Ergonomics Intervention Program to Train Water Measurers (Al-Kayyals) for Work at Foggara Irrigation System in Algeria

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Abstract. The Foggara system consists of two main parts: The water obtaining part and the water distribution part. One of the main figures in the management of the Foggara system is the water measurer (Al-Kayyal). Among his work activities are monitoring the amount of water that flows from Foggara, and measuring the share of each beneficiary. Al-Kayyal should have basic knowledge of math, keep accurate records, be honest, intelligent, and have religious values.

Nowadays, most of Al-Kayyals are elderly. They are unable to fulfill the demands of water measuring job. As a result, many Foggaras have serious problems to stay functioning in the absence of Al-Kayyal. The aim of the present research is to introduce a training program to train interested young people to do the job of Al-Kayyal.

Researchers chose randomly five students who expressed a desire to learn the profession of Al-Kayyal. They are of approximate age (mean age was 22.40 and standard deviation of 1.14 years). The data collection tool was the ergonomics intervention program. The development of the program has gone through four successive phases: preparation, implementation, evaluation and follow-up phases. It consisted of (8) sessions as follows: an introductory session, (5) working sessions to cover both the theoretical and practical parts of the program, a closing session for evaluating the program and a final session for follow-up.

The evaluation of the program using both the quantitative (experimental), and the qualitative (Kirkpatrick model) approaches, and the follow-up test have confirmed the program effectiveness.

Keywords: Foggara · Al-Kayyal · Intervention program · Job competencies

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1 Introduction

Physically, the Foggara system consists of two main parts: First, the water obtaining part which consists of the main well, shafts used for maintenance and ventilation of the Foggara, and a tunnel of several kilometers in length, with a low slope that leads to the delivery of groundwater to the surface of the earth. Second, the water distribution part which consists of the Kasriya (the comb-shaped distributer of water to the beneficiaries participating in the water of the Foggara), the Saqiyah (channel that delivers water to beneficiaries), and the Majen (the basin in which the farmer collects the water carried by the channel for use when needed) [1].

The Kasriya is placed at the outlet of each Foggara. The intervals between its teeth are calculated so as to allow a certain amount of water to reach the beneficiary. The flow of the Foggara is constant in principle, so that each beneficiary receives the same amount of water at night as during the day. This amount is either used or stored in the Majen.

The Ministry of Culture in Algeria and the UNESCO are now keenly interested in the Foggara. In 2018, the job of Al-Kayyal was considered a great human heritage [2].

One of the main figures in the management of the Foggara system is the water measurer (Al-Kayyal). He is the person who calculates the amount of water that is given to any of the beneficiaries. Among his work activities are monitoring the amount of water that flows from Foggara, measuring the share of each beneficiary, designing the Kasriya, and checking the Saqiyah that transports water to beneficiaries as he makes sure that there is nothing obstructing the flow of water.

However, the job competencies (knowledge, skills, abilities, other things) that make Al-Kayyal successful on the job, are to have a basic knowledge of math, to maintain neat and accurate records, to be honest, sincere, intelligent, religious and ethical. If these competencies are available, Al-Kayyal does his job properly and efficiently accompanied by his assistant Al-Zammam (the book keeper).

Currently, most of the Al-Kayyals are elderly. They are hardly able to fulfill the demanding task of water measurement. For this reason, a number of Foggaras are having serious problems staying functioning in the absence of the Al-Kayyal, and finding replacement to fulfill his duties.

Researchers have warned of the shortage in the people doing the water measurement job. Remini, et al. [3] stated; “the scarcity of Al-Kayyal has become a thorny social problem”. Slimani, et al. [4] commended the role of Al-Kayyal in the continuation of the Foggara life, and stressed its importance.

The aim of the present research is to develop, implement, evaluate and follow-up an ergonomics intervention program to train young people to acquire the job competencies that enable them to perform the activities of Al-Kayyal efficiently.

2 Methodology

2.1 Method

Researchers used the mixed approach because they realized that using one approach (i.e., quantitative or qualitative) does not enable them to reach an accurate conclusion about the effectiveness of the intervention program used. The quantitative approach alone can show that the program is effective, but if the qualitative approach confirms this result, then researchers are reassured about the program’s effectiveness.

2.2 Sample

Due to the COVID-19 circumstances, and taking into consideration the principle of preventing large gatherings, researchers have chosen randomly five students who expressed a desire to learn the profession of Al-Kayyal. They were of mean age of 22.40 and standard deviation of 1.14 years. All belong to the department of socials sciences at Adrar University (Algeria). Subjects possessed superficial information about Al-Kayyal profession. None of them had previously practiced it.

2.3 Tool

The data collection tool used in this study was the ergonomics intervention program. Researchers developed, implemented, evaluated and followed-up the program.

First, the Development Phase. To have a successful intervention program, researchers identified the intervention needs, defined the intervention content, decided on the appropriate method for intervening and carried out the follow-up process. It is evident that an ergonomics intervention program has a better chance of success when trainees needs are identified, a good content is identified, and training methods are carefully selected [5].

Identifying the Intervention Needs. It was previously indicated that the sample subjects had never experienced the water measure job. Also, it was found that they were eager to learn this profession. To ascertain the existence of the need for training, the researcher (B.M.) conducted an interview with the sample members, whose questions focused on the profession of Al-Kayyal. The results indicated that the respondents lack water measuring skills, and would like to learn them.

Determining the Intervention Content. Researchers included in the intervention content a theoretical part, and a practical part.

The theoretical part consisted of information about the Foggara, its role in the Touat community, major components of Foggara (Wells, shafts, tunnel, Kasriya, Saqiyah, Majen), people necessary for the continuation of the course of the Foggara (Foggara Chair, Al-Kayyal, Al-Zammam), the tools required for the distribution of Foggara water.

As for the practical part, it included real-world applications about practicing the profession of Al-Kayyal. Initially, the applications took place in the lecture hall where the theoretical part was presented. Then, the practical work was completed in three real Foggaras, which are MataAllah Foggara, Abido Foggara, and Bukhari Foggara. All the three Foggaras are located in the department of Reggane in the state of Adrar (Algeria).

Deciding on the Appropriate Method for Intervening. It was found that the trainees lack theoretical and practical information about the Foggara and Al-Kayyal job. Therefore, the apprentice training method was used. Apprenticeship training consists of theoretical instructions and an on-the-job training at actual work place [6].The model of apprenticeship that was adopted in this research was the "young-person paradigm" according to Gonon, et al. [7]. In order to make the apprenticeship training of a good quality, ILO instructions were as much as possible followed [8].

After the program was developed, it had to be judged to see how good the development process was. To estimate the validity of the program, researchers used the content validation method. After completing its preparation, the program was handed over to a group of experts (Four engineers working in the National Observatory of Foggara in Adrar) to ensure the validity of the content. The four judges stated that the program content is consistent with what we know about the tasks that Al-Kayyal should normally perform. Accordingly, the program was considered valid. The validity rate has reached (100%). To assess the reliability of the program, **the inter-rater reliability method was used**. Two psychologists at the University of Adrar were requested to implement the program, at the same time, but in two different locations. At the end of the implementations, results were analyzed. It was found that rater (A) results confirm the results of rater (B), see Table 1.

Table 1. Inter-rater reliability.

Applications	Conformity level between raters (A&B)	% of agreement	Cohen's k	Interpretation
1st application in Tsabit (Algeria)	73 points from 100 points (60 points for theory, 40 for practice)	73	0.780	Substantial agreement
2nd application in Adrar (Algeria)	82 points from 100 points (60 points for theory, 40 for practice)	82	0.668	Substantial agreement

According to Landis, & Koch, [9], both results mean that agreement between the two raters is substantial. These results indicate that the program is sufficiently reliable.

Second, the Implementation Phase. First of all, it should be noted that the intervention program consisted of (08) sessions. Table 2 shows the sessions, the length and the content of each session.

Third, the Evaluation Phase. This phase consisted of one session with two types of evaluation. In the quantitative evaluation, researchers used the one-group method. Trainers are given a pre-exam, then training program, then a post-exam.

Fourth, the Follow-Up Phase. This phase consisted of one session. The follow-up session (the last session), took place after three weeks of closing the program. In this session the test that was used in the quantitative evaluation session was used.

Table 2. The session, the length and content of each session.

Session number	Nature of session	Session length (minutes)	Session content
1	Introductory session	90	After acquaintance, trainees were given an introduction to the intervention, program objectives, number of sessions, content of each session, training methods
2	Working session	90	Trainees were given an introduction to the Foggara, the challenges facing it, the efforts made to preserve it, and job analysis of Foggara team (the head of the Foggara, the technician, Al-Kayyal, Al-Zammam). The focus was on the Al-Kayyal job analysis
3	Working session	60	The trainees were presented with the ergonomics of equipment used by Al-Kayyal such as the Kasriya and water measuring instrument (Hallafa)
4	Working session	120	A visit was made to MataAllah Foggara (Reggane). Trainees were accompanied by the trainer and Al-kayyal (S.A.), to demonstrate and practice the water measurement process. At the Q and A session, Al-Kayyal asked various questions to the trainees to see how well they understood what they had witnessed
5	Working session	120	A visit was made to Abido Foggara (Reggane). Trainees were accompanied by the trainer and Al-Kayyal (H.B.), to test what the trainees learned in the previous session in the Foggara of MataAllah. Al-Kayyal chose two of the trainees who wanted to practice, and asked them (one before the other) to perform the water measurement using only virtual data
6	Working session	120	A visit was made to Bukhari Foggara (Reggane). Trainees were accompanied by the trainers, and Al-Kayyal (B.A.). Its goal was for every trainee to practice the job as water measurer. Al-Kayyal provided accurate feedback to each trainee on his application. At the end, the floor was open for discussion
7	Evaluation and closing	90	The training was evaluated. Researchers used two types of evaluation. The quantitative evaluation and the qualitative evaluation
8	Follow-up	60	Follow-up evaluation

3 Results

This research aimed at developing, implementing, evaluating and following-up an ergonomics intervention program to train young people to acquire the job competencies that enable them to do efficiently the work activities of Al-Kayyal.

In this part of the research, results related to the evaluation and follow-up of the program will be presented.

3.1 Results of the Evaluation of the Program

To identify the effectiveness of training, a quantitative comparison between the results of the pre-exam and the post-exam was carried out [10]. Results are depicted in Table 3.

In addition, researchers supported this with a qualitative approach represented in the Kirkpatrick model, which has four levels: (1) reaction, (2) learning, (3) behavior, and (4) results [11]. Results are depicted in Table 4.

3.2 Results of the Follow-Up of the Program

A comparison was made between the results of the quantitative evaluation (post-exam results) and the results of the follow-up evaluation. Results are tabulated in Table 5.

Table 3. Mann-Whitney results.

Group	Sum of ranks	Mean of ranks	Standard deviation	Mann-Whitney U test value	P-value	Decision
Post-measurement	15	3	1.58	0.00	0.01	The critical value of U at $p < .01$ is 0. Therefore, the result is significant at $p < .01$
Follow-up measurement	40	8	1.54			

Table 4. Kirkpatrick model results.

Model level	Results
Reaction	Trainees enjoyed the intervention
Learning	Trainees' knowledge, skills and attitudes towards water measurement have increased
Behavior	Trainees believe that their water measurement behavior has changed positively
Results	Trainees showed the intervention has impacted their personality, and society as a whole

Table 5. Mann-Whitney results

Group	Sum of ranks	Mean of ranks	Standard deviation	Mann-Whitney U test value	P-value	Decision
Post-measurement	40	8	1.54	0.00	0.01	The U-value is 11. The critical value of U at $p < .05$ is 2. Therefore, the result is not significant at $p < .05$
Follow-up measurement	26	5.2	3.17			

It can be seen from the results depicted in both Table 4 and 5 that the ergonomics intervention program is effective.

4 Discussion

After knowing that the ergonomics intervention program is effective, we can ask what led to its effectiveness. Here, we refer to some factors that we think are important.

First of all, the alignment of trainees and ergonomics intervention program goals [12]. According to Semler's systematic agreement theory of organizational alignment, if alignment between trainees and program goals is achieved, the organization can achieve greater individual and collective efficiency and effectiveness [13].

When it comes to the practical work, it has been found that having your trainees practice what they learn as much as possible, will lead to successful training program [14].

It was mentioned above that those selected to participate in the training process were students who wanted to learn the Al-Kayyal profession. Consequently, their enthusiasm and attendance of the training program sessions without delay or absence are indications that the trainees have positive attitudes towards training. The researchers indicated that positive attitudes towards training contribute to the success of training [15].

5 Conclusions

The field of work in the Foggara is in dire need of water measures. There are some Foggaras that do not have Al-Kayyal, which is a major issue to the beneficiaries. Consequently, the need to train new personnel to undertake the Al-Kayyal's task is becoming evident. In this case, the existence of Ergonomics Intervention Programs and competent trainers is necessary in order to achieve this goal. This research presented one of these interventions. The researchers built it and ensured its effectiveness.

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