Original article

How Resilient are Lucid Motivators? Endeavoring Reforms for Effects of Psycho-social Factors on Workers Health Through Concurrent Engineering

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ABSTRACT

Background: As the tremendous impact of extreme workloads, arduous working conditions, and disorganization disrupt humane job definitions in some industries, the need for workplace re-articulation was interfered to ameliorate psycho-social factors and suggest organizational intervention strategies. Especially for colossally wounded health-care (HC) systems, today it is now even more unrealizable to retain workforce resilience considering the immense impact of overwhelming working conditions.
Methods: This study introduces employment of concurrent engineering tools to re-design humane workplaces annihilating abatement over devoured resources. The study handles HC-workforce resilience in a pioneering motive to introduce transformation of well-known motivators and proposes solutions for retention and resilience issues grounding on HC workers' own voice.
Results: The proposed adjustable approach introduces integral use of focus group studies, SWARA, and QFD methods, and was practiced on a real-world case regarding Turkish HC workforce. The paper also presents widespread effects of findings by tendering generalized psycho-social rehabilitation strategies. Results confirmed the modifications of the most potent incessant motivators.
Conclusion: "Burn out issues" and "Challenging work" were found as the most important motivator and satisfier, respectively, to be exigently fulfilled. Corrective interventions, required resolutions, and workplace articulation connotations were arbitrated in terms of entire outcomes on four dimensions in three different planning periods considering the current status, repercussions of pandemic, and contingency of similar catastrophes. Descriptive illustrations were additionally presented to support deducted interpretations.

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1. Introduction

Many valuable researches from existing occupational safety and health science literature underlines the vigorous bond between psycho-social work environment factors and adverse health outcomes [1—14]. Since the fundamentals of occupational health and safety science ground on providing safe, convenient, and bearable working environment in regards to ergonomics philosophy, the prevention of traditional physiological and psychological risks has always been the must-have element as well as the biggest challenge to workers' health [15].

There are currently 7.5 HC workers; medical doctors, nursing and midwifery personnel (HCWs) per 1,000 populations globally (59 million in total for 7.9 billion of the population), and 4.8 HCWs (1.8 medical doctors and 3 nursing and midwifery personnel) per 1,000 populations in Turkey according to the latest WHO data [16]. As revolts and strikes over heavy workloads and unsatisfying working conditions pervade, national health systems worldwide might face serious problems in regards of insufficient staff numbers more frequently [17,18]. The gravity of tremendous impact of ever-decreasing heavy workloads and arduous working conditions disrupts the hardly maintained humane job definitions and psycho-

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social work environment, especially for HC practitioners. As an output of this disruption, employee resilience is put forward as a new challenge, especially for frontline services such as public health services. As the resilience of the workforce becomes a serious issue, resignations and retirement requests are increasing as a result, which will become an even greater problem, especially in such frontline services where there is constant demand and supply cannot be cut.

Employee resilience is a resource reservoir that helps individuals manage the ever-changing situations experienced in working life and impacts the appraisal of a stressful job environment. Employee resilience is tightly attached to ascertaining adequate motivation and job satisfaction, and gains importance in terms of scarce sources of new recruitment.

Furthermore, Schaufeli, Bakker, and Willem [14] indicated that changes in job demands and job resources predict future burnout and work engagement, more specifically, when job demands (i.e., work overload or emotional demands increase and job resources (i.e., job control, feedback, social support, and opportunities for learning) decrease, future burnout possibility of employee increase.

There are different valuable models to analyze the psycho-social work environment depending on empirical studies [5–9,11,12] e.g., Five Factor Model, QPS Nordic scale, Job Content Questionnaire, Effort-Reward Imbalance Questionnaire, Quality Work Competence Questionnaire, Developmental Leadership Questionnaire; but none of these models ground on engineering methods nor are competent to investigate and design the psycho-social work system tenets through employees own voice, as the main shortcoming of existing literature.

This paper scrutinizes and addresses challenging system essentials in the importance sequence to point out psycho-social work environment articulation resolutions by defining a novel approach employing focus group studies, multi-criteria decision-making (MCDM), and concurrent engineering tools. The proposed adjustable approach introduces integrally use of Stepwise Weight Assessment Ratio Analysis (SWARA) and Quality Function Deployment (QFD) methodologies. As a well-trusted MCDM method, SWARA was employed to calculate the importance degrees of the employee needs which are identified by focus group studies and detailed literature research outcomes. After that, QFD methodology, which is the most essential tool of concurrent engineering approach, was employed to analyze the relationship between the system requirements to fulfill the identified employee needs, to determine the importance degrees of these requirements to specify managerial strategies, and, to suggest implementation strategies special to the handled challenges. Since the employed methods are very familiar and reliable engineering methods which mostly depend on mathematical computations rather than the subjective views and assessments of participants or questionnaire results, a very rare point-of-view was provided to the existing work health and safety literature, especially considering psycho-social system tenets which grounds on more reliable results by being influenced as little as possible by the influence of the deficient human judgment and the possible bias of the assessments. A real-world application was performed on a case regarding one of the biggest public HC institutions of Turkey. As further interpretation of delineated results, findings were supported with detailed graphical illustrations to scrutinize the developed system redesign strategies, and, short-, mid-, and long-term HCW resilience strategies were constructed.

This research contributes to the state-of-the-art literature in four-folds; (i) short-, mid-, and long-term strategies deliberating modifications on the decisive motivators were developed; (ii) concurrent engineering tools and occupational health and safety science were introduced to be co-employed in amelioration of psycho-social environment as a first; (iii) the motivational-hygiene related factors were analogized, and urgency statuses to be met were addressed; (iv) the priority and extremity attained to fulfillment magnitudes of requirements to accouter the ferreted out psycho-social work environment quality determinants were portrayed.

Remainder of this study was organized as follows; the ground arguments of theoretical research model and proposed approach were introduced in Materials and Methods Section. Application findings were unveiled under Results Section. Further interpretation of the analysis outcomes, research limitations, future work recommendations and practitioners' implication suggestions were conferred under Discussions Section. The Conclusion Section presents a summary of the work and concludes the paper.

2. Materials and methods

2.1. Theory, ground arguments, and contributions

The phenomenon of psycho-social work environment has been described in several aspects, e.g., organizational climate, culture, job definitions, work density, leadership, empowerment, co-worker support and collaboration. As the basis of all, psychosocial work environment quality is closely correlated with motivational factors and job satisfaction. Especially when arduous conditions related to a job could not be diluted (e.g., amid pandemics, environmental disasters, political or cross-national conflictions, etc.) re-investigating the problem space regarding job satisfaction and motivational factors could be an ingenious way to assure psycho-socially appropriate environment. Workplace intervention at the organizational level to improve psycho-social work environment was identified to be more preferable compared with individual-level intervention [7] since it offers a more preventive, sustainable, and fundamental approach.

Concurrent engineering is typically thought of as designing in parallel with service or manufacturing and uses cross-functional resources and teams [3]. As one of the most rigorous concurrent engineering tools, QFD [19] is often employed in real-life concurrent engineering applications as a reliable, result-oriented, and objective tool translating emerging needs into relevant design requirements based on mathematical calculations [20–22].

There are many and multi-dimensional physical and psycho-social environment parameters to be considered, solved, and appended into current processes for establishing or ameliorating systems for both humanitarian and economic concerns. These parameters often conflict with each other, have different levels of influence on the solutions, and, generally span in a very wide set of criteria space to be investigated. These facts lead the handled problem to be a complex MCDM problem. In the related literature, there are several good and valuable examples which evaluate the problem with proper MCDM techniques [15,23–31]. As one of the recent instances, Jain Rana, Meena, and Vibhora [23] identified the priority for the Musculoskeletal Disorders (MSDs) risk factors for mobile device users through a case study and weighted the identified individual, personal, and psychosocial factors with the related-sub factors by the employment of Best–Worst Method (BWM). Yılmaz Kaya [15] developed a novel approach grounding on inventory control aiming Occupational Health and Safety (OHS) risk minimization by the employment of spherical fuzzy sets and

Simple Additive Weighting (SF-SAW) method to enlighten the best decisions minimizing the OHS risks of maintenance employees and possible adverse impacts on human health. Bathrinath, Bhalaji, and Saravanasankar [24] used Analytical Hierarchy Process (AHP) and The Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) methods together to examine accidents and possible risks that constitute critical alternatives in the textile industry. In another study, Jain, Vibhora, Rana, and Meena [24] reviewed human factors and ergonomic principles based on studies using MCDM approaches to provide current situation information about MCDM-based human factors and ergonomic methodologies employment in different sectors. Delice and Can [26] proposed an ergonomic risk assessment approach for manual lifting tasks, taking into account two sets of criteria, lift-related and human-related criteria by the employment of Kemeny Median Indicator Ranks Accordance (KEMIRA) and a novel two-dimensional BWM integration. Delice, Can, and Kahya [27] determined the strain levels caused by office components using the − Rapid Office Strain Assessment (ROSA) method and the importance weights of these components using SWARA and Weighted Aggregated Sum Product Assessment (WASPAS) to rank the sections according to the voltage levels for a company operating in the aviation industry. Koppiahraj, Bathrinath, and Saravanasanka [28] used fuzzy VIseKriterijumsa Optimizacija I Kompromisno Resenje (F-VIKOR) to select a suitable ergonomics assessment method to expose the difficulties faced by the workers. Rajabi et al. [29] identified and prioritized occupational stress factors among firefighters using fuzzy Delphi method and fuzzy AHP. Delice and Zegerek [30] proposed a new fuzzy MCDM model incorporating the fuzzy Decision Making Trial and Evaluation Laboratory (F-DEMATEL) and fuzzy Grey Relational Analysis (GRA) to rank the occupational risk levels of emergency departments considering the dependencies among risk factors. As another instance, Yılmaz Kaya and Dağdeviren [31] used two powerful MCDM methods, AHP and fuzzy Preference Ranking Organization Method for Enrichment Evaluation (F-PROMETHEE) to evaluate occupational safety equipment by taking into account universal design and technical requirements both separately and simultaneously.

As the literature research brief also demonstrates, almost all of the studies conducted on the working environment subject are focused on the physical parameters, where very little set of particular studies investigates the psycho-social parameters related to this context grounds on sole employment of MCDM techniques.

Unlike existing normative studies, this study introduces employment of concurrent engineering tools to re-design humane workplaces, annihilating abatement over devoured resources through proponent motivators. Existing literature instances selectively chose motivators (HC work system requirements - HCSRs) and psycho-social system design needs (HC workers' needs - HCWNs) solely based on researchers' opinions, and, almost none of them assigned any scores corresponding to the importance levels prior to each problem tenet [4–8,10–13,32–35] as an important gap of the related literature. This study identifies HCWNs and HCSRs prior to focus group studies and an extent literature review, then elucidates and prioritizes these identified tenets with SWARA method to close the denoted gap in the literature. Furthermore, as another covered research gap, concurrent engineering design tool QFD was employed in psycho-social work environment analysis as a pioneer study focusing on health and safety at work.

As the main motivation of the study, new research outcomes were aimed to enlighten the existing literature in a novel point-of-view, where, the influencing factors of the psycho-social environment and the required system determinants were identified relying on the current instances and expert opinions. The HCWNs were distinguished in the light of the results of in-depth literature researches [1,2,6–12,32–41] by field expert focus group members, where, the "motivators" to satisfy these HCWNs, HCSRs were determined again based on an in-depth literature research [1,2,4–14,32–42] and field experience of DMs.

Additionally, proposed approach presents widespread effect of practiced case by tendering generalized rehabilitation strategies developed in three implementation periods in four dimensions ("*patient relations*", "*working environment*", "*resources and facilities*", "*education*") according to the impact magnitude of HCWNs regarding the HCSRs in question. This study mainly tries to fill these three gaps and presents its contributions to the current literature of contemporary work safety science in these means.

2.2. The proposed approach

Theoretical model of the proposed method was illustrated schematically for the convenience of readers with Fig. 1, hereinafter.

All calculation steps related to SWARA and QFD methods were performed by adhering to the works of [43] and [19,21,22], respectively, and, the interested readers were advised to review these valuable instances of the literature. As the first stage of proposed approach, decision-making problem, and decision-making team (DMT) (DM_k, $k = 1,2,...,l$) were identified. The roles of DMs are important in SWARA [44], thus, it would be more proper to assign DMs with a good command of the subject and sufficient proficiency.

Next, psycho-social work environment tenets, HCWNs ($HCWN_i$, $i = 1,2,...,m$) and HCSRs ($HCSR_j$, $j = 1,2,...,n$) were identified by DMT by elucidating the wider proto sets.

Then, the most important HCWN was determined by each DM, and then, each DM identifies each HCWNs' importance relative to the most important HCWN (p_i^k). Here p_i^k is the score assigned by the kth DM for ith HCWN and ranges in $0 \leq p_i^k \leq 1$. Using p_i^k values and Equation (1) the mean value of the relative importance score (RAI) of the ith HCWN ($\overline{P}_i$) was found.

$$\overline{P}_i = \frac{\sum_{k=1}^{l} p_i^k}{l}, i = 1,2,...,m \qquad (1)$$

Thereafter, all HCWNs were sorted in $\overline{P}_i$ scores from smallest to largest. s_i values, representing the comparative significance values of RAIs were calculated. Then, c_i values were obtained by pairwise comparisons and calculated with Equation (2) for all HCWNs.

$$c_i = s_i + 1, i = 1,2,...,m \qquad (2)$$

Afterwards, adjusted importance values (s_i') were calculated with Equation (3) for all HCWNs.

$$s_i' = \frac{s_{i-1}'}{c_i}, i = 1,2,...,m \qquad (3)$$

As the last SWARA sub-step, final importance values (w_i) of all HCWNs were calculated with Equation (4).

$$w_i = \frac{s_i'}{\sum_{i=1}^{m} s_i'}, i = 1,2,...,m \qquad (4)$$

As the next calculation step, the relationship between HCWNs and HCSRs, and, the correlations among HCSRs were evaluated by DMs with a scale of 0-1-3-9 [45], where "0" indicates that "*there are no relations*", "1" indicates that "*there is a weak relation*", "3" indicates that "*there is a moderate relation*", and, "9" indicates that "*there is a strong relation*" between mentioned HCWNs and HCSRs, or, handled HCSRs, respectively.
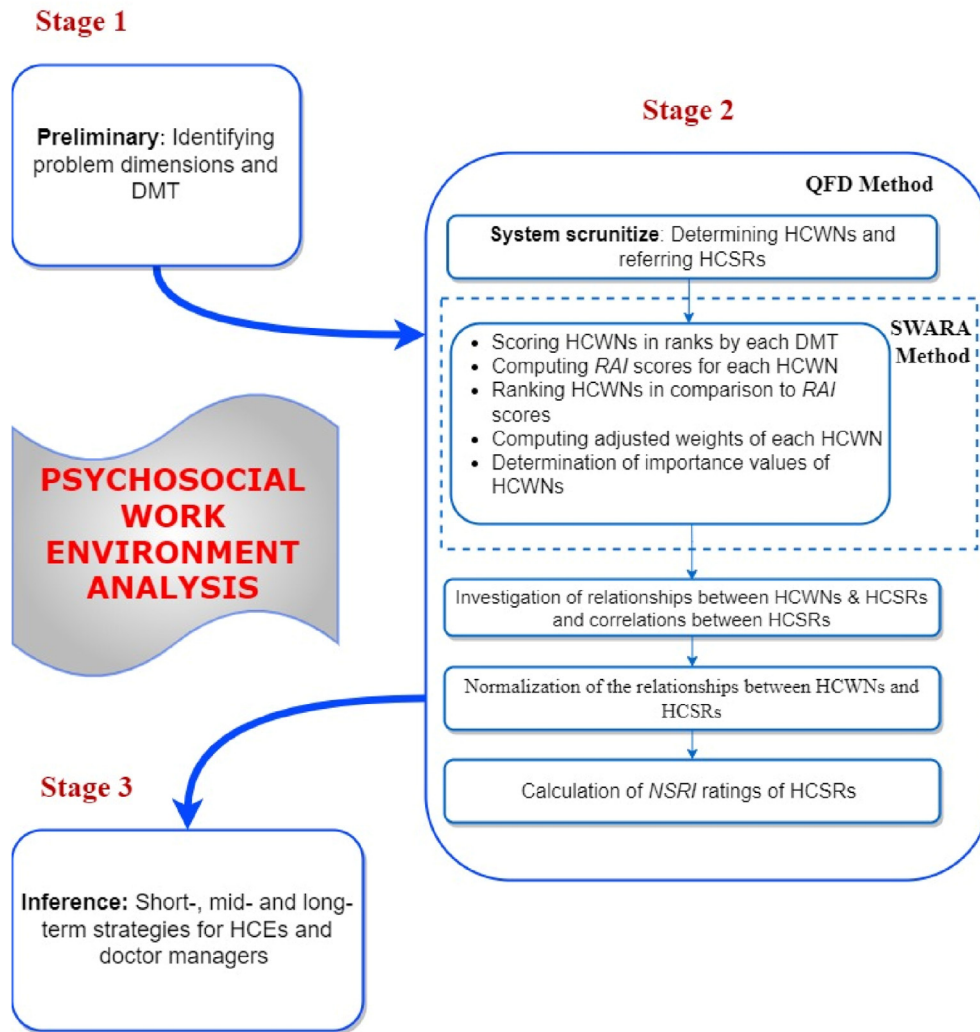
Fig. 1. Decision-making process regarding psycho-social work environment.

The relationship values between HCWNs and HCSRs were normalized by correlation values among HCSRs then, as it was described in Equation (5) [46], where, R_{ij}^{norm} represents the normalised relationship value between $HCWN_i$ and SR_j, and, "$\sum_{j=1}^{n} R_{ij} = 1$" for each $HCWN_i$ ($i = 1, 2, …, m$).

$$R_{ij}^{norm} = \frac{\sum\limits_{k=1}^{n} R_{ik}\gamma_{kj}}{\sum\limits_{j=1}^{n}\sum\limits_{k=1}^{n} R_{ij}\gamma_{jk}}, i = 1, 2, …, m; \quad j = 1, 2, …, n \qquad (5)$$

Next, the normalized HCSR importance (*NSRI*) ratings were adjusted by using Equations (6) - (8).

$$NSRI_j = \frac{ISR_j}{ISR_{max}}, j = 1, 2, …, n \qquad (6)$$

$$ISR_j = \sum_{i=1}^{m} \left(R_{ij}^{norm}\right)x(w_i), i = 1, 2, …, m; \quad j = 1, 2, …, n \qquad (7)$$

$$ISR_{max} = \max_{j} ISR_j, j = 1, 2, …, n \qquad (8)$$

Here individual rating scores (ISR_j) of each $HCSR_j$ reflects the overall importance of that $HCSR_j$ after taking into account R_{ij}^{norm} and w_i values. Critical $HCSR_j$ can be singled out based on the ISR_j values obtained. $NSRI_j$ rating uses the ratios of ISR_j over the maximum individual rating (ISR_{max}) to facilitate this identification process.

3. Results

Five DMs ($DM_1, DM_2, DM_3, DM_4, DM_5$) were employed in DMT. The DMT of the study was identified as including five field experts of managers, nurses, medical doctors, and ergonomists, where, different backgrounds were preferred to be able to consider particular perspectives of different parties of the health

Table 1
Demographics of DMT

DMs	Age	Gender	Experience (years)	Title	Occupation
DM_1	42	Male	25	Asst. Prof. Dr.	Doctor/Vice Dean
DM_2	48	Female	20	Nurse	Nurse/Head of Nurses
DM_3	35	Male	10	Medical Doctor	Doctor
DM_4	42	Female	20	Assoc. Prof. Dr.	Lecturer
DM_5	35	Female	15	Asst. Prof. Dr.	Lecturer

DM, decision making.

Table 2
Problem parameters, descriptions and related references

HCWNs/HCSRs	Descriptions	References
$HCWN_1$	Job satisfaction	Spector (1997); Liu (2006); Paulin et al. (2006); Rich, Lepine & Crawford (2010); Fu, Deshpande & Zhao (2011); Spagnoli, Caetano & Santos (2012); Ojakaa, Olang & Jarvis (2014); Valaei & Rezai (2016); Vijayakumar & Shanthini (2020); Bergefurt et al. (2022); Bodys-Cupak, Scislo & Kozka (2022); Brokmeier et al. (2022); Ndengu & Leka (2022)
$HCWN_2$	Burn-out issue	Aronsson et al. (2019); Bergefurt et al. (2022); Bodys-Cupak, Scislo & Kozka (2022); Brokmeier et al. (2022); Qi et al. (2022); Salvagioni et al. (2022)
$HCWN_3$	Relationship with immediate boss	Liu (2006); Rich, Lepine & Crawford (2010); Fu, Deshpande & Zhao (2011); Spagnoli, Caetano & Santos (2012); Uchiyama et al. (2013); Kim et al. (2021); Vijaya Kumar & Shanthini (2020); Qi et al. (2022); Salvagioni et al. (2022)
$HCWN_4$	Status (respect and recognition)	Liu (2006); Ojakaa, Olang & Jarvis (2014); Vijaya Kumar & Shanthini (2020); Qi et al. (2022)
$HCWN_5$	Career development	Liu (2006); Ojakaa, Olang & Jarvis (2014); Valaei & Rezai (2016); Vijaya Kumar & Shanthini (2020); Brokmeier et al. (2022); Ndengu & Leka (2022)
$HCWN_6$	Monetary compensation	Spector (1997); Liu (2006); Fu, Deshpande & Zhao (2011); Spagnoli, Caetano & Santos (2012); Valaei & Rezai (2016); Vijaya Kumar & Shanthini (2020); Brokmeier et al. (2022); Ndengu & Leka (2022); Qi et al. (2022)
$HCWN_7$	Training	Liu (2006); Spagnoli, Caetano & Santos (2012); Ojakaa, Olang & Jarvis (2014)
$HCWN_8$	Job content	Spector (1997); Fu, Deshpande & Zhao (2011); Spagnoli, Caetano & Santos (2012); Uchiyama et al. (2013); Valaei & Rezai (2016); Aronsson et al. (2019); Kim et al. (2021); Bergefurt et al. (2022); Brokmeier et al. (2022); Ndengu & Leka (2022); Salvagioni et al. (2022)
$HCWN_9$	Flexible work arrangements-Work life balance	Fu, Deshpande & Zhao (2011); Uchiyama et al. (2013); Ojakaa, Olang & Jarvis (2014); Aronsson et al. (2019); Vijaya Kumar & Shanthini (2020); Ndengu & Leka (2022); Qi et al. (2022); Salvagioni et al. (2022)
$HCWN_{10}$	Working conditions	Spector (1997); Liu (2006); Fu, Deshpande & Zhao (2011); Uchiyama et al. (2013); Ojakaa, Olang & Jarvis (2014); Valaei & Rezai (2016); Vijaya Kumar & Shanthini (2020); Kim et al. (2021); Bergefurt et al. (2022); Qi et al. (2022); Salvagioni et al. (2022)
$HCWN_{11}$	Lack of technology and equipment	Ojakaa, Olang & Jarvis (2014); Vijaya Kumar & Shanthini (2020); Bergefurt et al. (2022); Ndengu & Leka (2022)
$HCWN_{12}$	Social environment	Liu (2006); Rich, Lepine & Crawford (2010); Uchiyama et al. (2013); Aronsson et al. (2019); Vijaya Kumar & Shanthini (2020); Brokmeier et al. (2022); Qi et al. (2022); Salvagioni et al. (2022)
$HCWN_{13}$	Organizational values and beliefs	Liu (2006); Paulin et al. (2006); Valaei & Rezai (2016); Vijaya Kumar & Shanthini (2020); Brokmeier et al. (2022); Salvagioni et al. (2022)
$HCWN_{14}$	Organizational commitment	Paulin et al. (2006); Rich, Lepine & Crawford (2010); Fu, Deshpande & Zhao (2011); Spagnoli, Caetano & Santos (2012); Valaei & Rezai (2016); Vijaya Kumar & Shanthini (2020); Bergefurt et al. (2022); Bodys-Cupak, Scislo & Kozka (2022); Brokmeier et al. (2022); Ndengu & Leka (2022); Salvagioni et al. (2022)
$HCWN_{15}$	Organizational justice and prestige	Liu (2006); Ojakaa, Olang & Jarvis (2014); Aronsson et al. (2019); Valaei & Rezai (2016); Brokmeier et al. (2022); Uchiyama et al. (2013)
$HCWN_{16}$	Location of facilities	Ojakaa, Olang & Jarvis (2014); Vijaya Kumar & Shanthini (2020); Ndengu & Leka (2022)
$HCSR_1$	Person−organization fit	Schele, Hedman & Hammarström (2011); Valaei & Rezai (2016); Vijaya Kumar & Shanthini (2020); Kang (2022)
$HCSR_2$	Rewards	Spector (1997); Liu (2006); Uchiyama et al. (2013); Ojakaa, Olang & Jarvis (2014); Valaei & Rezai (2016); Fahim (2018); Aronsson et al. (2019); Vijaya Kumar & Shanthini (2020); Chelliah & Ahmed (2021); Brokmeier et al. (2022); Kang (2022); Ndengu & Leka (2022); Qi et al. (2022)
$HCSR_3$	Recognition and appreciation	Spector (1997); Liu (2006); Rich, Lepine & Crawford (2010); Ojakaa, Olang & Jarvis (2014); Fahim (2018); Vijaya Kumar & Shanthini (2020); Ndengu & Leka (2022)
$HCSR_4$	Leadership behaviour	Spector (1997); Liu (2006); Rich, Lepine & Crawford (2010); Uchiyama et al. (2013); Aronsson et al. (2019); Vijaya Kumar & Shanthini (2020); Brokmeier et al. (2022); Ndengu & Leka (2022)
$HCSR_5$	Teamwork relationship	Spector (1997); Liu (2006); Rich, Lepine & Crawford (2010); Schele, Hedman & Hammarström (2011); Uchiyama et al. (2013); Vijaya Kumar & Shanthini (2020); Aronsson et al. (2019); Ndengu & Leka (2022)
$HCSR_6$	Communication channel	Spector (1997); Liu (2006); Rich, Lepine & Crawford (2010); Schele, Hedman & Hammarström (2011); Uchiyama et al. (2013); Aronsson et al. (2019); Vijaya Kumar & Shanthini (2020); Brokmeier et al. (2022); Ndengu & Leka (2022)
$HCSR_7$	Challenging work	Spector (1997); Uchiyama et al. (2013); Aronsson et al. (2019); Bodys-Cupak, Scislo & Kozka (2022); Brokmeier et al. (2022)
$HCSR_8$	Training and participation programs	Spector (1997); Liu (2006); Rich, Lepine & Crawford (2010); Fahim (2018); Vijaya Kumar & Shanthini (2020); Chelliah & Ahmed (2021); Brokmeier et al. (2022); Ndengu & Leka (2022)
$HCSR_9$	Freedom of innovative thinking	Brokmeier et al. (2022)
$HCSR_{10}$	Job security	Spector (1997); Liu (2006); Aronsson et al. (2019); Vijaya Kumar & Shanthini (2020); Kang (2022)
$HCSR_{11}$	Salary	Spector (1997); Liu (2006); Ojakaa, Olang & Jarvis (2014); Fahim (2018); Vijaya Kumar & Shanthini (2020); Chelliah & Ahmed (2021); Kang (2022); Ndengu & Leka (2022)

Table 2 (*continued*)

HCWNs/HCSRs	Descriptions	References
$HCSR_{12}$	Superior–subordinate relationship	Spector (1997); Liu (2006); Rich, Lepine & Crawford (2010); Uchiyama et al. (2013); Aronsson et al. (2019); Vijaya Kumar & Shanthini (2020); Brokmeier et al. (2022); Ndengu & Leka (2022)
$HCSR_{13}$	Facilities	Spector (1997); Ojakaa, Olang & Jarvis (2014); Vijaya Kumar & Shanthini (2020); Chelliah & Ahmed (2021); Ndengu & Leka (2022)
$HCSR_{14}$	Job analysis methods	Liu (2006); Uchiyama et al. (2013); Brokmeier et al. (2022)
$HCSR_{15}$	Information sharing	Liu (2006); Rich, Lepine & Crawford (2010); Vijaya Kumar & Shanthini (2020)
$HCSR_{16}$	Procedures	Schele, Hedman & Hammarström (2011); Uchiyama et al. (2013); Vijaya Kumar & Shanthini (2020); Brokmeier et al. (2022)

HCSR, HC work system requirements; HCWN, HC workers' needs.

management system. The existing literature indicates that the DM profile amounts have a decisive impact on the complexity level of the decision problem; the complexity of the decision problem will be increased as the dimensions of the investigated problem space get larger, hence defining too many profiles unnecessarily enlarges the problem size and leads the problem to insolvency, besides increasing the processing load, causing misuse of resources and making the results more error-prone, where, in case fewer DM profiles were defined than that should be then the results may be more insensitive to reflect the real-life conditions since all perspectives might not be taken into account [15,47]. The demographic and proficiency information of DMs were presented in Table 1. Data collection method of this research was face-to-face interviews regarding all sub-steps, steps, and stages of proposed approach.

Research HCWNs were distinguished from a wider proto set constructed in the light of the results of in-depth literature researches [1,2,6,8–12,32–40] through a focus group study performed with 21 HCWs consisting of clinician doctors and nurses working in different COVID-19 related branches (pulmonology, emergency and infection departments). Then, among that proto set, 16 HCWNs ($HCWN_1, HCWN_2, ..., HCWN_{16}$) were identified to be analyzed (Table 2).

Afterwards, as "motivators" to satisfy these HCWNs, 16 HCSRs ($HCSR_1, HCSR_2, ..., HCSR_{16}$) were determined by DMT (Table 2) again based on an in-depth literature research [1,4–7,9,10,12,14,35–42] and field experience of DMs. Descriptive delineations related to each tenet were presented under Practice Implications Section as further information for interested researchers.

Table 3
$HCWN_i$ ranking and $\overline{P}_i$, s_i, c_i, s_i', w_i values

HCWNs	$\overline{P}_i$	Ranked $HCWN_s$	$\overline{P}_i$	s_i	c_i	s_i'	w_i
$HCWN_1$	0.65	$HCWN_2$	0.93	—	1	1.00	0.085
$HCWN_2$	0.93	$HCWN_6$	0.9	0.03	1.03	0.97	0.083
$HCWN_3$	0.43	$HCWN_{10}$	0.87	0.03	1.03	0.94	0.080
$HCWN_4$	0.42	$HCWN_8$	0.85	0.02	1.02	0.92	0.079
$HCWN_5$	0.53	$HCWN_{11}$	0.82	0.03	1.03	0.90	0.077
$HCWN_6$	0.90	$HCWN_9$	0.72	0.1	1.10	0.82	0.070
$HCWN_7$	0.62	$HCWN_1$	0.65	0.07	1.07	0.76	0.065
$HCWN_8$	0.85	$HCWN_7$	0.62	0.03	1.03	0.74	0.063
$HCWN_9$	0.72	$HCWN_5$	0.53	0.09	1.09	0.68	0.058
$HCWN_{10}$	0.87	$HCWN_{12}$	0.45	0.08	1.08	0.63	0.054
$HCWN_{11}$	0.82	$HCWN_3$	0.43	0.02	1.02	0.62	0.053
$HCWN_{12}$	0.45	$HCWN_4$	0.42	0.01	1.01	0.61	0.052
$HCWN_{13}$	0.35	$HCWN_{13}$	0.35	0.07	1.07	0.57	0.049
$HCWN_{14}$	0.33	$HCWN_{14}$	0.33	0.02	1.02	0.56	0.048
$HCWN_{15}$	0.23	$HCWN_{15}$	0.23	0.1	1.10	0.51	0.043
$HCWN_{16}$	0.20	$HCWN_{16}$	0.2	0.03	1.03	0.49	0.042

HCSR, HC work system requirements; HCWN, HC workers' needs.

Thereafter, p_i^k, $\overline{P}_i$ and s_i values related to each $HCWN_i$ ($i = 1, 2, ...,$ 16) were acquainted (Table 3). The coefficients c_i, s_i' and w_i were then calculated with Equations (2), (3), and (4), respectively (Table 2).

Table 3 indicates that, the most significant HCWN was identified as "$HCWN_2 - Burn\ out$" with final weighting score of "0.085" which was in line with existing literature findings, where, the last HCWN in the descending order of importance was identified as "$HCWN_{16}$ - Location of facilities" with a final weighting score of "0.042".

Data denoting relationship between HCWNs and HCSRs, and also, correlation trade-offs among HCSRs were retrieved through the 0-1-3-9 scale [45,46] by DMT as it was indicated in Appendix 1 (Table A1) and illustrated in Fig. 2. Equation (5) was used to normalize relationship values between HCWNs and HCSRs (Fig. 2).

NSRI ratings of HCSRs were calculated and adjusted with Equation (6), Equation (7), and Equation (8), respectively, to identify final weighting scores of each $HCSR_j$ ($j = 1, 2, ..., 16$) (Fig. 2). Results revealed that ISR_{max} was calculated as "0.108", additionally, the most urgent $HCSR_j$ ($j = 1, 2, ..., 16$) was identified as "$HCSR_7$-Challenging work" as a surprising finding, where, the last one to be fulfilled was identified as "$HCSR_{11} - Salary$" in a completely different direction from existing literature findings according to calculated *NHRI* rating scores (Fig. 2).

Fig. 3 indicates that expectations and system requirements regarding psycho-social work environment differ in their order of importance, and therefore, in their urgency to be fulfilled. The importance corollaries of HCSRs were computed with $NSRI_j$ scores of $HCSR_j$ (Fig. 2), where w_i scores were employed to identify importance levels of each $HCWN_i$ (Table 3). In-depth analysis of the procured calculation results, practical strategies considering different system dimensions and application periods were presented under the Practice Implication Suggestions Sub-section, as paper's precious denouement.

4. Discussion

As introduced, the most important HCWN was found to be "*Burn out issues*" (w_{HCWN2}:0.085) instead of any others related to *monetary compensation* slated in the consuetudinary, pointing out the pressure of uninterrupted working conditions under excessive workloads on HCWs and necessity of this study to be performed. The most important HCSR was identified as "*Challenging work*" (ISR_{max}: 0.108, $NISR_7$: 1.000) representing the need for job enrichment activities for HCWs, and, addressing the unexpected desire of being saddled with new job definitions in lieu of terminating existing ones, confirming the modification on the most potent incessant motivational factors with the effects of long-running stressful and challenging job environment (Fig. 3). These results correspond with the real stratum of HC professionals, who have been working on similar patients almost three full years since the beginning of
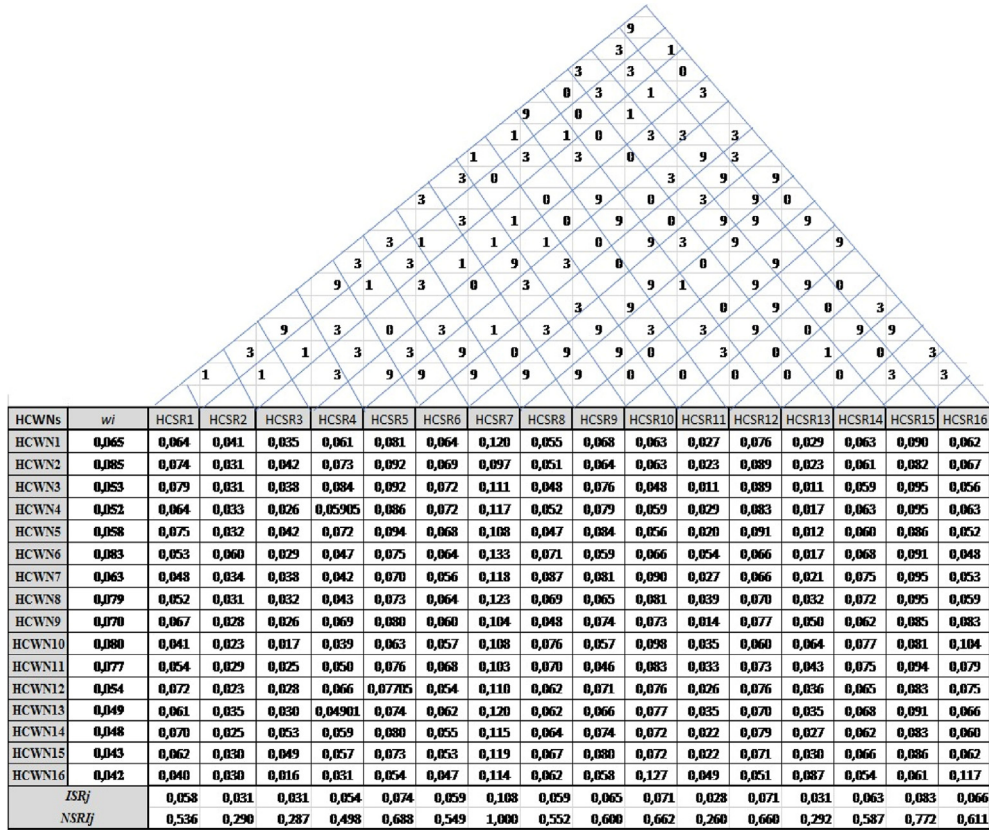
HCWNs	wi	HCSR1	HCSR2	HCSR3	HCSR4	HCSR5	HCSR6	HCSR7	HCSR8	HCSR9	HCSR10	HCSR11	HCSR12	HCSR13	HCSR14	HCSR15	HCSR16
HCWN1	0,065	0,064	0,041	0,035	0,061	0,081	0,064	0,120	0,055	0,068	0,063	0,027	0,076	0,029	0,063	0,090	0,062
HCWN2	0,085	0,074	0,031	0,042	0,073	0,092	0,069	0,097	0,051	0,064	0,063	0,023	0,089	0,023	0,061	0,082	0,067
HCWN3	0,053	0,079	0,031	0,038	0,084	0,092	0,072	0,111	0,048	0,076	0,048	0,011	0,089	0,011	0,059	0,095	0,056
HCWN4	0,052	0,064	0,033	0,026	0,05905	0,086	0,072	0,117	0,052	0,079	0,059	0,029	0,083	0,017	0,063	0,095	0,063
HCWN5	0,058	0,075	0,032	0,042	0,072	0,094	0,068	0,108	0,047	0,084	0,056	0,020	0,091	0,012	0,060	0,086	0,052
HCWN6	0,083	0,053	0,060	0,029	0,047	0,075	0,064	0,133	0,071	0,069	0,066	0,054	0,066	0,017	0,068	0,091	0,048
HCWN7	0,063	0,048	0,034	0,038	0,042	0,070	0,056	0,118	0,087	0,081	0,090	0,027	0,066	0,021	0,075	0,095	0,053
HCWN8	0,079	0,052	0,031	0,032	0,043	0,073	0,064	0,123	0,069	0,065	0,081	0,039	0,070	0,032	0,072	0,095	0,059
HCWN9	0,070	0,067	0,028	0,026	0,069	0,080	0,060	0,104	0,048	0,074	0,073	0,014	0,077	0,050	0,062	0,085	0,083
HCWN10	0,080	0,041	0,023	0,017	0,039	0,063	0,057	0,108	0,076	0,057	0,098	0,035	0,060	0,064	0,077	0,081	0,104
HCWN11	0,077	0,054	0,029	0,025	0,050	0,076	0,068	0,103	0,070	0,046	0,083	0,033	0,073	0,043	0,075	0,094	0,079
HCWN12	0,054	0,072	0,023	0,028	0,066	0,07705	0,054	0,110	0,062	0,071	0,076	0,026	0,076	0,036	0,065	0,083	0,075
HCWN13	0,049	0,061	0,035	0,030	0,04901	0,074	0,062	0,120	0,062	0,066	0,077	0,035	0,070	0,035	0,068	0,091	0,066
HCWN14	0,048	0,070	0,025	0,053	0,059	0,080	0,055	0,115	0,064	0,074	0,072	0,022	0,079	0,027	0,062	0,083	0,060
HCWN15	0,043	0,062	0,030	0,049	0,057	0,073	0,053	0,119	0,067	0,080	0,072	0,022	0,071	0,030	0,066	0,086	0,062
HCWN16	0,042	0,040	0,030	0,016	0,031	0,054	0,047	0,114	0,062	0,058	0,127	0,049	0,051	0,087	0,054	0,061	0,117
ISRj		0,058	0,031	0,031	0,054	0,074	0,059	0,108	0,059	0,065	0,071	0,028	0,071	0,031	0,063	0,083	0,066
NSRIj		0,536	0,290	0,287	0,498	0,688	0,549	1,000	0,552	0,600	0,662	0,260	0,660	0,292	0,587	0,772	0,611

Fig. 2. HOQ matrix related to psycho-social work environment.

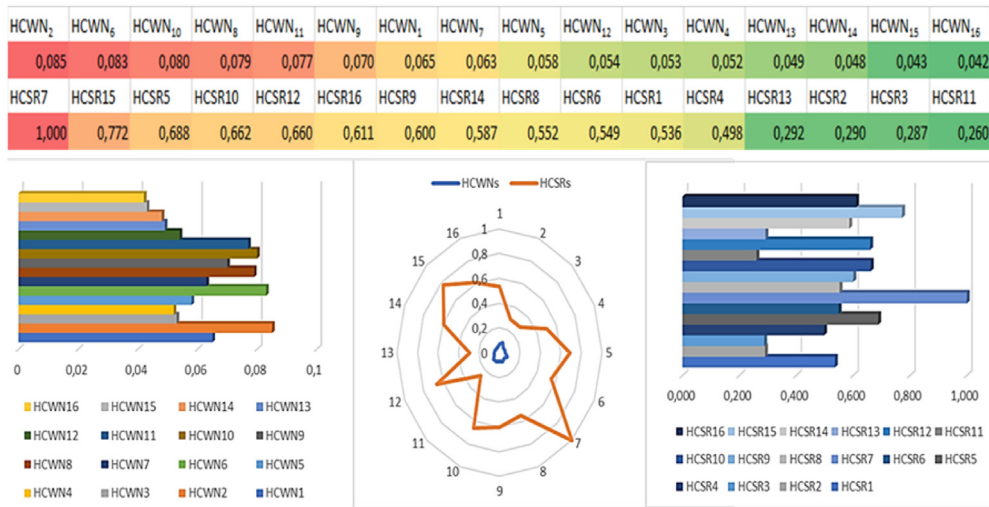| HCWN₂	HCWN₆	HCWN₁₀	HCWN₈	HCWN₁₁	HCWN₉	HCWN₁	HCWN₇	HCWN₅	HCWN₁₂	HCWN₃	HCWN₄	HCWN₁₃	HCWN₁₄	HCWN₁₅	HCWN₁₆
0,085	0,083	0,080	0,079	0,077	0,070	0,065	0,063	0,058	0,054	0,053	0,052	0,049	0,048	0,043	0,042
HCSR7	HCSR15	HCSR5	HCSR10	HCSR12	HCSR16	HCSR9	HCSR14	HCSR8	HCSR6	HCSR1	HCSR4	HCSR13	HCSR2	HCSR3	HCSR11
1,000	0,772	0,688	0,662	0,660	0,611	0,600	0,587	0,552	0,549	0,536	0,498	0,292	0,290	0,287	0,260

Fig. 3. Benchmark of HCWN and HCSR importance corollaries.

pandemic, under severe conditions, with long working hours and compelling equipment; which validates the research outcomes to reflect real-life conditions quite well.

Obtained $NSRI_j$ ($j = 1, 2, \ldots, 16$) results imply that HCSRs that point to the expected improvements in financial assets (i.e., "*Salary*" and "*Reward*") were considered as the least important ones by

falling short in priority order (ISR_2: *0.031*, $NISR_2$: *0.29*; ISR_{11}: *0.028*, $NISR_{11}$: *0.26*) (Fig. 3). This matter added extra importance to study outputs and provided an opportunity to show how psycho-social work environment problem could be handled in situations where financial improvements were not possible due to budget constraints.

4.1. Limitations

This study was conducted by focusing on the HC systems and services and amongst HCWs, hence, the study results would be more proper to be evaluated for HC services-specific, where, the handled case could be considered as this sector depended, and, the analyzed structure, considered parameters and developed amelioration strategies would be re-assessed and justified before being utilized for other sectors to be valid for all workers. As it applies to any scientific study a wider respondent audience might be considered in future works. DMT and focus group audience was limited to only one hospital, where, this hospital is one of the most biggest ones in service capacity among all Turkish HC institutions with an annual service capacity of approximately 400,000 patients, and, treated more than 1,000 patients daily and over 83,000 COVID-19 patients from the beginning of pandemic, which is solely more
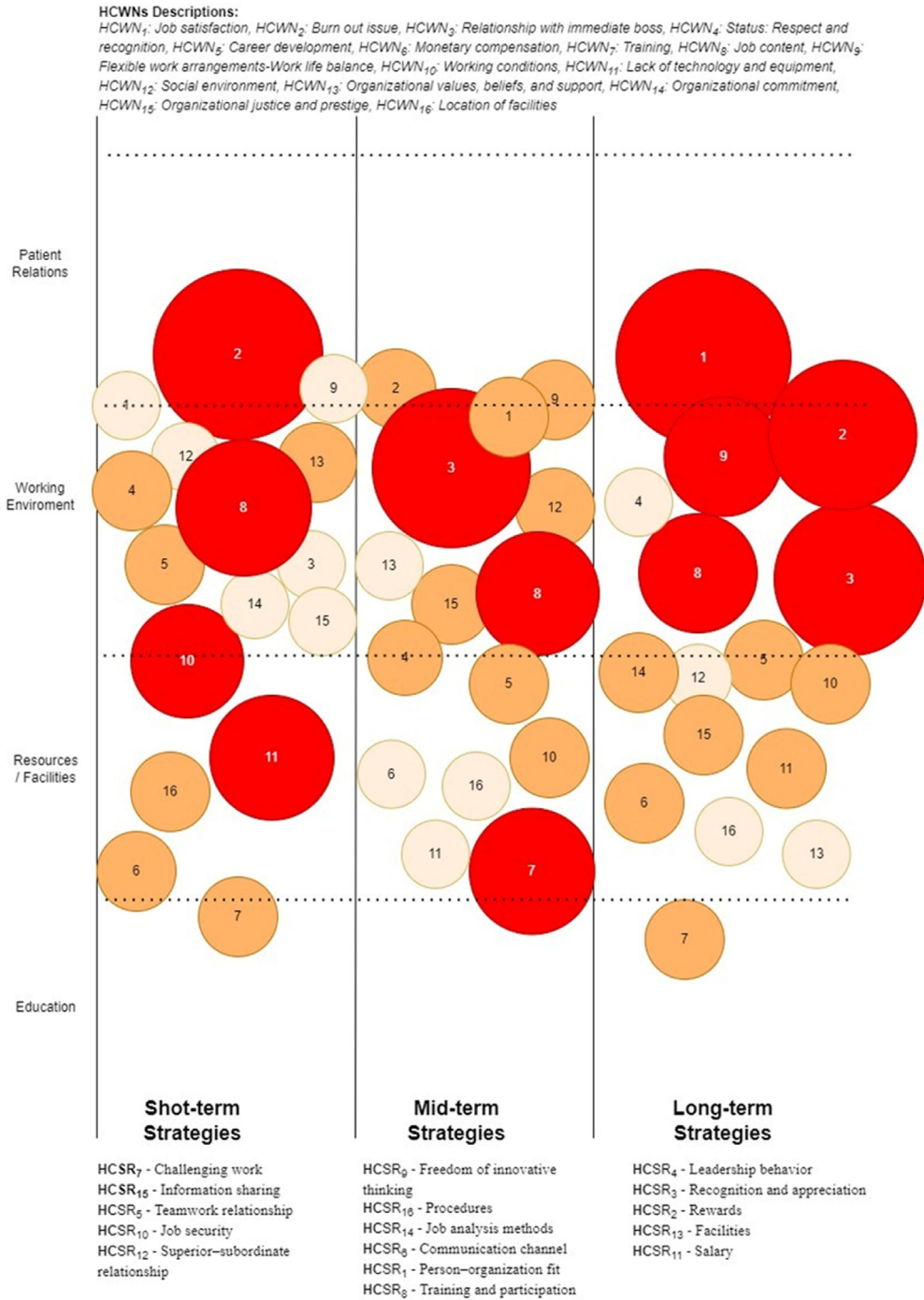

HCWNs Descriptions:
$HCWN_1$: Job satisfaction, $HCWN_2$: Burn out issue, $HCWN_3$: Relationship with immediate boss, $HCWN_4$: Status: Respect and recognition, $HCWN_5$: Career development, $HCWN_6$: Monetary compensation, $HCWN_7$: Training, $HCWN_8$: Job content, $HCWN_9$: Flexible work arrangements-Work life balance, $HCWN_{10}$: Working conditions, $HCWN_{11}$: Lack of technology and equipment, $HCWN_{12}$: Social environment, $HCWN_{13}$: Organizational values, beliefs, and support, $HCWN_{14}$: Organizational commitment, $HCWN_{15}$: Organizational justice and prestige, $HCWN_{16}$: Location of facilities

Shot-term Strategies
$HCSR_7$ - Challenging work
$HCSR_{15}$ - Information sharing
$HCSR_5$ - Teamwork relationship
$HCSR_{10}$ - Job security
$HCSR_{12}$ - Superior–subordinate relationship

Mid-term Strategies
$HCSR_9$ - Freedom of innovative thinking
$HCSR_{16}$ - Procedures
$HCSR_{14}$ - Job analysis methods
$HCSR_6$ - Communication channel
$HCSR_1$ - Person–organization fit
$HCSR_8$ - Training and participation

Long-term Strategies
$HCSR_4$ - Leadership behavior
$HCSR_3$ - Recognition and appreciation
$HCSR_2$ - Rewards
$HCSR_{13}$ - Facilities
$HCSR_{11}$ - Salary

Fig. 4. Developed psycho-social work environment amelioration strategies.

than the regional patient care capacity of most African and European cities in total, and, indicates the extreme workloads that the participant group was exposed to.

4.2. Practice implication suggestions

As practice implication strategies for re-articulation of work system were developed and illustrated gregariously and comparatively on one plane under four different operative dimensions in Fig. 4.

In order to better explain the relationship between analyzed system tenets (HCWNs and HCSRs), four different dimensions representing the work organization system were defined; "*patient relations dimension*", "*working environment dimension*", "*resource and facilities dimension*", and, "*education dimension*".

Suggested short-, mid-, and long-term strategies were developed according to computed $NSRI_j$ ($j = 1, 2, …, 16$) values of identified HCSRs and relationships between $HCWN_i$ ($i = 1, 2, …, 16$) and $HCSR_j$ ($j = 1, 2, …, 16$) (Fig. 2, Appendix 1).

$HCWN_i$ ($i = 1, 2, …, 16$) importance levels determined on the basis of w_i values obtained by SWARA calculations (Table 3, Fig. 3) were also symbolized in Fig. 4 with diameters and color tones. In consequence, as the power of that HCWN to influence psychosocial work environment, its diameter also grows and its color darkens.

"*HCSR_7: Challenging work*", "*HCSR_15: Information sharing*", "*HCSR_5: Teamwork relationship*", "*HCSR_10: Job security*", "*HCSR_12: Supervisor-subordinate relations*" have the biggest importance for psycho-social work environment with the highest ISR_j ($0,108$; $0,083$; $0,075$; $0,072$) and $NSRI_j$ (1; $0,772$; $0,688$; $0,662$; $0,660$). Short-term strategies were developed on the basis of these HCSRs, as they had the highest importance, hence, were needed to be provided urgently. Mid-term and long-term strategies were created in a similar perspective, and, normal distribution rules were used to assign HCSRs to strategies according to their ISR_j and $NSRI_j$ values.

HCWNs were appended to the solution space (Fig. 4) according to their relevance to the four pre-identified system dimensions, w_i values (Table 3, Fig. 3), and their influence on work system (Fig. 2, Appendix 1). $HCWN_2$, $HCWN_{11}$, $HCWN_8$ and $HCWN_{10}$, with the highest w_i values ($0,085$; $0,077$; $0,079$; $0,080$) (Table 3, Fig. 3) and the strongest HCWN-HCSR relations (Fig. 2, Appendix 1) on the basis of the HCSRs covered in short-term strategies ($HCSR_7$, $HCSR_{15}$, $HCSR_5$, $HCSR_{10}$, and $HCSR_{12}$) were positioned in the solution space of short-term strategies as it was presented in Fig. 4. This process was likewise administrated for each strategy type, and, three useful management strategies were proposed as priceless essence of the study results.

4.2.1. Implication suggestions as short-, mid-, and long-term

Suggestions to be implemented as short-term articulation strategies must deal with the most urgent needs. "*Employee burn-out issues*", which is of the greatest importance ($w_2 = 0,085$) and relevant to two system dimensions, *HCW - patient relations* and *working environment* (Fig. 4), issues about "*job content*", "*working conditions*" and "*lack of technology and equipment*" were listed as other HCWNs that need to be satisfied urgently.

Managerial implication suggestions in short-term might be indicated as (*i*) increasing assigned minimum patient care times to reduce the number of patients per HCW (regarding "*burn-out*" issues in *patient relations* dimension); (*ii*) improving physical working conditions e.g., rest room comfort, extra breaks and private outdoor areas for COVID-19 HCWs, maintaining required equip-

ment and materials ("*burn-out*" issues in *working environment* dimension, and, "*working condition*" issues in *working environment* and *resources and facilities* dimensions); (*iii*) appropriately specifying the content and authority limits of job descriptions ("*burn-out*" and "*job content*" issues in *working environment* dimension); (*iv*) supplying advanced technology equipment ("l*ack of technology and equipment*" problem in *resources and facilities* dimension).

Needs related to "*relationship with immediate boss*", "*job content*", and "*training*" had the highest system impact magnitudes while creating mid-term strategies, wherein, regarding long-term strategies "*job satisfaction*", "*burn-out issues*", "*job content*", "*work-life balance*" and "*relationship with immediate boss*" were addressed as the ones having immerse impact on work system and should be enhanced in advanced levels (Fig. 4). Suggestions focusing on mid-term implementations could be (*i*) practicing requirement analysis for training programs; (*ii*) developing a training tracking system; (*iii*) performing job design activities with objective job assessment techniques, (*iv*) re-designing jobs with motivation replenishment tools e.g., mentoring, job enrichment, job enlargement, etc. Implication suggestions for long-term strategies could be considered as (*i*) ensuring balanced workloads through job analysis and accurate scheduling; (*ii*) diversifying jobs with new tasks; (*iii*) establishing a 360-degree appraisal performance management system which considers the views of subordinates, self-assessments, and, supervisors.

As a compilation of all obtained results, the fact that psycho-social work environment tenets that evoke monetary opportunities lose their effect on motivation and that new tenets should be developed to enhance working environment not to facilitate to endure working under rotting conditions.

As Fig. 4 indicates, improvements in "patient relations" and "resource and facility allocation" dimensions of HC system were most urgently needed psycho-social work environment enhancements considering short-term strategies, where, the most important and prior improvements considering mid-term and long-term strategies were found to be related to "working environment" dimension.

Issues regarding "*lack of technology and equipment*" should be urgently put on the agenda in the short-term; while the same HCWN lost its importance for mid-term strategies. On the basis of long-term strategies, the same HCWN gained importance again, which could be explained as it was desired to be reconsidered and checked at certain intervals.

Some work system tenets play a decisive role considering whole planning horizon; e.g., issues related to "*job content*", "*burn-out issues*" and "*relationship with immediate boss*" (Fig. 4). This underlines the impact of these system tenets on psychosocial work environment independent of the planning horizon. It is recommended for field practitioners to put special effort on job design activities, workload planning and job enrichment studies, plan and implement necessary programs such as coaching, communication, and empowerment trainings to ensure particular attention to these tenets.

5. Conclusion

In the age of sustainability, as the most important system input, HCW resilience will always be a vital problem even after pandemic repercussions have faded. So, the perspectives presented by this study would be beneficial for ergonomists and field practitioners in

any time, where, are also suitable to be implemented for different application areas.

This article aims to scrutinize and address the challenging system essentials in the importance sequence to point out psychosocial work environment articulation resolutions by defining a novel approach employing focus group studies, MCDM, and concurrent engineering tools, different from the normative studies which dominate the existing related literature of papers studying psycho-social working environment.

The most important motivator to be exigently fulfilled was found as related to "*Burn out issues*" instead of any other motivators related to monetary compensation slated in the consuetudinary, where, the most urgent satisfier to be provided was identified as "*Challenging work*" addressing the unexpected desire of being saddled with new job definitions in lieu of terminating existing ones, confirming the modification on the most potent incessant motivator tools with the effects of long-running stressful and challenging job environment.

COVID-19 pandemic has worsened the massive gap between the lowest and highest levels of attainable financial HC service resources all over the globe. Considering different dimensions of HCWN-HC system interaction rather than solely depending on financial ones, results of this study might be insightful for a wider range of HC institutions globally and practically employed, since the financial improvements regarding the personal rights of HCWs could not find enough space in private institutions' and state's budgets, not only considering the pandemic period or a similar catastrophe, but also for HCSs suffering from the addressed problems as usual system patterns.

In future works, samples from different organization types could be analyzed to address the differences in description and importance of psychosocial work environment tenets between organizational structures with this proposed approach, furthermore, worn out workforce in different service sector branches badly affected by COVID-19 e.g., food services, courier services, accommodation, etc. could also be examined.

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Conflicts of interest

The authors have disclosed that they have no significant relationship with, or financial interest in, any commercial companies pertaining to this article. No potential conflict of interest was reported by the authors.

Data availability statement

The authors confirm that the data supporting the findings of this study are available within the article.

CRediT authorship contribution statement

Burcu Yılmaz Kaya: Writing — review & editing, Writing — original draft, Visualization, Validation, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Elif Kılıç Delice:** Writing — original draft, Visualization, Validation, Project administration, Methodology, Investigation, Formal analysis, Data curation.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.shaw.2024.05.003.

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