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Methods for Assessing Workwear Ergonomics in the Field of Public Nutrition

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Abstract: *Advanced in the current paper is an innovative methodology for the design of workwear for the food and beverage industry environment, integrating regulatory requirements, ergonomic principles, and end-user preferences. The methods herein proposed address critical sector-wide issues such as the lack of a standardized normative framework, minimal employer incentives to invest in premium specialized workwear, and restricted access to relevant certified materials.*
By aligning regulatory compliance with economically viable solutions, the developed methodology provides a comprehensive approach to effectively overcoming these constraints.

Key words: methodology, workwear, research, design, public nutrition, ergonomics, functionality, safety

1 Introduction

Modern food and beverage industry necessitates an innovative approach to workwear design, integrating three fundamental aspects: ergonomics, functionality, and safety. Introduced, accordingly, in the present study, is a comprehensive methodology for workwear design, grounded in a systems analysis of the interactive triad "individual-work clothing-work environment".

The primary focus is on the systems identification and analysis of key determinants that affect both functional performance and ergonomic comfort, while maintaining strict compliance with technical parameters, specifications and constraints. The developed approach facilitates the optimization of design and material selection, ultimately enhancing worker protection and safety, and contributing to increased productivity (Georgieva, B., 2021).

The results obtained provide a scientific basis for establishing contemporary standards that achieve an optimal balance among the above-stated fundamental aspects.

2 Exposition

The proposed methodology analyzes the ergonomic requirements in public nutrition workwear in line with current ergonomic standards and in response to the demands for more up-to-date alternatives.

The primary objective is to establish a methodology for ergonomic design of occupational clothing, prioritizing improvements throughout all phases of development. This methodology aims to reduce the product life cycle - from initial concept to final implementation- while ensuring superior ergonomic comfort for end-users.

To achieve the intended research objective, the following specific tasks are defined, providing a framework for the overall workflow:

1. Systematic investigation and critical analysis of the historical development and current state of specialised work clothing, with particular emphasis on their functional and ergonomic characteristics.
2. Theoretical justification of the conceptual principles and methodological approaches for the ergonomic design of professional workwear.
3. Development of an innovative methodology for ergonomic approach to workwear design, guiding the entire process from initial concept to final realisation, ensuring enhanced ergonomic performance and overall user comfort.
4. Experimental application of the developed methodology in real working conditions.

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5. Comprehensive assessment of the ergonomic parameters of the resulting prototypes to validate the effectiveness of the proposed methodology.

The object of study is conventional workwear intended for daily use incorporating protective, ergonomic, and hygienic attributes in compliance with relevant European regulatory standards. The research focuses on a thorough examination of organisational production-related factors affecting employees' occupational health. The emphasis is predominantly on standard industrial workwear, with the exclusion of specialised protective apparel designed for extreme occupational environments.

The subject of study relates to the ergonomic and design aspects of workwear, as critical factors for adapting individuals to the specific demands of their working environment and for ensuring their psycho-physiological well-being and comfort.

Adopted, within the present paper, are two complementary methodological approaches: theoretical-applied and experimental. The theoretical-applied approach involves analysis of the problem domain from a systemic perspective with a deliberate synthesis of key ergonomic and design considerations as to the development of specialized workwear. The experimental approach encompasses both the creation of methodology for workwear design and the establishment of a system for evaluating the ergonomic parameters of garments, as well as the practical assessment of their functional effectiveness. The principal methods applied include:

- comparative analysis of prevailing prototypes.
- surveys conducted among end-users to evaluate satisfaction levels and the ergonomic performance of the designed workwear (Methodology for comprehensive assessment).
- expert evaluations by specialists in industrial design and ergonomics (BG05M9OP001-1.051-0006-C01, 2020).

The selection of evaluation methods determines the way the study is conducted and is guided by factors such as time, funding, qualified personnel, and the degree of complexity, among others.

Direct observations of the actual work processes are also conducted, along with on-site assessments, involving surveys, interviews, and discussions with both employers and users.

The principal challenges identified in the current study stem from the absence of a clearly defined regulatory framework governing the design and production of specialized workwear; a lack of sufficient motivation among employers to invest in premium work clothing; and the limited availability of certified primary and auxiliary textile and haberdashery materials on the market.

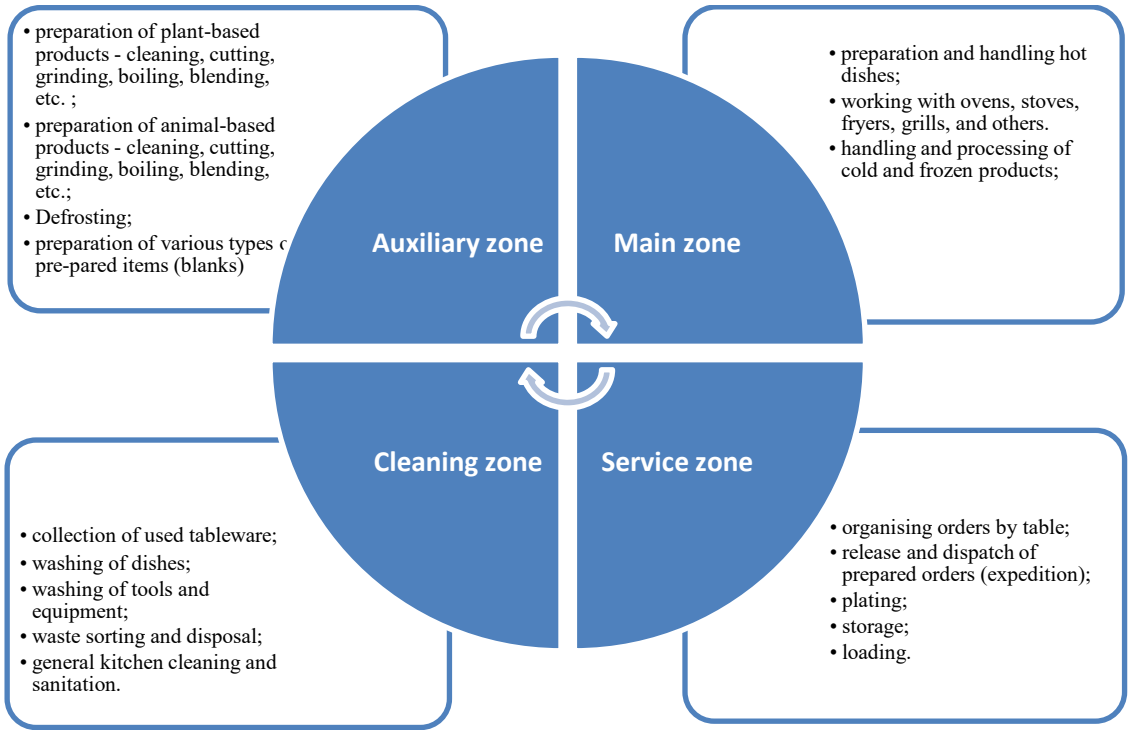

Fig. 1 Work zones within the general production area (author's research contribution)

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(Murzova, Ts., 2009), (Norms for physical workload of workers and hygienic-physiological and ergonomic requirements for rational organisation of the work-place and labour process № 5 MNZ, 1999), (BDS 14776:1987)

The systems study, in view of the above, addresses current and unresolved concerns in workwear design. Proposed, within the research, are concrete alternative solutions that integrate contemporary visual aesthetics and ergonomic functionality, in accordance with the outlined methodology.

For the purposes of the present study, the work zones within the general production area (Figure 1) differentiated by clarifying the production processes, technology, and equipment utilised, as well as by identifying the changes the professional workwear undergoes throughout the work schedule in each zone.

Comparable models, variants, or products, are analyzed, and a comparative assessment of existing market offerings is conducted through user surveys to identify their constraints, advantages, and opportunities for improvement.

Ergonomic design methodology for modern workwear

Stage 1: Pre-design studies.

A systematic establishment (BG 051PO001–2.1.07, 2013) of existing ergonomic, visual, functional, and structural challenges, followed by defining the design context and formulating appropriate solutions through comprehensive analysis of empirical data.

1. Prepare a task specification detailing the intended usage and specific functions of each part of the work apparel. For every part, identify its type, primary and auxiliary functions, the areas of application, and the anticipated duration of use in accordance with the work schedule.

2. Drawing on insights obtained from design developments, direct observations, and user surveys, analyse the characteristic features of the workwear with respect to the following factors:

2.1. Form, volume, and structure of the individual workwear components.

2.1.1. Is there a need for alterations in the form of workwear - to facilitate freedom of movement?

2.1.2. Is there a need for adjustments in the volume of workwear -to ensure optimal fit and comfort?

2.1.3. Is there a need for changes in the functionality of individual workwear components?

2.1.4. Is it necessary to differentiate between workwear components based on varying temperature zones within the workplace and specific job activities?

2.1.5. Is there a necessity of colour differentiation among individual workwear components to reflect team hierarchy and improve recognition and orientation?

2.2. Characteristics and properties of the available primary and auxiliary materials, in terms of market availability, and the project's budget constraints?

2.3. Hygiene (microclimatic) parameters of the work environment:

2.3.1. Establish the temperature profile of the workspace and individual work zones and identify opportunities for compensation through appropriate adaptations of the corresponding workwear and its components.

2.3.2. Identify sources of excessive contamination and propose solutions through the selection and design of suitable workwear elements.

3. Define the constraints, requirements, and preferences related to the human factor:

3.1. Assess the nature and duration of work activities performed within the designated workspace and its functional areas; identify potential sources of fatigue and/or discomfort (physical, psychological, mental, or sensory) and determine, accordingly, the corresponding requirements for additional protective measures or equipment.

3.2. Evaluate colour preferences when selecting workwear for the primary user groups, ensuring alignment with the specific types of work activities performed.

4. Analyze the functional purpose of individual elements in existing workwear, highlighting ergonomic challenges encountered during typical work activities.

4.1. Review the ergonomic properties of the main components of current workwear.

4.1.1. Conduct on-site observations to record inconsistencies, inadequacies, non-conformities, and deficiencies experienced during actual use, and propose solutions to address these issues.

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4.1.2. Collect user feedback through structured interviews and surveys, systematically compiling perspectives and concerns regarding the impact of workwear on comfort, health protection, and work performance.

Stage 2: Design and layout of workwear components.

Ergonomic challenges identified during the pre-design analysis should form the foundation for the development of optimal solutions that address the specified human factors' requirements and needs.

The primary components of the workwear should be clearly defined, with consideration to additional features and solutions that are likely to improve workplace safety, user protection, and overall functionality.

1. Specify the characteristics/dimensions of the main workwear components and identify potential options for their adaptation to accommodate various work zones during the operational processes.
2. Ensure that the defined characteristics/dimensions of the primary workwear elements are compatible with a range of anthropometric profiles, incorporating features that allow for individual adjustments (including fasteners, elastic bands, zippers, rings and hooks) to optimize fit and comfort.
3. Assess and validate the volumetric properties of the workwear components across diverse anthropometric groups and assess the practicality of individual adjustment mechanisms for every component of the garment.
4. Select appropriate colour combinations for the workwear and its components to achieve a cohesive and professional design, ensuring both functional differentiation and clear visual hierarchy across all organisational levels.
5. Integrate the selected colour palette and design elements with the company's overall branding strategy to reinforce corporate identity.
6. Based on the systems constraints and material availability identified during the pre-design analysis, select suitable materials for both the primary and auxiliary components of the workwear.
7. Develop a design solution - a prototype of the workwear:

7.1. Create a preliminary sample set that encompasses based a comprehensive range of standard clothing sizes, tailored to a representative group of fit models corresponding to the targeted size group.

7.2. Produce a prototype for functional testing.

8. Repeat steps 1-6 to validate the workwear methodology for users operating in various functional work zones, adapting solutions to address the unique requirements of each zone.
9. Revise and update the workwear project if necessary to ensure optimal user safety.
10. Assess the ergonomic quality of the workwear prototype (through functional evaluation, anthropometric compatibility analysis, and practical testing).

10.1. Evaluate user satisfaction with the hygienic conditions of the working environment in which the garment is utilised.

10.2. Assess the extent to which the form, volume, and structure of each workwear component meet user requirements.

10.3. Conduct interviews/surveys with end-users to gather feedback on the qualities of the proposed workwear and systematise their assessments to implement corrective actions in the project if any discrepancies are identified.

11. Prepare the complete set of project documentation for the proposed workwear, including graphic artistic representations (sketches); working design drawings (blueprints) with defined constructional and decorative lines; technical specifications of the model garment and execution standards; and a detailed description of the composition of the main, auxiliary and trim materials to be used in the production process of the workwear.

Stage 3: Implementation of the designed ergonomic workwear for specialists in public catering and food processing in a real-world environment.

The project should be executed in strict compliance with the parameters and standards outlined in the design documentation.

1. Selection and production of primary garment components.
2. Modelling of primary components to ensure construction aligns with the functional and ergonomic requirements.

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3. Constructive and decorative assembly of prototypes, with careful consideration of safety, aesthetics, and brand identity.
4. Preparation of a comprehensive set of working patterns for all elements of the work apparel.
5. Grading of workwear components according to the full range of size patterns.
6. Development of a detailed workwear manufacturing algorithm specifying the sequence of technological operations and quality control criteria.

To ensure thorough and high-quality realisation of the workwear project, as well as to maintain firm control of its execution at each stage, author supervision is strongly recommended.

Stage 4: Evaluation of ergonomics and design in workwear.

The implemented workwear is evaluated to determine its effectiveness in fulfilling the designated functions. Any identified nonconformities are analysed to ascertain the root causes, and appropriate corrective measures are proposed.

Evaluation process employs a combination of qualitative methods (observation), survey techniques, and expert assessments (BDS 16502-86). Direct observations of the application of designated workwear in a professional environment provide valuable insights regarding their functional suitability, comfort and aesthetic qualities. The distinct advantage of this method (observation) lies in its cost-effectiveness and time-efficiency. Moreover, interviews provide additional immediate information about the users' subjective experiences, which are essential for assessing factors that cannot be quantitatively measured and can only be determined by the direct users, who interacting with the product directly can attest to the workwear strengths and areas for improvement. Expert assessment which integrates in direct observation with structured surveys further enhances the process of evaluation. It is crucial to develop a robust and user-friendly assessment system complete with clearly defined evaluation scales.

The combined use of qualitative, expert, and survey methods, serves to:

1. Assess the degree of alignment between the workwear parameters and the requirements identified during the pre-design analysis as well as the characteristic features of human factor.
2. Evaluate user satisfaction and determine the impact of the workwear on health protection and workplace safety.

During interviews, workers provide assessments regarding the immediate impact of workwear on the overall comfort and protection against adverse environmental factors. All opinions and complaints are meticulously recorded, and the underlying causes of negative feedback are identified. Direct observation of actual work processes provides an on-site evaluation involving surveys, interviews and discussions with both employers and users. The primary objective is to evaluate the conformity of the work apparel with the established occupational safety standards and norms. For evaluation purposes, work zones within the general production area (Figure 1) are delineated with clarification of the production processes, technologies and equipment utilised in each zone. Changes that inevitably will occur in the condition of the uniforms throughout the work schedule in each zone are documented. At this stage, data should be collected on the compliance of existing workwear parameters (BDS EN 13402-2:2003) with those specified in the relevant normative documents. Conducted, additionally, are user interviews to gauge their satisfaction levels. Specialised studies are not considered necessary at this point, as existing risk assessments and workspace evaluation documentation provide sufficient information regarding the nature of the work and the corresponding ergonomic indicators.

3. Data are collected for each of the four zones emphasizing the impact of workwear on work efficiency and the extent to which it hinders user performance or well-being.
4. Colour scheme assessment of the respective workwear is produced along with its visual impact and effect on users' self-esteem.

Colour scheme assessment is performed using a scoring system based on clearly defined criteria and indicators employing both satisfaction and conformity scales.

Survey and interview results are compiled with particular attention given to identifying the reasons for negative assessments.

The survey incorporates both closed questions with predefined response options and open-ended questions to allow for detailed feedback. Filter questions are also used to differentiate results according to the specific characteristics of each work zone.

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5. Conclusion (based on the phases 1 - 4 from the stage under discussion):

5.1. Provide a comprehensive evaluation of the ergonomic performance of the workwear;

5.2. Assess the overall design quality of the workwear.

This stage includes a detailed analysis, featuring:

- **Advantages:** functionality and user comfort, alignment with the corporate image, incorporation of modern design solutions.
- **Disadvantages:** ergonomic limitations, misalignment with practical user needs, insufficient integration of innovative features.
- **Proposals for improvement:** introduction of flexible materials and adaptive constructions, integration of additional functional elements tailored to user requirements, implementation of regular user surveys to gather appropriate feedback.

5.3. Articulate the outstanding problems in the development of the workwear, taking into account factors such as functionality, individual user preferences, seasonal adaptability, material durability, and technological limitations. Emphasise the challenges related to the complexity of optimising the design for diverse activities while maintaining a unified standard; the need for adaptive systems suitable for different seasons; the pursuit of innovative materials with enhanced durability and the necessity to overcome manufacturing constraints. Highlight the importance of comprehensive research, real world testing, and close collaboration among manufacturers, researchers, and end-users to achieve sustainable, functional, and comfortable workwear solutions.

5.4. Develop a targeted set of recommendations to address the identified issues and prepare a forecast for the potential effects of their implementation (Murzova, Ts., 2009).

Addressing a given ergonomic or design problem at a specific point in time does not provide a lasting solution. As the process evolves, new user needs, preferences and expectations continually arise. The increasing adoption of innovative techniques to enrich catering menus, alongside advancements in food preparation technologies, underscores the need for improved protection of workers' hands and bodies. Furthermore, to remain competitive, employers frequently upgrade their corporate image, branding and business development strategies. The textile industry is also in a state of constant evolution, with ongoing developments in textile materials used in apparel production, leading to the introduction of new primary and auxiliary materials for workwear, and active pursuit of advanced manufacturing technologies. Progress in computer technology further accelerates the transition from design concepts to finished products. The factors listed above, necessitate continuous information updates and regular user feedback to refine existing workwear and develop novel functional designs that meet the changing demands of the industry.

3 Conclusion

The proposed methodology for the ergonomic design of contemporary workwear is applicable to any production environment involving food handling and processing. The developed methodological toolkit offers a systematic framework for decision-making, highlighting the necessity of revising current practises in professional clothing design. By integrating key parameters from ergonomic requirements, functional characteristics, and user expectations, the methodology ensures a comprehensive approach to workwear development.

The system of methods and principles, previously described, is distinguished by its flexibility and adaptability, facilitating the integration of new production requirements and technological advancements, while ensuring ongoing compliance with current European safety standards (BDS EN ISO 13688:2013) and ergonomic guidelines (REGULATION № RD-07-3 from July18, 2014). Employing a modular design principle and standardised validation protocols, the system supports the rapid incorporation of structural modifications, new materials and protective features without compromising quality.

Automated design and production systems (CAD/CAM) are integral part of the broad set of computer tools used throughout the production creation process, supporting all stages of product development, from conceptualization and detailed design to production optimization. "And if today we

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can speak of computer-simulated garments and three-dimensional virtual design, the beginning remains the hardest." (Popova-Nedyalkova, N. S., 2012). The findings of this research establish the foundation for future developments in the field, focusing on achieving an optimal balance between workwear protective performance and user comfort, underscoring the importance of collaboration among users, manufacturers, and experts, paving the way for the creation of work apparel that effectively addresses contemporary demands.

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