITY AND SCHEDULE OF APPLICATION OF METHODS

The chapter is devoted to the analysis and methodological integration of the proposed complex of logistics techniques, moving from their descriptive presentation to the examination of systemic compatibility and operational synergy. Apparent methodological collisions are resolved; in particular, the temporal complementarity of tactical control (FBSI) and strategic verification (REDI) is demonstrated through their phasing within an annual operational cyclogram adapted to seasonal logistics cycles. In an analogous manner, the integration of spatial optimization is examined, where HASS is positioned as the basic macrostructure of zoning by turnover rate, and APLA is defined as the priority microlevel constraining algorithm that neutralizes cognitive errors (mis-sorting). Thus, the chaptep finalizes the construction of a unified adaptive socio-technical warehouse management model, in which permanent procedural regulations (RTP-Dispatch) and methods of cultural adaptation of personnel (5S) ensure the integrity and functional stability of the entire system under specified operational constraint conditions.

2.1 Evaluation of methodological conflict between FBSI and REDI [1, 13, 15]

Criterion	FBSI	REDI	Conflict?
Coverage	Only buffer (active) positions	Entire nomenclature by ABC groups	No
Purpose	Baseline stabilization of accounting	Deep reconciliation and quasi-inventory	No
When applied	Immediately after warehouse launch, in case of overload or chaos	When accounting is stabilized. Pause in logistics, with varying levels of activity, and 3 months before the annual inventory.	No
Labor intensity	Minimal (10–15 min per day)	Moderate (30–40 min for 2 employees) instead of 60 days of counting and analysis in -40 cold during the active period of logistics and construction work.	No
Benefit	Local control and identification of critical discrepancies	Cumulative effect and preparation for INV	Synergy

2.2 Evaluation of methodological conflict between APLA and HASS [4, 12, 14]

Parameter	APLA	HASS	Conflict?
Goal	Eliminate item mix-up	Increase speed and logical accessibility	No
Basis	Logic of similarity / external appearance	Movement frequency / turnover	No
Priority in placement	Separate similar items, placing them far from each other	Bring active items closer, move passive items farther away	Potential intersection, but solvable
Conflict risk	When visually similar and fast-moving items end up next to each other	When the placement system prioritizes activity, ignoring visual or code similarity	Only in absence of coordination
Required correction	Human judgment during layout	Algorithm or table based on turnover	Combines

2.3 Compatibility of applying FBSI, REDI, APLA, HASS [7, 16]

Methodology	**Function**	**Space**	**Frequency**	**Selection principle**	**Conflicts with…**	**Combines with…**
FBSI (Fast Buffer Stock Inspection)	Daily fast reconciliation of the active zone	Buffer only (≈20–25% of MRO inventory)	Daily, year-round	Movement frequency and importance for repairs	—	REDI (targets intensively)
REDI (Ranked Everyday Inventory)	Systematic micro-reconciliation by ranking	Entire warehouse (ABC approach)	Spring, autumn: once every two weeks; in summer — targeted. Inactive zones sealed.	Priority of turnover and error history	—	FBSI (escalates into full check), HASS
APLA (Anti-Persort Logistics Algorithm)	Elimination of item mix-up and logical placement errors	All zones where there is external or code similarity	At initial placement + upon detection of errors	Visual, code, or packaging similarity	Only if the visual factor is ignored	HASS (corrects addressing)
HASS (Hybrid Addressable Storage System)	Combined placement: active closer, passive farther	Entire warehouse	Upon receipt or during replanning	Movement frequency	Only if APLA is not taken into account	APLA (adjusts placement plan)

2.4 Application schedule of the methodologies [5, 8, 10]

Month	Characteristics	Priority methodology	Goal of the period
January–March	Severe cold, active inbound and issuing.	FBSI	Buffer-only reconciliation. Labor savings. Control over stock balances in warehouses and winter roads.
April–May	Spring flood, logistics pause. Ability to stay outside longer.	FBSI + targeted REDI	Reinforced buffer zone. Implementation of REDI in active, medium-active, and passive zones. We use the decline in inbound and outbound activity. We check tags, labels — apply them if needed.
June–August	Start of river navigation, mass repairs, equipment entering operation. Spare parts demand	FBSI → REDI	Summer activity. We maintain checks once every two weeks for active and medium-active zones, once per month for passive zones.
September	Information gathering for INV, end of season	REDI	Active closure of gaps, coverage of balances. Preparation of documents for INV. Passive / illiquid zones sealed with numbered seals recorded in the log.
October	Inventory	REDI (final) + FBSI	Comparison with accumulated REDI results. Buffer check before INV.
November–December	Inbound via winter roads, winter preparation	FBSI + inbound control	Allocation by zones, preparation of locations for new receipts and their movements.

CHAPTER 3. PRACTICAL APPLICATION OF THE METHODOLOGIES

The chapter is devoted to the practical operationalization and systemic synthesis of the previously analyzed methodologies, translating them from the theoretical domain into an applied model of functioning. The principle of temporal complementarity between tactical control (FBSI) and strategic verification (REDI) is disclosed in detail, substantiating their relay-like alternation within the annual operational cycle determined by seasonal fluctuations in logistics activity and resource availability. Simultaneously, a hierarchical algorithm of spatial integration is asserted, in which HASS forms the basic macrostructure of zoning (according to the criterion of turnover rate), and APLA functions as a superordinate corrective constraint that neutralizes cognitive risks (mis-sorting) at the microlevel of placement. This comprehensive model relies on an invariant procedural framework (RTP-Dispatch), which ensures end-to-end accountability and documentary traceability.

FBSI (buffer reconciliation) is used:

– In January–March, when workloads are high but time is limited, only direct reconciliation is performed.

– In April–May, it is applied as the basis, with selective integration of REDI, since the level of operational workload allows this to be done;

– In the summer months, a transitional stage occurs. FBSI remains, but gradually yields to REDI, and the shift is primarily one of changing priorities;

– In the autumn months, FBSI is used as support for REDI for the final data verification (they assist each other rather than interfere).

– In November–December, FBSI is used together with incoming flow control, as an instrument of adaptation to the winter supply influx, which can paralyze the warehouse.

REDI is activated:

Selectively in spring, during the logistics decline – this is reasonable for conducting training. Fully in summer (during active repairs and issuance), where the FBSI method is no longer sufficient. In September and October, already as the primary mechanism for inventory preparation. Then it yields again to FBSI, since FBSI is an effective verification instrument.

Result: FBSI is responsible for daily tactical control, REDI is required for strategic accumulation of reconciliations. They do not duplicate each other, but alternate by season and by function. The methodologies are structured as a relay handover. One operates in periods of resource shortage, and the other is activated when there is an available window for in-depth control.

Execution of the HASS method does not imply verification by item name or packaging. At the first stage, HASS generates a movement map, placing the most active items closer to the issuing zones. Then, on top of this map, APLA is applied, which identifies positions that are visually or code-wise similar (risk pairs). APLA prescribes physically separating these pairs, even if both are located in the HASS active zone, in order to prevent mispicking. HASS specifies: If Filters A and B are used frequently, they are placed at the aisle (in the active zone). APLA specifies: If Filters A and B have similar codes/packaging, they must not be placed next to each other.

Result: Both filters remain in the active zone, but are placed with physical separation (for example, Filter A at one aisle, and Filter B at the opposite end of this same active zone).

Practical template of placement rules:

1. HASS helps to build a frequency-based structure (ABC).
2. APLA sets constraints: if codes/names/appearance are similar, it is necessary to establish a distance of 2 meters or 2 rows between them.
3. In the case of overlap, APLA is preferable.

RTP-Dispatch operates on a permanent basis by default, without seasonality. It protects the warehouse from unjustified issuances and relocations, and therefore protects all reporting from paper-based failures. At the same time, it operates without ERP, RFID, or stable internet and electricity: the key elements are a request, a signature, and a purpose.

The greatest difficulty lies in effective personnel training and overcoming resistance to new procedures. Since the warehouse is a high financial liability zone, a high level of discipline and responsibility is required. The most suitable methodology for addressing this is the Japanese 5S system, implemented at Toyota plants in 1950.

Adaptation of the 5S system

Start: without knowledge of warehouse topology, the location-based storage system (WMS/ERP), and the nomenclature range.

Step 1: Together with an experienced employee, the trainee begins visual familiarization with the warehouse, participating in the analysis of placement and storage processes, and in identifying causes of losses, as well as determining factors that hinder effective work. What the trainee does: observes the work cycle (issuance, receipt, placement); participates in sorting and cleaning (forming an understanding of how disorder affects labor productivity); helps label shelves and verify tags.

This provides a foundation for understanding what is happening in the work field.

Step 2: Introduction to the accounting system and standardization of operations (RTP Dispatch – issuance control) Seiketsu (standardization)

What the employee does: documents the issuance of materials and equipment at the request of a mechanic, records the purpose; learns to verify consumption norms (if exceeded — attaches a note). The trainee is trained in document flow and in registering operations in the accounting system.

Step 3: Introduction to FBSI and APLA Seiri (sorting)

What the employee does: receives the list of active items for the day and compares it with the issuance documents; manually checks stock levels, notices similar parts stored next to each other, and learns to identify items that fall into the APLA risk group; helps move duplicates to different zones. Only items that are currently in motion are checked. As a result, excess is eliminated and an Excel template or reconciliation log is created; the employee processes only the transactions that occurred today. Each day they see logical errors and oversorting risks more clearly.

Step 4: Introduction to HASS. Seiton (order), Seiso (cleanliness)

What the employee does: helps place incoming items into zones: high-activity, medium-activity, and passive (HASS), avoiding APLA; becomes more familiar with location-based storage. Understands that logistics is not only numbers, but also routes (activity zones, location-based storage).

Step 5: REDI. Shitsuke (discipline), Seiton (systematization) expansion of control coverage across all zones through reconciliation of actual quantities with accounting records. Implemented last to prepare for annual inventories.

What the employee does:

- during logistics slowdowns, first inspects the inactive zone (easier to control), then the active and medium-activity zones.
- identifies discrepancies with accounting records and documents them for further root cause analysis.
- performs visual control (what is not in its place) according to 5S.

The training period for basic techniques is 10 days, and forming them into stable habits takes up to 2.5 months. Without a culture of work (discipline), the warehouse will fall into chaos, even with all modern technologies. These methods also function as a backup system under conditions of dependence on diesel generators and unstable connectivity, when meeting construction deadlines is critically important.

CHAPTER 4. EXERCISES FOR THE DEVELOPMENT OF COGNITIVE ABILITIES USING THE EXAMPLE OF AN AUTO PARTS WAREHOUSE

Within the chapter, the focus of the study shifts from process-organizational aspects to the cognitive-ergonomic optimization of the warehouse operator, positing that the fundamental cause of a significant share of operational errors (in particular, during receiving and order picking) is not a systemic failure or malicious intent, but cognitive bottlenecks: deficit of attentional stability, low speed of differentiated perception, and vulnerability to visual interference. A set of targeted neurocognitive training protocols is proposed, developed as direct simulators of key warehouse tasks: 1) analysis of complex technical diagrams (Fig. 1) for training visually-associative links between article and location; 2) tasks for resolving cognitive dissonance (Stroop paradigm, Fig. 3) for strengthening mnemonic links (e.g., color codification); 3) visual search paradigms (Fig. 2, 4) for training signal extraction (the sought material asset) from visual noise (chaotic storage). The culmination of the section is the introduction of psychophysiological instrumentation (Landolt rings, Fig. 4) as a highly effective method for the development of specific properties of attention (concentration, switching, distribution), directly modeling the cognitive load in working with risk groups for mis-sorting (APLA).

1**.** Exercise in schematics and numbering distinction

Justification. One of the main causes of losses in the warehouse sector is a lack of attentiveness among employees. Moreover, this occurs most frequently: in more than fifty percent of cases, the source of the problem was precisely inattentiveness, and not external or internal theft or fraud related to the goods stored in the warehouse. Most of the deficiency is associated with an incorrect receiving procedure, which requires maximum concentration, especially considering the presence of similar items. This is observed, for example, in the field of automotive spare parts, where a discrepancy of one digit in an inventory number may mean that the part will not fit into place, as in the case of sensors that have a specific orientation.

Consequently, the employee must be able to determine the placement of the part within an assembly and create an association between its number and its position. This is best achieved by providing receiving personnel not only with the standard nomenclature list, but also with assembly diagrams where the location of the parts included in them can be seen. In this case, it is possible to avoid not only receiving excess items, but also to ensure the correct placement of spare parts within the warehouse, based on the principle of correspondence.

Nevertheless, without the skill of recognizing differences in the layout of assemblies and the inventory numbers of parts, such a diagram will not be effective. To develop this skill, employees should be given similar images with minimal differences in configuration or discrepancies in numbering so that they can identify them within a limited amount of time. Such training may help avoid errors during the actual receiving of spare parts into the warehouse and, at an early stage, identify discrepancies in the initial supply plan, which is especially critical in the conditions of the Far North.

Example of an exercise. An example of such an exercise may be the comparison of several diagrams of complex technical assemblies that differ due to a revision of their configuration. The main point is not to use constructions that are excessively simple and, at the same time, overly complex. An ideal example may be an assembly diagram provided as supporting documentation for actual equipment related to the warehouse (Fig. 1).

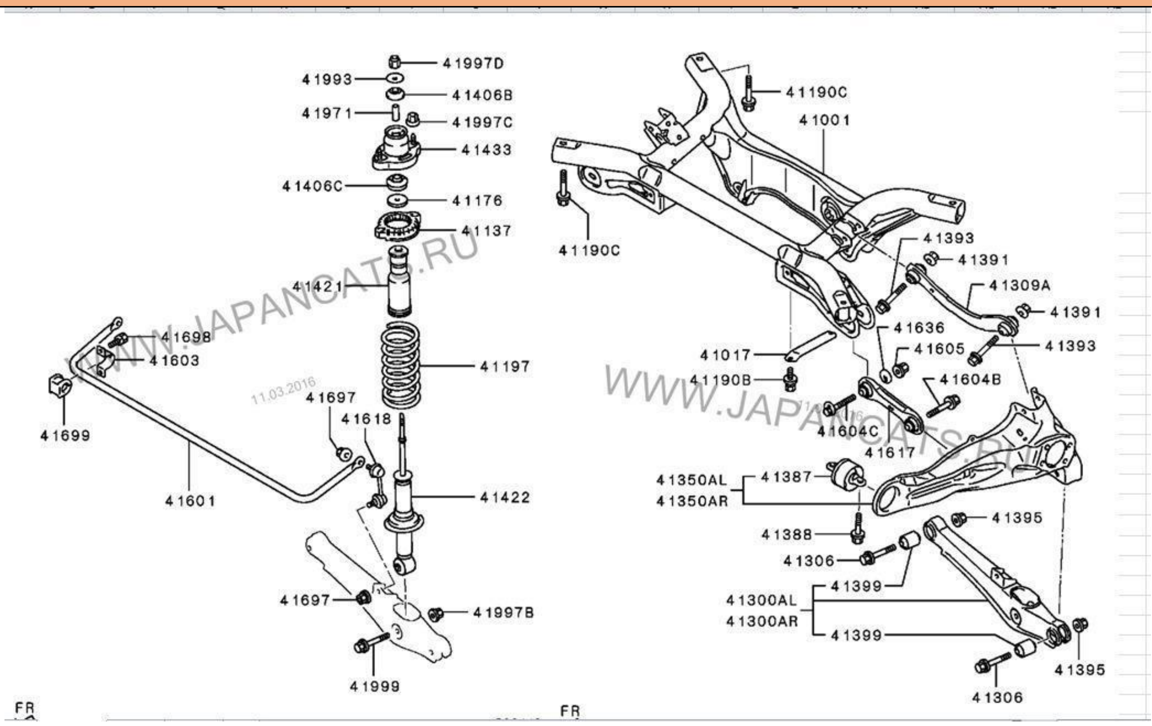

Figure 1. Example of a technological diagram of an assembly.

After allowing sufficient time to study the image, it is possible to ask questions about the main spare parts included in the specific assembly. In addition, it is possible to provide, together with the correct codes, one spare part taken from this list by its number and ask the person to locate it. This can help identify patterns in the numbering sequence and improve the skill of interpreting complex technical diagrams in general.

Result. Studying such a diagram, comparing it with a similar one, and then answering questions after its review may help improve concentration on complex technical diagrams and contribute to the reduction of errors during the receipt and issuance of spare parts to the warehouse.

Note. This diagram can be used not only to improve receiving processes, but also to increase the efficiency of orientation in the warehouse, if a familiar diagram is placed in the field of view on the container where the spare parts belonging to a specific assembly are stored.

Applications for spotting differences in images may also contribute to the ability to quickly identify discrepancies, if those applications are based on images containing a large number of details (Fig. 2).

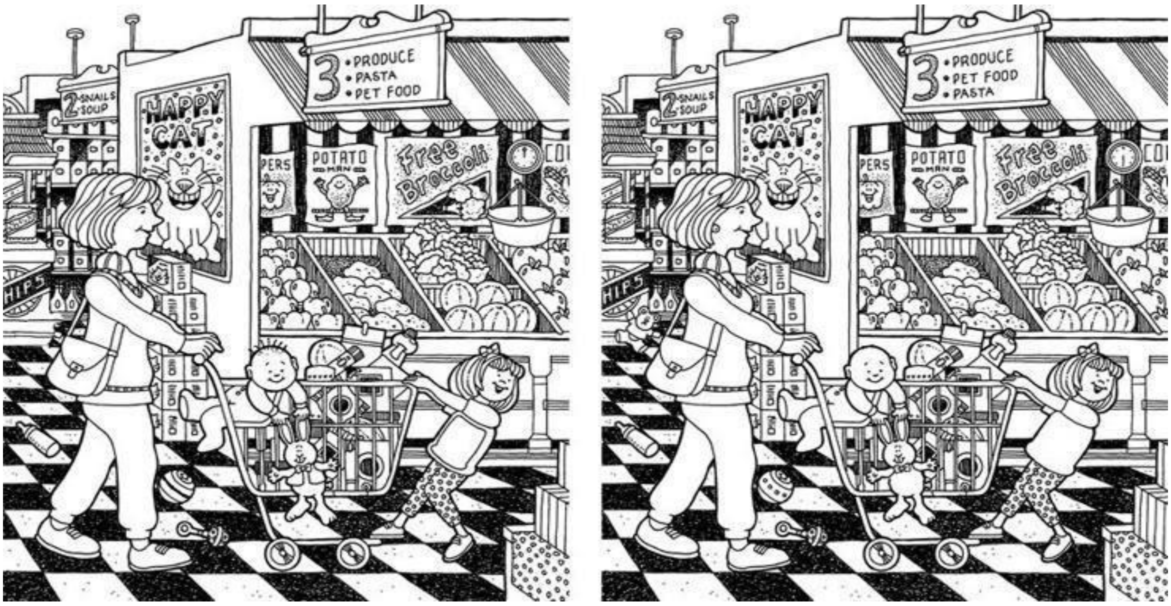

Fig.2. Example of an image for a spot-the-difference task

2. Exercise in color-object correlation (color coding)

Justification. A significant amount of time may be spent searching for the correct storage location of an item, especially in the context of an extensive warehouse complex and the presence of a large number of spare parts with similar construction. This situation may lead not only to a substantial increase in search time, but also to cases in which, instead of one item, a different one is retrieved.

This may also become a cause of downtime and, in the worst case, equipment failure,, since repair and maintenance under Far North conditions may be complicated.

To normalize the situation, color codes are used, but the problem is that employees simply do not remember which color corresponds to what exactly. As a result, they either spend time searching through records where a note has been made, or they act by intuition, which also leads to errors.

Example of an exercise. At the same time, color designation is indeed good practice; it simply needs to be reinforced through training that links the color of the shape to the designation of the color in text. Moreover, the text itself does not necessarily have to match the color of the shape (Fig. 3).

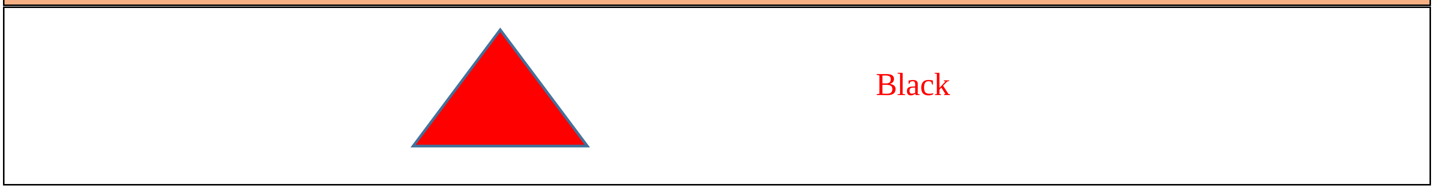

Fig.3. Example of a perception development card

For example, employees can be offered this type of cards, where within a limited time they must answer whether the textual definition matches the color of the figure. The human brain may incorrectly process signals under time constraints, which will lead to errors and reliance on the color rather than the actual meaning of the text.

Result. Training will allow a faster establishment of associations and a more complete characterization of the qualities of a specific image. As a consequence, a person is more likely to link the color to a specific container, node, and finally, type of part. The more effective the ability to establish interrelations between the figure, the color, and what it stands for, the shorter the time of interaction with the warehouse.

3. Exercise for rapid visual search of the target item

Justification. The current reality is the fact that inside the container spare parts may be located outside the order initially established and specified in the regulatory documents. As a rule, the arrangement of spare parts is chaotic, and it is difficult to single out a specific item among them. A situation may arise in which an employee is looking at a part but does not actually see it, because there are too many of them to properly process the signal entering through the visual system.

Example of an exercise. Item search is one of the popular types of applications, and they differ in their level of difficulty. Taking into account the specifics of the warehouse, it is advisable to gradually progress toward a high level, in which, within a limited time, it is necessary to locate on the screen a large number of small objects whose placement is non-trivial (Fig. 4).

Fig.4. Example of an object search task

Result. Employees handle object search in warehouse clutter more efficiently, as they have developed the ability to identify specific features of named objects within a limited time.

Note. Images can be adapted to specific items within the warehouse to increase training efficiency.

Addition for training attention stability under frequent task switching

Landolt rings (Landolt optotypes) are optotypes developed by the Swiss ophthalmologist Edmund Landolt in 1888. Originally developed for ophthalmology, they have also found application in psychology. They consist of a set of rings with gaps on different sides, resembling a Latin letter C rotated in different ways. The width of the ring and the width of the gap are in a 1:5 ratio to its outer diameter.

For the gaps, either a simple form of four variants is used (top, bottom, right, and left; north, south, east, and west; 12, 6, 3, and 9 o'clock), or a more complex form of eight variants (plus four diagonal ones) (Fig. 4).

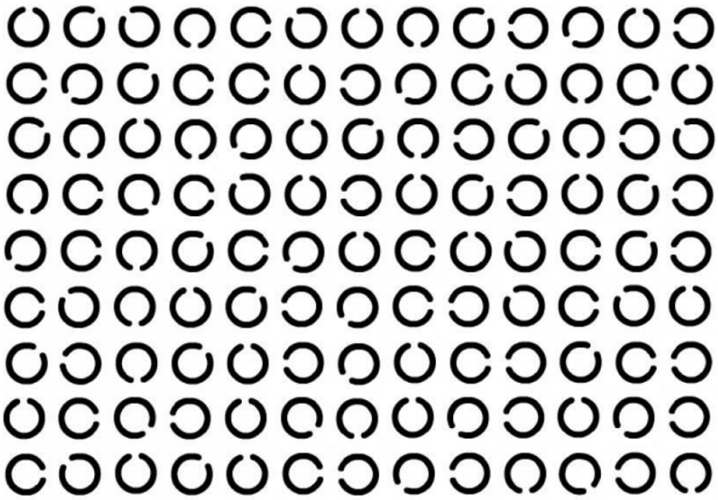

Fig.4. Landolt Rings

Required skills: detecting differences.

Application and development of the skill:

Exercise 1: Basic Scanner (for beginners and warm-up)

Purpose: Formation of automaticity in detecting a single key feature — analogous to searching for one specific SKU by its main distinguishing attribute (e.g., searching only for purple labels).

Instruction: In front of you are rows of Landolt Rings. Your task is to find and mark, as quickly and without errors as possible, all rings with the gap strictly at the top (↑). Methodology: The classic template is used. The exercise is performed daily for 2–3 minutes before the start of the shift. The direction of the gap changes every day (right, left, down). Relation to APLA: This is training of filtering by a single parameter. The employee learns to ignore all other visual noise and to concentrate on one difference.

Exercise 2: Double Code (core exercise for APLA)

Purpose: Development of the ability to hold two features in working memory and search for them simultaneously, which models searching for twin SKUs (e.g., filter 4321 and filter 4322). Instruction: Find and mark two different types of rings according to the specified rules. For example, rings with the gap up-right (↗) — circle them; rings with the gap down-left (↙) — underline them with two lines. Methodology: This exercise is more difficult. More time is given (4-5 minutes). Accuracy, not speed, is critically important. After completion the number of errors must be checked. Relation to APLA: Direct analogue of working with similar SKUs. The brain learns not just to search for similar items, but to create separate slots for each combination of features, which is the essence of differentiated perception.

Landolt Rings are a highly effective tool for training warehouse personnel because they create a direct analogy with key work tasks. Exercises based on quickly locating gaps in rings simulate the need to scan barcodes, locate a SKU among similar markings, and visually control packaging integrity (detection of defects). Regular practice develops four critically important properties of attention: concentration (the ability to ignore interference), stability (maintaining effectiveness throughout the entire day), shifting (rapid transition between tasks), and distribution (the ability to perform several actions at once, for example, operating a forklift while checking a packing slip). Thus, the test purposefully trains exactly those cognitive skills that ensure accuracy and safety of warehouse operations.

CHAPTER 5. THEORETICAL FOUNDATION OF THE STUDY

A fundamental theoretical-methodological basis of the study is formed, providing scientific justification for the previously presented applied methods and cognitive protocols. As the central explanatory construct, a multicomponent model of working memory (Baddeley & Hitch, 1974) is used, with the focus placed to the functions of the central executive mechanism (attentional control) and the visuospatial sketchpad (processing of visual and navigational information). These cognitive constructs are invoked for the theoretical validation of the effectiveness of methodologies that require the development of skills of spatial orientation and differentiated perception (e.g., FBSI, APLA). In addition, the section integrates the neurobiological foundations of the spacing effect, positioning it as the theoretical core for the optimization of the proposed training regimes (Chapter 4). Thus, it is demonstrated that it is precisely the distributive (distributed) approach to training, as opposed to massed training, that represents the optimal strategy for ensuring long-term retention of skills and the formation of a stable production culture among personnel.

Baddeley and Hitch working memory model (1974)

In 1974, Alan Baddeley and Graham Hitch proposed a working memory model consisting of several components.

Central executive: manages attention and coordinates the work of other components.

Phonological loop: processes and stores auditory information.

Visuospatial sketchpad: responsible for processing visual and spatial information [15].

Later, the episodic buffer was added, integrating information from various sources.

Visuospatial working memory

Visuospatial working memory plays a key role in navigation and manipulation of visual information. It allows us to maintain and process information about the location of objects and their visual characteristics [16].

The role of attention in visual working memory

Research shows that the focus of attention can simultaneously encompass several elements, which is important for understanding the limitations and capacities of working memory [17].

Spacing effect

Numerous studies confirm that distributing learning sessions over time (as opposed to cramming) significantly improves long-term retention.

Mechanisms and optimization of spaced learning

A 2016 study in the journal Nature Reviews Neuroscience examines the neurobiological mechanisms underlying the spacing effect and proposes strategies for optimizing learning intervals to maximize information acquisition [18].

Application of spaced repetition in educational practice

The University of California, San Diego (UCSD) emphasizes that distributed learning leads to better retention compared to massed repetition, and recommends incorporating this approach into educational programs.

CONCLUSION

In this work, an integrated warehouse management system is developed and substantiated for extreme conditions of limited infrastructure, unstable communications, and climatic stress. This system is positioned not as a private set of regulations for material and technical support, but as an adaptive model of resilient logistics applicable in high-risk zones such as the Far North, remote construction sites, extraction projects, and humanitarian missions. The key thesis of the study is that classical digital solutions (ERP, WMS, RFID) in such environments are not only difficult to implement but structurally vulnerable. What is critical here is not only stock control, but also controllability of the human factor — attention, memory, discipline. Under these conditions the proposed methodologies FBSI, REDI, APLA, HASS, RTP-Dispatch and the adapted 5S system form an alternative paradigm in which the quality of logistics is ensured not by equipment, but by cognitive training of personnel, visual protocols, and rhythmic operational discipline.

The functional role of each methodology in this paradigm is not duplicated, but rather covers a separate layer of the logistics task. FBSI acts as a mechanism for daily stabilization of accounting and physical stock tracking in the most critical warehouse zone — the active buffer stock — when the warehouse is not yet organized and there is neither time nor resources for total inventory. REDI solves a strategic task — it breaks the annual inventory into a manageable series of micro-checks by ranked groups of stock keeping units, thereby eliminating the need to freeze the warehouse for weeks. APLA reduces the risk of item substitution by intentional separation of visually similar materials and by training personnel in visual differentiation, whereas HASS defines the logic of location-based storage itself through division of space into dynamic and static zones. RTP-Dispatch closes the loop at the level of issuance and accountability: each unit of material assets is tied to a specific piece of equipment, repair node, and person. Collectively the methodologies ensure not only stock accuracy, but also full traceability of each item's movement from receipt to write-off.

An important contribution of the work is the demonstration that these methodologies are not merely compatible, but structurally complementary in terms of time, logic, and cognitive load. FBSI and REDI form a rhythm of tactical ↔ strategic complementary: FBSI ensures daily transparency where turnover and risks are maximal, while REDI is used in logistics windows for phased coverage of the entire assortment and preparation of the annual inventory. Similarly, HASS forms the rational topology of the warehouse, arranging the most demanded items closer to the issuance zone, and APLA overlays a corrective layer, spreading apart parts that are similar in code/appearance in order to eliminate erroneous issuance. The author directly evaluates the conflict potential of these methodologies and reduces it to points of controlled coordination: item substitution is prevented by prioritizing APLA, inventory workload is distributed through seasonal planning in REDI, and peak personnel load in the cold period is compensated by FBSI due to its low labor intensity. Thus logistics receives not a monolith, but a living regulation synchronized with the seasonality of supplies, the climate, and windows of personnel availability.

Of particular note is that the work departs from the typical reduction in warehouse literature of the problem to accounting and placement and instead treats the operator's cognitive limitations as the root source of losses. It is shown that in the North the key causes of losses are not only theft, negligence, or lack of automation, but elementary overload of attention under monotonous work, fatigue, low temperatures, and rigid time windows. In this context the author advances the principle that minimization of errors in accounting and issuance is not only a logistics task, but also a neurocognitive task. This is precisely why the work integrates a block of exercises (spotting differences in assembly diagrams, searching for objects in visual noise, tasks on matching color and textual description, training with Landolt rings) directly aimed at developing selective attention, visuospatial working memory, and sustained focus. This linkage between operational protocols and attention training moves the study beyond the classical description of warehouse business processes and brings it closer to applied cognitive ergonomics.

The theoretical basis of the research substantiates this linkage rather than merely illustrating it. Through the Baddeley and Hitch model of working memory, the warehouse operator's work operations are formalized as the work of the central executive, the visuospatial sketchpad, and the episodic buffer, which maintains the association between an item's storage location, its visual appearance, and its intended use. [15]. It is indicated that the distributed repeated checks according to the FBSI and REDI methodologies are not a manual crutch instead of WMS, but essentially exploit the spacing effect, which, according to cognitive neuroscience data, improves long-term retention of material through cyclic return to it with intervals over time [18]. Thus daily micro-checks and seasonal audits are described as a managed system for consolidation of professional memory, rather than as a forced inventory without a computer. This creates scientific legitimacy for the proposed model and allows it to be transmitted as a method of professional training, and not only as an emergency regulation for remote warehouses.

The practical contribution is expressed along three dimensions. First, economic: every error in procurement, placement, or issuance in Far North conditions turns into disproportionately large losses, since return and reverse logistics are often economically impractical. Consequently, stock accuracy becomes not an accounting formality, but a mechanism of direct budget protection for the project. Second, organizational: RTP-Dispatch creates a transparent chain request → issuance → responsibility, eliminating the chronic problem of personal material debt and of material assets remaining assigned to dismissed employees. Third, operational: HASS and APLA in combination sharply reduce search time and lower the number of incorrect issuances, and do so without scanners, online ERP access, or a staff of highly qualified logisticians. These results are especially critical where work windows are limited by weather, equipment, and transport accessibility, and where human error is immediately scaled into equipment downtime or accident risk.

Methodologically the work forms a reproducible implementation framework. A seasonal application map of the methodologies is proposed, reflecting northern supply cycles: winter delivery and peak issuance (focus on rapid FBSI checks), spring lull and availability of personnel for in-depth reconciliations (transition to REDI), summer period of active repairs (biweekly REDI rhythm and supporting selective checks), preparation for the annual inventory (full-scale REDI), followed by a return to FBSI as a means of controlling inbound flows in the next cycle. In parallel, a phased training trajectory for new employees is defined through the adapted 5S system — from initial spatial orientation in the warehouse, through mastering the documentary discipline of RTP-Dispatch, to practical differentiation of similar parts (APLA), understanding the logic of addressability and activity (HASS), and then to independent work with REDI. The result is not merely an implementation regulation, but a professionalization route for personnel over 10 days of basic onboarding and approximately 2.5 months to stable habit formation.

In conclusion, the work develops a theoretically grounded and practically validated concept of a resilient warehouse contour for remote and resource-constrained territories. The proposed system of methodologies not only reduces the risk of item substitution, losses, and sabotage, but also creates a controllable culture of accountability in which each stock unit has an address, a movement history, and a confirmed purpose of use. As a result, the warehouse ceases to be a black box of supply and becomes a controllable cognitive-logistics infrastructure supporting critical assets — power generation, transport, construction, extraction. Thus the contribution of the study is dual in nature: on the one hand, it is an applied instruction for building resilent warehouses in extreme conditions; on the other hand, it is a model for transferring neurocognitive principles of attention, working memory, and spaced repetition into the domain of industrial logistics, that is, a step toward forming a new field — cognitive logistics in an extreme environment.

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