




RESEARCH ARTICLE



Barriers and Challenges to Human Factors/Ergonomics Knowledge Transfer to Small Business Enterprises in an Industrially Developing Country

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OCCUPATIONAL APPLICATION

We found that small business enterprises (SBEs) face intra- and extra-organizational barriers in different dimensions related to their work system to practically implement human factors/ergonomics (HFE) knowledge transfer and to achieve its benefits in an industrially developing country. Utilizing a three-zone lens, we evaluated the feasibility of overcoming the barriers identified by stakeholders, especially ergonomists. To overcome the identified barriers in practice, three types of macroergonomics interventions (top-down, middle-out, and bottom-up) were distinguished through macroergonomics theory. The bottom-up approach of macroergonomics, as a participatory HFE intervention, was considered as the entry point to overcome the perceived barriers in the first zone of the lens, which included such themes as lack of competence, lack of involvement and interaction, and inefficient training and learning approaches. This approach focused on improving emotional literacy as a care zone among the small business enterprise personnel.

TECHNICAL ABSTRACT

Background: The human factors/ergonomics (HFE) knowledge transfer process is one of the potential challenges for organizations in industrially developing countries (IDCs), especially in small business enterprises (SBEs).

Purpose: We explored perceived barriers and challenges to the practical implementation of HFE knowledge transfer to SBEs in Iran, as an IDC, to improve their work systems.

Methods: An exploratory qualitative study was conducted using a conventional content analysis. To identify perceived barriers, we conducted individual interviews ($n = 38$) and a focus-group discussion ($n = 17$) with the participation of the SBEs personnel and the officials of related organizations. Inductive content analysis was used for data analysis. We then categorized the identified perceived barriers (themes) to determine the feasibility of overcoming them.

Results: Regarding perceived barriers, the following nine themes were extracted: lack of competence, resistance to change, technological infrastructure problems, lack of involvement and interaction, using an inappropriate mode of knowledge, lack of culture-building about HFE, inefficient training and learning approaches, lack of scientific management, and extra-organizational problems. Further, a three-zone lens was identified for the extracted themes to check the feasibility of overcoming them.

Conclusions: We identified nine intra- and extra-organizational barriers in the HFE knowledge transfer process to SBEs. We further evaluated the ways of overcoming perceived barriers defined in the three-zone lens to adapt them for building creative workplace culture zones (care, creative, and improvement). We distinguished three types of macroergonomics interventions (top-down, middle-out, and bottom-up) and three supporting strategies, including, knowledge, management and employees, and participatory HFE.

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1. Introduction

Small business enterprises (SBEs with 1-50 employees) play a key role in the economics and employment of developed and developing countries (World Bank,

2021). However, in these enterprises there are often problems caused by ineffective human factors/ergonomics (HFE) conditions. Accordingly, and especially in industrially developing countries (IDCs), poor working

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conditions, occupational injuries and incidents, low wages, and low job security are more prevalent in SBEs than larger enterprises (Hermawati et al., 2014; Jahangiri et al., 2019).

HFE knowledge has the potential to improve human well-being and the overall performance of a work system, by understanding the interactions between human and other components of the work system and by applying different principles and methods to design and manage work system (ILO & IEA, 2021). However, most SBEs in IDCs have limited knowledge and experience in HFE standards (Silalahi et al., 2021) and need appropriate knowledge transfer in this field (Hermawati et al., 2014). Knowledge transfer deals with knowledge communication (Wiewiora et al., 2009), as well as the application of previous knowledge in new learning situations (Riege, 2007). In this respect, Argote et al. (2000) noted that knowledge transfer can be considered as a process during which one unit such as individual, group, department, and organization is affected (i.e., learns) by the experiences of another unit.

The HFE knowledge transfer process is one of the potential challenges for organizations in IDCs (Helali, 2008), especially in SBEs (Hermawati et al., 2014; Silalahi et al., 2021). The limited studies reported among SBEs in IDCs with a specific focus on occupational health and safety indicates the existence of various barriers related to the transfer and application of HFE knowledge in these enterprises. Such as barrier include the low awareness and competence of managers and employees in the use of HFE (Garnica & Barriga, 2018; Kheni et al., 2010; Silalahi et al., 2021; Unnikrishnan et al., 2015), inefficient management of HFE (Garnica & Barriga, 2018), inadequate government support (Kheni et al., 2010), and the lack of sufficient working culture and HFE (Singh et al., 2013). SBEs often do not have the proper facilities and equipment to obtain knowledge quickly, and therefore knowledge providers do not provide them with necessary support on knowledge transfer. These conditions may make knowledge recipients less motivated to try to understand the concepts of knowledge transfer and enable them to find functional problems in practical knowledge transfer (Huang et al., 2008). In addition, there are inadequate activities in the field of safety, health, and ergonomics management in enterprises (Podgórski, 2010). Hence, some researchers have argued that it is necessary to apply efficient strategies for knowledge transfer to have more effective HFE (Dagenais et al., 2017).

For HFE knowledge transfer management in IDC organizations, it is essential to design proper and comprehensive planning through using different interventional

techniques (Helali, 2012). In this regard, Helali (2008) presented a framework for the HFE knowledge transfer process at the individual, group, and organization levels based on macroergonomics approach and participatory ergonomics in IDCs organizations. Macroergonomics is a systemic and participatory approach seeking to optimize the work system sub-system (Hendrick & Kleiner, 2002). Accordingly, implementing macroergonomics can lead to a significant improvement in various aspects of the performance and effectiveness of organizations (Hendrick & Kleiner, 2002). The results of this approach have been studied in different large- and medium-scale Iranian industries such as Glucosan factories and three subsidiary companies with a systemic macroergonomics intervention work (Helali, 2008), a power plant manufacturing company as a middle-out macroergonomics intervention (Abdollahpour & Helali, 2016), a pharmaceutical manufacturing company (Dastranj & Helali, 2016), an Iranian gas refining company, and in a manufacturing company as a bottom-up macroergonomics or participatory ergonomics intervention (Abdollahpour & Helali, 2022; Shojaei et al., 2020). Hence, the application of macroergonomics intervention has three main approaches (Hendrick & Kleiner, 2002), including: Top-down (i.e., strategic approach to analysis), middle-out (i.e., focus on processes), and bottom-up (i.e., participatory ergonomics).

Central to macroergonomics is the expectation that the analysis and design of work systems will be participatory in nature (Vink et al., 2008). Applying the participatory ergonomics approach through involving all stakeholders in the HFE knowledge transfer process can improve institutionalizing HFE knowledge and improving the human well-being and performance of work system (Helali, 2008). Nevertheless, according to the study by Hermawati et al. (2014), ergonomists in IDCs do not pay enough attention to using a participatory ergonomics approach to transfer and apply HFE to SBEs.

Most studies carried out in SBEs in IDCs, such as Iran, have focused on investigating working conditions (Jahangiri et al., 2019) and implementing interventions without focusing on the HFE knowledge transfer process to the work system of these enterprises (Heidarimoghadam et al., 2020; Hermawati et al., 2014). Hence, we aimed to explore perceived barriers and challenges to the practical implementation of HFE knowledge transfer to SBEs in Iran to improve their work system. We also aimed to address the following question: "How can an ergonomist overcome these perceived barriers by applying macroergonomics intervention

approaches to practically implement HFE knowledge transfer to the SBEs?”

2. Methods

Given the limited literature on HFE knowledge transfer to SBEs in IDCs, this exploratory qualitative study was conducted using a conventional content analysis approach (Hsieh & Shannon, 2005) to explain the barriers of HFE knowledge transfer to SBEs (Hermawati et al., 2014). Content analysis is a method of analyzing written, verbal, and visual communication messages (Cole, 1988) and it is a systematic method for a deep description of the phenomenon; as such, it is suitable for examining people's views on a specific issue (Hsieh & Shannon, 2005). In this regard, to collect data, we used two common methods, for data collection (Hsieh & Shannon, 2005), specially individual interviews and focus-group discussion (FGD) involving different stakeholders.

2.1. Setting and participants

This study was conducted from July 2019 to July 2020 in Tabriz city in Iran, one of the industrial hubs with numerous SBEs in Iran (High Supervisory Board of Trade Organizations of Iran, 2019). Inclusion criteria were those working in high-risk enterprises in terms of safety, health, and ergonomics based on the classification by the Iranian Ministry of Health (Environmental Health and Work Center, 2018), and with at least one year of experience. The selected SBEs had the highest number of enterprises and employees in Tabriz (High Supervisory Board of Trade Organizations of Iran, 2019). A total of 38 participants completed individual interviews, and 17 individuals participated in the FGD. Most participants were male (90%) and had a bachelor's degree or higher (68%). Other characteristics of the participants are presented in Tables 1 and 2. Using a purposive sampling method of the maximum variation type, we selected participants from different enterprises and organizations due to the great variety of SBEs and related organizations and their different experiences.

2.2. Data collection

Individual interviews

Semi-structured and face-to-face individual interviews (15 - 90 minutes) were conducted with SBE personnel, officials, and experts of the relevant organizations. After preparing initial questions based on the study aim, several open interviews were conducted with participants. Then, based on their experiences, we

determined more specific questions to conduct semi-structured interviews. The main open-ended questions were as follows:

- What are your experiences regarding HFE principles in your workplace?
- How are HFE principles implemented in your workplace?
- In what ways do you acquire knowledge about HFE principles and implement them in your workplace?

To gain more information, we also asked the following two exploratory questions: “What else do you think about this issue?” and “Is there anything else to add?” Since most participants were not familiar with the terms “human factors” and “ergonomics”, we used other terms such as “safety,” “health,” and “improvement of working conditions” and we provided various related examples in the interview questions. Officials of the associated organizations were also asked about experiences and plans of their organizations about knowledge transfer of HFE principles in SBEs and the related barriers. The interviews continued until data saturation was reached (Elo & Kyngäs, 2008).

Focus-group discussion (FGD)

To organize the FGD, we invited 30 participants from the individual interviews and three new officials and employers. In end, 17 individuals (14 interviewees and three newly invited people) from different levels were involved, including the SBE personnel and officials of supporting organizations and the FGD lasted for 3.5 hours. Given the importance of involving different organizational levels to identify barriers in terms of participatory ergonomics (Wilson & Haines, 1997), the FGD was done with different stakeholders and facilitators (first, second, and third authors). At first, the participants presented the barriers from their own point of view. Then, a nine-item form, including the results (themes) of individual interviews was presented to the participants to prioritize the barriers (score range: 1-9) in terms of HFE knowledge transfer to SBEs. The more highly involve the participants (Wilson & Haines, 1997) and better understand the barriers through easier dialogue in smaller groups and share their own perceptions (Krueger & Mary, 2014), the participants were divided into four working groups of four to five people. Each working group was comprised of a combination of different stakeholders (SBEs personnel and the officials of associated organizations). Finally, the relevant nine-item form for prioritization was completed in these workgroups.

Table 1. Demographic and organizational characteristics of participants in individual interviews and the focus-group discussion session.

Participants	Number of participants		Age (year)	Job tenure (year)
	Individual interviews	FGD	Mean	Mean
Employers and workers of SBEs	18	9	40	14.9
Iranian guild room officials (at the national level) and trade unions heads and officials	8	3	44.75	20.25
Ergonomics and occupational health experts of the Ministry of Health and Healthcare Service Centers	8	4	38.15	13.1
Officials of other related organizations, including the officials of the Small Industries and Industrial Parks Organization, the 'Industry, Mining and Trade Organization, and the 'Cooperatives Labor and Social Welfare Office	4	1	47.5	20

Table 2. Classification of participants from SBEs and trade unions in individual interviews and the focus-group discussion by enterprise type.

Participants	Enterprise type <i>n</i> (%)							
	Metalworking (Pressing, molding, casting, welding)	Shoes production	Garment and clothing	Car repair and mechanical service	Stonework	Chemical production	Cabinet making	Carpentry and sofa making
SBE employers and workers and related heads and officials of the trade unions	11 (42.3)	5 (19.2)	3 (11.5)	3 (11.5)	1 (3.9)	1 (3.9)	1 (3.9)	1 (3.9)

2.3. Data analysis

Data were analyzed using inductive content analysis according to the following steps: data reduction (coding), data grouping, and formation of concepts or (sub) themes to answer research questions (Kyngäs et al., 2020). The recorded individual interviews and FGD were transcribed and reviewed two to four times to ensure accuracy. Then, the first author coded the text of the interviews, and the codes were read several times. Next, conceptually similar codes were classified into one class (sub-theme). Characteristics and different dimensions of the codes were then reevaluated in terms of similarities and differences, and the related sub-themes were determined. Eventually, the subthemes were merged through a continuous comparison and the main themes were extracted. The extracted codes were managed using MAXQDA 10 software.

For a better and more comprehensive understanding of the extracted themes in terms of HFE principles, we then evaluated the relationships between the themes and HFE principles according to the guidelines presented by the International Labor Organization (ILO) and International Ergonomics Association (IEA) (ILO & IEA, 2021). After analyzing the results of prioritizing the extracted themes by the participants in the FGD (presenting the average scores related to the prioritization of themes), we identified the feasibility of overcoming perceived barriers through a deductive view

based on their research experiences in HFE interventions with a macroergonomics approach (Abdollahpour & Helali, 2016, 2022; Helali, 2008, 2012, 2015).

2.4. Rigor

To increase rigor, we used the criteria suggested by Guba and Lincoln (1989), including credibility, conformability, transferability, and dependability. To improve data credibility, we allocated sufficient time to data collection and interpretation, selected eligible participants from different enterprises and organizations, and encouraged close and accurate participation. To create high level of interaction, the first author conducted the individual interviews, and three authors participated in the FGD. To conform with individual interviews, we established on-going collaboration with the participants in the process of interpreting data during the implementation of FGD. Moreover, conformability was achieved by keeping notes on raw data, field notes, and categories. For dependability, reviewing the codes was done independently by each research team member, as well as through holding different group sessions at different stages of the study. Furthermore, the entire research process was recorded and reported precisely. The transferability of findings was evaluated using a detailed description of situation, participants, and data analysis methods.

3. Results

We used the data from individual interviews and FGD to extract the barriers in different themes, including intra- and extra-organizational barriers. In this regard, nine themes and 23 sub-themes were determined in Table 3, along with the related HFE principles (ILO & IEA, 2021). These principles include: “Principle 1”: Ensuring worker safety, health, and wellbeing in the optimization of work systems as a top priority; “Principle 2”: Designing and managing work systems to ensure organizational and worker alignment, continuous evaluation and learning, and sustainability; “Principle 3”: Creating a safe, healthy, and sustainable work environment from a holistic perspective, understanding and providing for human needs; “Principle 4”: Accounting for individual differences and organizational contingencies in the design of work; and “Principle 5”: Using collective trans-disciplinary knowledge and full participation of workers for designing systems, detecting problems, and creating solutions for HFE in work systems.

3.1. Analyzing the extracted theme

To understand the feasibility of overcoming perceived barriers, we analyzed the extracted themes (Table 3) based on the results of the prioritization of themes by the participants in the FGD (Table 4) and their experiences in implementing macroergonomics interventions. Accordingly, the themes were evaluated in the form of a three-zone lens, including A, B, and C (see Figure 1). Each of the three zones included related themes in terms of the feasibility of overcoming them so that the degree of feasibility decreased from zone A to zone C. The description of each zone is as follows:

- Zone A: In this zone, a competence zone, the focus is on overcoming the lack of competence through improving the other two barriers (themes) in this zone. This improvement happens when personnel have the ability to increase their technical and social skills through appropriate interaction and participation, and improve and learning, especially by using deep learning methods (Abdollahpour & Helali, 2022; Helali, 2008).
- Zone B: This zone a practical knowledge zone, which focuses on overcoming the non-utilization issue by a proper knowledge mode such as using the mode two knowledge (Gibbons et al., 1994) through a practical HFE knowledge transfer to expand culture-building about HFE.
- Zone C: This is a scientific management zone, which focuses on overcoming the lack of scientific

management by considering the other two themes when resistance to change in SEBs can be reduced through a creating awakened need of change for the application of HFE knowledge in their work system. In this regard, it is necessary to pay attention to different levels of learning from organizational knowledge (see, Abdollahpour & Helali, 2016; Helali, 2008). In addition, proper management of the work system in SBEs can make them more flexible in facing extra-organizational problems as factors of the external environment proposed in the theory of macroergonomics (Hendrick & Kleiner, 2002). In the meantime, more support from the related organizations can facilitate improving the work systems in SBEs.

4. Discussion

Due to the limited literature on HFE knowledge transfer to SBEs in IDCs (Hermawati et al., 2014), this exploratory qualitative study was conducted to identify perceived barriers. We identified nine perceived barriers of HFE knowledge transfer to SBEs (Table 3). To better explain the findings, we focused on the theory, which is emphasized in qualitative studies. Theory serves as a framework to guide the study in qualitative studies, and a theoretical framework involves the use of a theory or theories that simultaneously conveys the deepest values of the researcher (s) and provides a clear indication or lens for how the process provides new knowledge. A theoretical framework is at the intersection of 1) existing knowledge and previously formed ideas about complex phenomena; 2) the researcher's epistemological dispositions; and 3) a lens and a methodically analytic approach. Working through these three components renders theory a valuable tool to the coherence and depth of a study (Collins & Stockton, 2018).

In this regard, and to have a proper epistemology of the feasibility of overcoming perceived barriers, a three-zone lens was presented (Figure 1). Focusing on the three-zone lens to overcome perceived barriers, we present the findings in a theoretical framework from two angles, including macroergonomics theory and its various intervention approaches, as well as the three zones of a building creative workplace culture. There were two reasons for this approach. The first reason is that, as Neumann et al. (2012) emphasized, to solve HFE problems in organizations, relevant experts and stakeholders need to learn how to transfer and apply HFE knowledge (both tacit and explicit knowledge) to the work system. Hendrick and Kleiner (2002) introduced different

Table 3. Results from individual interviews and the focus-group discussion with the related HFE principles (see text) proposed by the ILO and IEA (2021).

Themes	Subthemes	Participants comments	Summary of participants' perceptions	Related ILO & IEA HFE principles
Lack of competence	Insufficient skill in providing practical and low-cost solutions	<i>"I didn't know that if we opened the screws of the sewing machine tables, its height would be adjustable; we were unaware of this option. Many people do not know how to solve their problems in workplace with a series of simple ways." (Worker)</i>	This issue focuses on insufficiency of SBEs' skills in presenting and implementing simple and practical solutions to improve their working conditions, which can be due to the lack of HFE knowledge transfer.	Second and fifth
	Poor management skills	<i>"Many employers don't have managerial literacy. For example, somebody with 10 or 15 years of experience working as a mechanic has no managerial skills and have never attended management courses. So, they can only be a traditional manager." (Employer)</i>	The participants stated that many employers who are self-employed are more skilled in the technical issues of their field of work. However, they were not skilled enough in other fields such as marketing, improved working conditions, human resource management, organizational behavior, proper communication, and organizational development.	
	Low education	<i>"In our work, many people are not scientifically educated and work without sufficient knowledge about their working conditions. For example, the air in the workplace is polluted, and they don't know that this can cause respiratory problems." (Employer)</i>	This barrier is one of the reasons for their insufficient qualifications and skills in improving SBEs working conditions.	
Resistance to change	–	<i>"Once and for the sake of improving efficiency, we decided to change the way our workers worked to get rid of the single-person complete production of shoes and make the workers produce the shoes in a chain. However, there was a lot of resistance from the workers. They said that you want to reduce our wages in this way." (Employer)</i>	The participants emphasized a resistance does exist against new changes in workplace due to traditional work methods and fear of change.	Second, fourth, and fifth
Technological infrastructure problems	Absence of infrastructures and facilities	<i>"The area of our workshop is around 60 m2. This space is very small for all the equipment and machinery." (Employer)</i>	From the participants' point of view, inadequate working space and rented workshops, absence of safety and health units, absence of training units in SBEs, and interactive offices between SBEs and universities and other responsible organizations have led to improper transfer and application of HFE knowledge in these enterprises.	First and third
	Limitations on the development and utilization of appropriate technology and machinery	<i>"Our welding machine is old and has a lot of radiation and ... this is bad for my health, and I cannot change it because of economic problems ... " (Employer)</i> <i>"... When I do not have</i>	The factors raised in this regard include the following: limitation in the development and use of new technologies and appropriate machinery for different reasons such as unawareness, economic and problematic political problems,	

(Continued)

Table 3. Continued.

Themes	Subthemes	Participants comments	Summary of participants' perceptions	Related ILO & IEA HFE principles
Lack of involvement and interaction	Low motivation and distrust	<i>the modern technology, the products will not be of good quality... The responsible organizations do not support us in this regard." (Employer)</i> <i>"Most of us as manufacturers are afraid of copying each other's product models as competitors. So, we trust less and share less of our experiences." (Employer)</i> <i>"Most of them (i.e., SBEs personnel) are less motivated to participate and exchange information with the inspectors of government organizations, because many inspectors do not have positive attitudes; therefore, the SBEs personnel believe that they have come to make problems instead of helping them to solve the problems." (OHE)</i>	and the lack of support on behalf of associated organizations, especially trade unions. The participants emphasized the lack of interaction between the enterprises (either between themselves or with responsible organizations), which leads to less motivation and trust.	Fifth
	Poor interaction and cooperation	<i>"There is very little interaction between the enterprises, even the neighboring enterprises, with each other. If we interact with each other, we can work together to solve problems." (Employer)</i> <i>"We don't share our experiences with other enterprises, while we can share these experiences, at least in cyberspace." (Employer)</i> <i>"The health services center should evaluate the jobs here (i.e., in SBEs) as specialized. We should read scientific papers and prepare brochures for each job. There is no practical research in these enterprises." (Employer)</i>	The participants stated a poor interaction between SBEs and even inadequate communication between employers and workers within each enterprise. This factor makes the enterprises unaware of the positive experiences and unable to help each other in improving working conditions.	
Using an inappropriate mode of knowledge	–	<i>"Over 40 to 50 percent of my coworkers have lung problems. In the cabinet making and stonework workshops, because of the unsafe working conditions and high workload, they usually have a problem in their back and hands." (Employer)</i> <i>"In some enterprises, workers use gasoline to clean the hands. The skin on their hands is completely dry and cracked." (A head of trade union)</i>	Weakness in conducting practical research about the problems of these enterprises is another perceived barrier posed by the participants.	Fifth
The lack of culture-building about HFE	Unsafe and unsanitary working conditions		The participants believed that there are improper working conditions in most SBEs, which can cause occupational accidents and diseases.	First and third

(Continued)

Table 3. Continued.

Themes	Subthemes	Participants comments	Summary of participants' perceptions	Related ILO & IEA HFE principles
Inefficient training and learning approaches	Lack of institutionalization of HFE	<i>"In SBEs, the culture of occupational health has not been rooted yet. The problem is that in many cases some people say what does the health services center have to do with us? Our big problem is that this culture has not been settled." (OHE)</i>	Participants emphasized that HFE principles are not applied through the localization of positive workplace. They considered the role of trade unions to be important in supporting its implementation.	Second
	Lack of codified and comprehensive training programs	<i>"Most of our work is just inspection and less training (i.e., to promote HFE)." (OHE)</i> <i>"Guild room and trade unions now hold some training classes to obtain business licenses. They can also consider safety and health education." (Employer)</i> <i>"The trainings offered in the guild room have low quality because it is mostly theory-based and not efficient enough to learn." (FGD)</i>	The participants stated that the relevant organizations such as the trade unions and health services centers do not prioritize HFE training programs for SBEs. The trade unions have not designed a training course in HFE for SBEs and have provided most of the trainings on business administration rules. Of course, the officials of the Small Industries and Industrial Parks Organization stated that they hold free short-term training classes in the health and safety field for SBEs in Industrial Parks, which include a limited number of enterprises. Some of the provided trainings by guild rooms and trade unions are non-practical. So, the SBEs fail to apply them and improve their working conditions.	
	Lack of appropriate tools and training materials	<i>"So far, I have not seen any brochures in these fields (i.e., HFE) and no one has given them to us. It is better to prepare a brochure in this field and make it available to the enterprises or be provided through cyberspace." (Employer)</i>	Participants emphasized the lack of appropriate training tools and materials, such as pamphlets, brochures, videos, and photos.	
	Low awareness and knowledge of HFE	<i>"Few years ago, I got a back pain. I did not know what it was for. I found out later that it was from my chair because it wasn't standard." (Worker)</i>	Participants emphasized a poor level of awareness, low HFE knowledge, and inefficient ways to utilize them among employers and workers of SBEs.	
Lack of scientific management	Lack of a proper humanistic approach	<i>"Here, there is no health and safety; and it is not clear whether they pay workers' wages according to the labor law or not. They are not supported in any way." (Employer)</i>	Most SBEs are simply production-centered and enough attention is not paid to the workers' salaries and welfare. Due to the insufficient knowledge of employers on the importance of humanism and their traditional and experimental work system, practical applications such as HFE knowledge do not exist in these enterprises.	First to fifth
	Not employing the required specialists	<i>"In this metalworking complex, there is no safety and health professional to tell us that safety must be</i>	The employers do not employ experts in different fields to give consultations on improving working system. This fact is highly true in the field	

(Continued)

Table 3. Continued.

Themes	Subthemes	Participants comments	Summary of participants' perceptions	Related ILO & IEA HFE principles
		<i>observed for these reasons. For example, there is no one to evaluate our working condition and tell us that these problems might happen." (Employer)</i>	of HFE. Most employers emphasized that they do not know who can help them to improve their business. In most cases, they do most of the management, accounting, marketing, and sales works themselves. However, they do not have enough experience and skills in these fields, and they are not necessarily qualified.	
	Lack of teamwork	<i>"... No one is looking forward to another development. Do you expect them to do teamwork? Teamwork in these industries is very weak." (One of the officials of guild room)</i>	The participants asserted that there is a lack of teamwork in SBEs, which causes many problems. This could be solved by cooperation inside any enterprise and associated enterprises.	
	Focus on traditional management	<i>"They (i.e., employers) just produce goods and do not think about other aspects of production such as safety and health. But it's important to keep producing, the issue that they never think about. Most of the employers have short-term thinking." (One of the officials of Small Industries and Industrial Parks Organization)</i>	The participants stated more focus on traditional management in SBEs. This focus has different aspects, including focus on technical and materialistic approach, improper production management system, loose futurism, and management to improve work conditions.	
	Improper plan and planning	<i>"Most small enterprises focus on short-term planning and profits, and very little attention is paid to long-term plans; it makes them not develop properly." (FGD)</i>	The participants emphasized that SBEs usually have inefficient planning almost in all tasks, and especially in improving working conditions based on HFE principles.	
	Absence of an appropriate organizational behavior	<i>"Here, most people such as my dad and my uncle have hearing loss. Nonetheless, my father, who is too careless, conveys this carelessness to me. If I want to do something, they say take it easy and suppress it. For example, several times, I decided to put a glass guard or metal guard in front of the circular saw so that metal chips are not thrown at our faces and eyes, but I was told to ignore it." (Worker)</i>	The absence of appropriate organizational behaviors in SBEs is another perceived barrier because it makes people pay less attention to doing work in a scientific way.	
	Recruitment and incessant employment problems	<i>"Our work is seasonal and not permanent, and in most workplaces, they are not in good order. And when the worker sees that it is not a permanent job, he becomes less interested in working in these enterprises." (Employer)</i>	Participants stated that low job security, low income, poor working conditions, and absence of skilled working force in these enterprises are different reasons behind this barrier.	

(Continued)

Table 3. Continued.

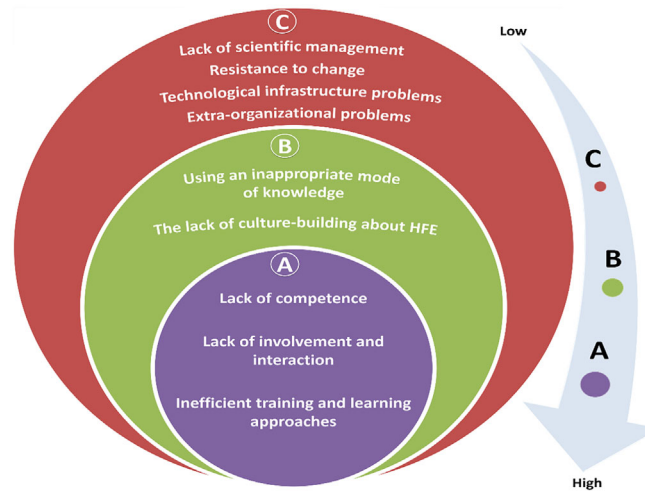
Themes	Subthemes	Participants comments	Summary of participants' perceptions	Related ILO & IEA HFE principles
Extra-organizational problems	Insufficient support from responsible organizations	<i>"Nowadays, governments and banks around the world are supporting SBEs; but there is little support in our country. Banks give loans for one or two years. It will take about ten years for the profits of expensive machines to return." (A head of trade union)</i>	This insufficient support has two levels, namely at the trade unions and guild room and other organizations, including health services centers, insurance organizations, banks, and other supporting organizations. Most employers expressed dissatisfaction with the lack of support from government organizations in improving their working conditions. However, the Ministry of Health officials stated that some programs to improve the HFE of SBEs are being implemented by that institution. This includes the programs to improve working conditions of carpet weaving workshops, deployment of trained personnel in the field of occupational health and safety in workshops with 20 to 49 people, and periodic inspections of SBEs by occupational health inspectors (also see, Environmental Health and Work Center, 2018). However, the occupational health inspectors stated that their focus is only on conducting inspections rather than properly transferring relevant knowledge to SBEs.	Fifth
	Weak public information system	<i>"I have never seen a TV program showing that a disease is caused by a particular job. We have many cases of back pain and neck pain. Training and providing information do not happen in a proper way." (OHE)</i>	The participants emphasized the weakness of the public information system for HFE culturalization, which can be performed in the SBEs by supporting organizations in person or through public media (such as television, radio, etc.).	
	Financial problems	<i>"When the employer or a worker is not financially secure, he doesn't even think about a mask and a hearing protector. The cost of personal protective equipment, such as a high-quality mask, is very high." (Employer)</i>	Participants stated that economic problems in SBEs, most of which are due to extra-organizational conditions, are a key barrier to the transfer and application of HFE knowledge in these enterprises.	
	Absence of proper supporting laws	<i>"To start a business, the trade union tells the employer that before he can get a business license, he should go the Technical and Vocational Training Organization and get approved or trained. There are no such laws for safety and health issues." (Employer)</i>	Some participants emphasized the absence of adequate supporting laws in improving the working conditions of SBEs.	

macroergonomics intervention approaches at three levels (top-down, middle-out, and bottom-up) to transfer and apply HFE knowledge to the work system. Accordingly, a suitable macroergonomics intervention approach was

also introduced for each defined zone of barriers (Figure 1) to properly understand the feasibility of overcoming perceived barriers in implementing the practical HFE knowledge transfer to the work system of SBEs.

Table 4. Prioritization of the importance of extracted barriers in the HFE knowledge transfer to SBEs by participants in the focus-group discussion.

Theme	Individual score (Mean)	Group score (Mean)
Inefficient training and learning approaches	6.43	8.25
Lack of scientific management	5.86	7.75
The lack of culture-building about HFE	6.93	7
Resistance to change	4.43	7
Lack of involvement and interaction	6.29	6.5
Using an inappropriate mode of knowledge	5	4.75
Lack of competence	5.57	3.5
Technological infrastructure problems	5.36	3
Extra-organizational problems	3.57	1.25

**Figure 1.** The three-zone lens used to categorize the feasibility of overcoming perceived barriers for practical HFE knowledge transfer to SBEs.

On the other hand, based on the results from Helali (2012), one of the main challenges in HFE knowledge transfer management to enhance human working for sustainable improvements in IDCs such as Iran, is the weakness in a building creative workplace culture. Ghaye (2008) suggested a framework to build creative workplace culture constructed in three zones “care, creative, and improvement” and 10 attributes. The attributes of each zone are as follows:

- Care zone attributes: The focus of this zone is on “developing emotional literacy” (Ghaye, 2008) through improving “trust” when people do not trust others and feel they are not open and honest with them; “team cohesion” when there is no sense of belonging and togetherness within a team or at work; “communication” when workers do not understand what is expected of them and procedures and policies are not communicated; “feeling supported” when workers do not feel appreciated, valued or treated courteously by others, and; “reflection” when workers do not feel that looking at and learning from their practice, in a structured way, makes a difference to how they do their work (Helali, 2012). Hence, the attributes of the care zone are about getting relationships ‘right’ between personnel in workplaces (Ghaye, 2008).
- Creative zone attributes: Ghaye (2008) noted that if care zone attributes are as good as they can or need to be, it gives us the confidence to think and act differently as “developing realistic optimism”. In the other words, attention is paid to improving “leadership” when people do not have leadership skills that help others to think and act differently; “decision making” when people do not feel empowered to make the most of your own decisions, and; “coping with work” when people do not cope with your workload rather than feeling constantly under pressure (Ghaye, 2008; Helali, 2012).
- Improvement zone attributes: Ghaye (2008) emphasized that providing the attributes of the creative zone in workplaces can provide a suitable platform for trying to improve individual or collective performance by making a difference in policy and practice. As a result, “innovation” when people do not feel can ‘try things out’ and be creative in their work, and “influence” when people do not feel collectively involved in shaping and

developing their service, in the workplace as two attributes of the improvement zone can be facilitated (Ghayee, 2008).

To overcome perceived barriers, we can adapt the three-zone lens (as shown in Figure 1) through building creative workplace culture zones in SEBs. Hence, this might be considered as a guide to achieve an intended learning outcome to practical implementation of HFE knowledge transfer to SBEs in IDCs such as Iran. Our findings (Table 3), especially the feasibility of overcoming barriers (Figure 1), could be discussed and interpreted based on different macroergonomics intervention approaches and the three zones of “building creative workplace culture” for intended learning outcomes of the macroergonomics intervention (see, Helali, 2012, 2008).

4.1. The perceived barriers themes in the first level of Zone A as a competence zone adapted with a “care zone”

Overcoming the first set of the perceived barriers in zone A of Figure 1 included the lack of competence, lack of involvement and interaction, and inefficient training and learning. These barriers might be overcome through using a bottom-up macroergonomics intervention, in which an ergonomist could overcome these perceived barriers by a participatory ergonomics approach. To overcome these barriers, it is essential to develop emotional literacy in the personnel for the feasibility of the practical implementation of HFE knowledge transfer.

According to Helali (2012), it is necessary to improve organizational behavior and suitable interfaces between individual, group, and organizational levels at work. The identified reasons included hierarchical management style, poor action learning, poor workplace participatory learning, and poor productivity and livelihood in the industries of IDCs such as Iran. Based on the perceived barriers in zone A, the participants emphasized the existence of factors such as the lack of proper management skills, lack of interaction and sharing of experiences, and the lack of proper training and learning programs in the field of HFE. According to Helali (2012), the root cause eliminates of these kinds of the barriers can be considered: such factors in enterprises can lead to a lack of or a poor “trust, team cohesion, communication, respect, feeling supported, and reflection”. He further emphasized that to improve these factors, the participatory ergonomics approach can be used to improve employees’ competence and

their interaction at the individual, group, and organizational levels.

Based on previous studies in IDCs, if individuals in organizations are actively involved in applying and transferring HFE knowledge using an appropriate learning approach such as action and continuous learning through participatory ergonomics process (Helali, 2008), their competence (both in the technical and social skills) is improved by promoting trust, motivation, and involvement of the participants (Dastranj & Helali, 2016; Shojaei et al., 2020). Furthermore, employers and workers need to be involved and empowered to apply HFE knowledge and improve work systems (ILO & IEA, 2021).

Hale and Swuste (1997) noted that many SBEs do not have the expertise or time to solve their problems. As Table 3 shows, the personnel of SBEs had insufficient education and were not able to solve their HFE problems. To solve these problems, they needed to improve their competence through the support of external experts (as facilitator) from related organizations. The participants emphasized the lack of skills in SBE personnel in providing and implementing solutions to improve working conditions, especially low-cost solutions (Table 3). Existing problems can be identified by involving workers, supporting their management, and empowering them by appropriate practical training tools such as ILO ergonomic checkpoints, and low-cost and easy solutions can be implemented using the local culture and facilities (Abdollahpour & Helali, 2022; Dastranj & Helali, 2016).

We found (Table 3) that the lack of interaction and cooperation in SBEs makes them rely more on experienced knowledge within their enterprises and not on continuous evaluation and learning approach to acquire explicit knowledge. When people are involved in a participatory ergonomics approach, information flow is created between different organizational levels and improves knowledge sharing and transfer and increases creativity and innovation in the organization (Antle et al., 2011). Hermawati et al. (2014) mentioned that the involvement of stakeholders, including employers and workers, through a participatory ergonomics approach has been less considered in HFE interventions in SBEs of IDCs, which makes the HFE culture not effectively institutionalized in these enterprises.

According to some participants (Table 3), training and learning programs on HFE knowledge were not held for most SBEs. However, according to the officials of related organizations, such as the Small Industries and Industrial Parks Organization and Healthcare Service Centers, some training programs, especially in the field of health and safety, had been organized for

these enterprises. In this regard, considering the economic problems of SBEs as an extra-organizational problem (Table 3), it is necessary for the related organizations to support the implementation of appropriate training and learning programs with the involvement of all stakeholders, especially workers in the field of HFE. Nonetheless, workers should be actively involved in learning processes to have proper HFE knowledge transfer in workplaces (Boatca et al., 2018). In this regard, the ILO (2020) proposed the implementation of a “Work Improvements in Small Enterprises (WISE)” program with a participatory training approach successfully implemented in some IDCs.

4.2. The perceived barriers themes in the second level of Zone B as a practical Knowledge zone adapted with a “creative zone”

Overcoming the second set of perceived barriers in Zone B of Figure 1 included using an inappropriate mode of knowledge and the lack of culture-building about HFE. These barriers might be overcome through using the middle-out macroergonomics intervention, in which an ergonomist could overcome these perceived barriers with focus on processes in the SBEs. To overcome these barriers, it is essential to develop realistic optimism for the HFE knowledge transfer. The HFE knowledge transfer process can be done in a different way when we consider the attributes of the “creative” zone, including leadership, decision making, and coping with work (Ghaye, 2008).

From our results (Table 3), occupational health inspectors of health centers paid more attention to inspecting and evaluating working conditions, and lack of HFE knowledge transfer in a practical way led to low motivation of SBEs personnel to interact with them. So, it can be inferred that the need for the application of practical knowledge is significant. However, using an inappropriate mode of knowledge and the lack of competence in utilization of HFE knowledge in SBEs makes HFE culture not to be prioritized in these enterprises. Hence, based on previous studies (Hermawati et al., 2014; Jahangiri et al., 2019) and the emphasis of the participants in this study (Table 3), the working conditions in these enterprises are not suitable, and the rate of accidents and occupational diseases is high. However, many SBEs in IDCs emphasize physical improvements of working conditions (Hermawati et al., 2014) and less attention is paid to the holistic view on applying HFE in design and management of work systems in all aspects, including physical, psychological, cognitive and other human characteristics such as knowledge and experience

(ILO & IEA, 2021). Applying HFE in the design and management of work systems happens through collective and trans-disciplinary knowledge as practical knowledge (or mode two knowledge proposed by Gibbons et al. (1994)), as well as the involvement of all stakeholders in achieving its benefits. In line with the need to joining up practice with theory, Helali (2015) presented taxonomy knowledge in relation to systemic ergonomics intervention work.

4.3. The perceived barriers themes in the third level of Zone C as a scientific management zone adapted with an “improvement zone”

Overcoming the third set of the perceived barrier's themes in Zone C in Figure 1 included the lack of scientific management, resistance to change, technological infrastructure problems, and extra-organizational problems. These barriers might be overcome through using the top-down macroergonomics intervention, in which an ergonomist could overcome these perceived barriers by different strategic understanding from getting HFE knowledge transfer (Helali, 2012). To overcome these barriers, it is essential to make a different way for the HFE knowledge transfer process. The HFE knowledge transfer process can make a difference in practice and policy when we consider the attributes of the improvement zone factors, including the innovation and influence (Ghaye, 2008).

The lack of scientific management is the first theme of zone C that needs to be considered in HFE knowledge transfer to SBEs. One aspect of the lack of scientific management is the lack of a proper humanistic approach. The humanistic approach or human-centered approach focuses on the well-being, motivation, interest, and stability of individuals, considering their physical and cognitive capabilities, knowledge, and experience (ILO & IEA, 2021). Often, organizations do not have the right humanistic approach, which has an adverse impact on the performance of individuals and organizations (Helali, 2008; Wagner, 2020). It causes employers to pay less attention to improving the working conditions of their workers and even leads to inappropriate organizational behavior in these enterprises. According to our findings (Table 3), focusing on traditional management in SBEs and the absence of comprehensive plan and planning and lack of teamwork are other barriers to the lack of scientific management, making these enterprises work in a management of traditional and experimental system.

Most SBEs are self-managed and employers perform most tasks themselves, such as sales, production

planning, and accounting (Down, 2006). Here, the employers also emphasized this issue (Table 3). Accordingly, experts in different fields such as HFE, industrial management, industrial engineering, occupational health, and other specialists are less employed. Practically, knowledge transfer (especially explicit knowledge) does not happen in these fields. In this regard, ILO and IEA (2021) emphasized that to apply high quality of HFE knowledge in work system such as in SBEs, it is necessary to involve employers, workers, external advisors, and internal HFE specialists.

Another dimension of the lack of scientific management is recruitment challenges and the high use of the labor force. According to ILO (2020), SBEs face weaknesses and challenges in management issues such as human resource management, labor relations, employment, and day-to-day work planning due to their low formal organization. Due to the lack of a formal structure for the permanent recruitment and employment of workers and the greater focus on their daily wages in SBEs, employers are less likely to focus on improving working conditions. Based on our findings, the lack of scientific management and a suitable process to recruit workers, along with the existence of improper working conditions in these enterprises lead to difficulty in the constant recruitment of workers.

On the other hand, in zone C, the resistance to change was one of the perceived barriers to the HFE knowledge transfer process. The participants stated that resistance to change occurred due to the use of traditional methods and fear of change. To overcome this barrier, the management needs to involve workers in change process. Further, proper change management is needed to overcome resistance to change in SBEs (Stavros et al., 2016). One appropriate approach is applying macroergonomics change management based on the participation of all stakeholders in the change process (Imada, 2008). Sandberg and Vinberg (2000) stated that when working in a workplace, especially in SBEs, if a strategy or change is implemented by a technical and specialized group without the involvement of workers in the process of identification and implementation, the employees will not have a positive attitude toward it. Although the solution could bring several benefits for them, they do not accept it in practice and resist its implementation. Accordingly, Vink et al. (2008) noted that resistance to change and personnel's fear could be reduced through active involvement of personnel in the change process by using participatory ergonomics.

Another theme in zone C was the technological infrastructure problems. Gualtieri et al. (2020) reported

that one of the challenges and needs of SBEs for development and progress is the use of new technologies such as mechanized machines that possess HFE standards and user-centered design. However, participants in study emphasized that one of the existing technological infrastructure problems is related to economic and political problems and the absence of support from responsible organizations. Some previous studies in IDCs also emphasized this issue (Hussain et al., 2012; Irjayanti & Azis, 2012).

Improving working and technological conditions can happen by participatory HFE, which is an approach to implement changes or new technologies in organizations and require end-users to be highly involved in developing and implementing the intervention (ILO & IEA, 2021). We should also consider the concept of organizational learning as learning process that is necessary for the development, success, and long-term sustainability, especially for the participatory HFE programs (ILO & IEA, 2021). Organizational learning includes a cybernetic learning process that requires supporting systems, policies, and procedures to support feedback control by employees (ILO & IEA, 2021). Hence, implementing research work can be emphasized in an appreciative way (i.e., research with company and the participation of the participants, not only on people or techniques and tools). As such, behavioral cybernetics deals with human behavior as a self-autonomous and closed-loop feedback control process and focuses on feedback relations between individuals and the environment (see also Abdollahpour & Helali, 2016; Dastranj & Helali, 2016; Shojaei et al., 2020).

On the other hand, improving organizational learning can be a key prerequisite in changing external environment factors and can play a significant role in improving organizational design and management (based on macroergonomics theory) with involvement of personnel (Smith et al., 2019). In this regard, the transfer and application of HFE knowledge through the top-down intervention of macroergonomics can improve the management of the work system of organizations and make it more flexible in external challenges such as economic, political, legal, and cultural (Hendrick & Kleiner, 2002). Here, the participants emphasized the existence of some extra-organizational problems (such as economic, legal) in the transfer and application of HFE knowledge in SBEs (Table 3). However, in terms of the importance of HFE knowledge transfer, the participants in the FGD categorized them with a lower priority (Table 4). For this reason and considering the low feasibility of overcoming extra-organizational problems

(zone C, [Figure 1](#)), SBEs can have more flexibility in facing extra-organizational barriers in the HFE knowledge transfer by improving the management of their work system. However, Kheni et al. (2010) noted that, due to the economic problems in SBEs that are more affected by the economic conditions of some IDCs, there is a need for more support from related organizations to improve the work system of these enterprises.

Therefore, the feasibility of overcoming the perceived barriers in zone C can be interpreted based on the attributes of the improvement zone where it focuses on making a difference in the practice and policy of SBEs. Change management is not so much about drawing detailed blueprints of desired target situations or about the application of methods and procedures to set strategic objectives. Rather, change management is about designing the path of change (Fritzenschaft, 2014). This distinction emphasizes that the key to successful action is to follow the right path (Redwood et al., 1999), given that one of the basic characteristics of HFE knowledge is to have a systems approach (Dul et al., 2012).

According to our results ([Table 3](#) and [Figure 1](#)), to overcome the perceived barriers it is essential to improve the sub-systems of the appreciative work system (Kleiner, 2008) as the existing facilitated challenges to practical implementation of the HFE knowledge transfer process to SBEs. For this, the Ergonomics Intervention Program Technique (EIPT) process presented by Helali (2008) and could be utilized. Accordingly, three types of supporting strategies, including knowledge support, management and employees support, and participatory HFE support along with the focus on external environment should be considered in HFE knowledge transfer to the SBEs. This emphasizes the key characteristics of the identified socio-technical system components (Kleiner, 2008). Hence, there are several important sub-systems, including, the personnel sub-system, technological sub-system, organizational job and task design sub-system, and the internal and external environments that it is called a work system sub-system (Kleiner, 2008). Any change in the sub-system also affects other sub-systems (Hendrick & Kleiner, 2002). ILO and IEA (2021) emphasize macroergonomics theory. Macroergonomics considers optimizing work systems by the focus on relevant social, technical, and environmental variables and their interaction (ILO & IEA, 2021).

4.4. Limitation of the study

The main limitation of this study was related to conducting individual interviews and the FGD, due to the high workload and working time of some participants,

especially SBEs personnel. To cope with this issue, we tried to consider the work schedule of the participants during the interviews and by involving a larger number of stakeholders from different SBEs and related organizations. Due to the qualitative nature of this study and the different characteristics of SBEs with large enterprises in various dimensions, such as size, structure, and human and financial resources, it may not be possible to directly generalize the results of this study to all organizations (Almeida & Aterido, 2015). However, given the existence of structural commonalities between small enterprises and medium-sized enterprises, as well as seeing them integrated into the relevant research in most countries, decision-makers and relevant stakeholders, can if necessary, can use the results of this study, especially our interpretation of how it is feasible to overcome barriers in considering the decisions. This research was conducted in Iran as an IDC, and due to different cultures, policies, and implementation programs in SBEs in different countries, it is suggested that further work examine the relevant barriers in other countries as well.

5. Conclusion

We identified nine intra- and extra-organizational barriers in HFE knowledge transfer to SBEs. We evaluated ways to overcome perceived barriers defined in the three-zone lens including: A Zone - lack of competence, lack of involvement and interaction, and inefficient training and learning approaches; B Zone - using an inappropriate mode of knowledge and the lack of culture-building about HFE; and C Zone - lack of scientific management, resistance to change, technological infrastructure problems, and extra-organizational problems, to adapt them for the building creative workplace culture zones (care, creative, and improvement) as intended learning outcomes of macroergonomics intervention. To overcome the identified barriers and build creative workplace culture zones in practice, three types of macroergonomics intervention approaches (top-down, middle-out, and bottom-up) were distinguished through macroergonomics theory. We also presented three supporting strategies, including knowledge, management and employees, and participatory HFE so as to facilitate the process of overcoming the perceived barriers. Hence, the bottom-up approach of macroergonomics, as a participatory HFE intervention, can be considered as the entry point to overcome the perceived barriers in the first zone of the lens (Zone A). This approach focuses on improving emotional literacy as a care zone in personnel of SBEs. To overcome the

barriers in Zones B and C, respectively a middle-out and a top-down macroergonomics intervention were suggested. These interventions could focus on developing realistic optimism and making a difference in practice and policy in SBEs.

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Conflict of Interest

The authors report no conflicts of interest that may have inappropriately influenced this work.

Ethics Approval

The study protocol was evaluated by the ethics committee of the research deputy of the Tabriz University of Medical Sciences (ethical code: IR.TBZMED.REC.1398.252). Research ethics were also followed by stating the objectives and reassuring participants about the confidentiality of information, recorded voices, and obtaining informed consent to participating in the research.

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