AN OCCUPATIONAL SURVEY OF REFRIGERATION TECHNICIANS

Nurettin IŞIK
Gaziantep Üniversitesi İklimlendirme-Soğutma Programı
27310 Gaziantep/TURKEY
Tel: 342.360 1200 X. 4738 Fax: 342.360 11 70
e-mail:isik@gantep.edu.tr
Ayhan ONAT
K.S.Ü. İklimlendirme-Soğutma Programı
Kahramanmaraş/TURKEY
Tel: 344.225 9255
e mail: onat@ksu.edu.tr
Mahit GÜNEŞ
K.S.Ü Bilgisayar Programı
Kahramanmaraş/TURKEY
Tel. 0344. 236 5818
e-mail: mahit_gunes@hotmail.com

ABSTRACT

At this study of "Occupational survey of refrigeration technician" in which the "Task Inventory Questionnaires" have been developed, we aim at determining the vocational psychomotor competencies (skills) of refrigeration technician for effectively carrying out the occupational duties in labor-life.

For implementing that purpose, by means of job/task analysis, it has been determined some fundemental psychomotor competencies indicating what is done in labor-life for refrigeration technicians.

In the second phase of the study, it has been founded out the degrees of frequency, importance, and difficulty of those competencies determined for refrigeration technician by applying "Task Inventory Questionnaires" to selected technical personnel in refrigeration industry. In addition to determining these degrees, it also founded out the correlation between the calculated values of frequency, importance, and difficulty among the respondents.

In the light of the findings, at the third phase of the study, some recommendations were made for development of refrigeration technician education.

SOĞUTMA TEKNİSYENLİĞİ MESLEK ARAŞTIRMASI

ÖZET

İçinde "Meslek Envanteri Anketinin" de geliştirildiği "Soğutma Teknisyeni Meslek Araştırması" çalışması ile, soğutma teknisyeninin meslek yaşamında görevlerini etkin bir şekilde yapabilmesi için, gerekli psikomotor mesleki yeterlilikleri(becerileri) tespit etmeyi amaçlıyoruz.

Bu amacı gerçekleştirebilmek için, iş analizi yöntemleri kullanılarak, soğutma teknisyeninin iş yaşamında mesleki olarak hangi işlemleri yapacağını gösteren bazı temel mesleki beceriler tespit edilmiştir.

Çalışmanın ikinci aşamasında, soğutma teknisyeni için tespit edilen yeterliliklerin "Meslek Envanteri Anketinin" soğutma endüstrisinden seçilen örneklem grubuna uygulanması ile sıklık, önem, ve güçlük dereceleri bulunmuştur. Bu derecelerin bulunmasına ilaveten, yeterliliklerin katılımcılar tarafından de?erlendirilen sıklık, önem, ve güçlük dereceleri arasındaki korelasyonlar da hesaplanmıştır.

Bulguların ışığında, çalışmanın üçüncü aşamasında soğutma teknisyenliği eğitiminin geliştirilmesi için bazı önerilerde bulunulmuştur.

Purpose and Research Questions:

In order to prepare a realistic curriculum satisfying the existing job requirements, firstly, it should be determined what type of vocational competencies are needed. Related to this purpose, the answers of following questions were tried to seek out:

1. For an effective implementation of their occupational duties, what type of psychomotor competencies should refrigeration technicians have?
2. What is the usage frequency psychomotor competencies determined for refrigeration technicians in their occupational area?
3. For implementation of occupational duties, what are the degrees of importance of psychomotor competencies determined for refrigeration technicians in their occupational area?
4. What are the degrees of difficulty of psychomotor competencies determined for refrigeration technicians?

Limitations of the Study:

This study was carried out among a limited number of participants from the Refrigeration Industry because of financial restrictions.

Assumptions:

This study has been based on the following assumptions:

1. The answers given in the questionnaires by the respondents reflected their own, true evaluation related to the competencies.
2. There are no categorical deviations between the evaluations of respondents who participated in the survey from the refrigeration industry, whether as supervisors or workers.

Method:

Sampling: To ensure the participation in the research in Gaziantep, firstly, a link was established with the Professional Chamber of Refrigeration Artisans of Gaziantep. The purpose of the study was explained by the researcher to the executive board of the chamber. They were requested to ensure the participation of their members in the study. Eight randomly-selected technical personnel from four member companies of the Chamber formed a sample group of Gaziantep Industry. The other companies participating in the study were randomly selected through the "Sector Introduction Catalog" from a magazine called "Tesisat" which is published periodically. These selected companies were requested to participate in the study. Eight companies from Istanbul, three companies from Ankara, and two companies from Izmir, agreed to participate in the survey.

All the technical personnel in the sampling group were at least at the level of qualified workers.

Data Analysis:

50 Task Inventory Questionnaires were sent to the companies which agreed to participate in the study. 41 TIQ's out of a total 50 sent were mailed back. 5 questionnaires among the returned 41's were discarded and the remaining 36 questionnaires were evaluated.

In order to determine the participants' evaluations on the degrees of frequency, importance, and difficulty of each task statement, a TIQ format was developed. Participants were required to evaluate the task statements by scaling their degrees of frequency, importance, and difficulty.

In answering and evaluating the questions in the questionnaires, a four-degree scale was used. The scale was accepted as having equal intervals. The positive and negative ends of the scale were taken respectively as 4 and 1.

The answers given to the task statements were transferred to an electronic spread-

Figure 1. Sample Spreadsheet, used for processing the "TIQ's"

	DEGREE OF FREQUENCY								DEGREE OF IMPORTANCE								DEGREE OF DIFFICULTY								CORELATION		
	# OF PARTICIPANTS					Statistical Process			# OF PARTICIPANTS					Statistical Process			# OF PARTICIPANTS					Statistical Process			Statistical Process		
...e of ...eteney	1	2	3	.....	36	Sequence of means	mean (x)	St. Deviation	1	2	3	.....	36	Sequence of means	mean (x)	St. Deviation	1	2	3	.....	36	Sequence of means	mean (x)	St. Deviation	r_{FI}	r_{FD}	r_{ID}
...TENC... 1																											
...TENC... 2																											
...TENC... 3																											
.....																											
.....																											
.....																											
.....																											
.....																											
...ENC...																											

sheet on *Microsoft Excel 7* as shown in Fig. 1 means and standard deviations of answers given to each task statement by the respondents were calculated. Depending on the calculated values of the means for psychomotor competencies, a sequence number was given to all questions for the degree of frequency, importance and difficulty. The correlation between the degrees of frequency-importance ($r_{F\ I}$),frequency-difficulty ($r_{F\ D}$),and importance-difficulty ($r_{\ ID}$),for each question (task statement) was calculated in order to determine whether there is a connection between the degrees of frequency, importance and difficulty.

Table 1 DEGREES OF FREQUENCY, IMPORTANCE, AND DIFFICULTY FOR PSYCHOMOTOR COMPETENCIES WITH THE CORRELATION BETWEEN THEM

	VOCATIONAL SKILLS (psychomotor competencies)	Evaluation of psychomotor competencies											
		Degree of Frequency			Degree of Importance			Degree of Difficulty			Correlation		
		Sequence of Means	Mean (x)	St.Dev. (s)	Sequence of Means	Mean (x)	St.Dev. (s)	Sequence of Means	Mean (x)	St.Dev. (s)	r_{PI}	r_{FD}	r_{ID}
,1	Measure temperature.	9	2.722	.779	10	3.139	.683	31	1.444	.735	.505	.172	.329
,2	Measure pressure.	5	2.889	.854	11	3.111	.708	26	1.972	.810	.588	.161	.205
,3	Connect gauge manifold to refrigeration system.	6	2.833	.845	11	3.111	.747	24	2.028	.654	.663	.319	.461
,4	Cut tubing using approved methods on a refrigeration system.	10	2.694	.951	15	3.000	.717	22	2.083	.649	.670	.181	.184
,5	Bend tubing using approved methods on a refrigeration system.	14	2.583	.996	17	2.944	.715	21	2.111	.747	.713	.070	.119
,6	Swage tubing using approved methods on a refrigeration system.	11	2.667	.920	17	2.944	.791	20	2.139	.639	.676	.225	.298
,7	Flare tubing using approved methods on a refrigeration system.	11	2.667	.920	14	3.028	.774	25	2.000	.586	.731	.264	.189
,8	Demonstrate soldering and brazing techniques for copper tubing.	12	2.639	1.018	11	3.111	.747	20	2.139	.723	.542	.225	.341
,9	Demonstrate brazing techniques for steel tubing.	37	1.722	.701	33	2.361	.833	19	2.167	.737	.225	.258	.178
10	Measure length by ruler.	1	3.139	.867	11	3.111	.820	28	1.889	.667	.701	.324	.180
11	Measure by varnier caliper.	8	2.778	.866	10	2.972	.654	25	2.000	.670	.443	.293	.194
12	Repair cracks and leaks in evaporators.	24	2.306	.980	10	2.972	.845	15	2.278	.615	.459	.045	.180
13	Measure superheat.	15	2.556	.809	5	3.278	.741	7	2.528	.609	.164	.142	.236
14	Adjust superheat on a refrigeration system using TXV.	10	2.694	.856	11	3.111	.854	6	2.556	.735	.399	.090	.308
15	Install a capillary tube to a refrigeration system.	25	2.278	.882	10	2.972	.736	3	2.639	.593	.584	.088	.238
16	Install TXV to a refrigeration system.	15	2.556	.998	15	3.000	.793	19	2.167	.697	.578	.151	.207
17	Dismantle TXV from a refrigeration system.	21	2.389	.903	18	2.917	.776	21	2.111	.622	.541	.277	.258
18	Clean TXV being used on a refrigeration system.	22	2.361	.931	19	2.889	.820	15	2.278	.659	.466	.204	.376
19	Measure voltage.	5	2.889	.916	8	3.194	.786	24	2.028	.560	.505	.062	.052
20	Measure amperage.	4	2.944	.802	10	3.139	.798	30	1.806	.525	.572	.403	.066
21	Measure resistance.	6	2.833	.845	11	3.111	.785	28	1.889	.622	.546	.018	.026
22	Start a hermetic monophase compressor motor manually without using a relay.	32	2.056	.826	23	2.806	.749	21	2.111	.854	.526	.436	.213
23	Adjust the running range of a High Pressure Switch.	18	2.472	.910	17	2.944	.791	15	2.278	.566	.514	.237	.227
24	Adjust the running range of a Low Pressure Switch.	19	2.444	.843	17	2.944	.754	20	2.139	.593	.669	.216	.018
25	Adjust thermostat to a desired temperature.	5	2.889	.854	4	3.306	.710	26	1.972	.609	.623	.269	.020
26	Install High Pressure Switch to a refrigeration system.	14	2.583	.875	6	3.250	.770	2	2.722	.741	.626	.081	.275
27	Install Low Pressure Switch to a refrigeration system.	15	2.556	.909	7	3.222	.760	9	2.472	.810	.519	.177	.242
28	Install Oil Pressure Switch to a refrigeration system.	27	2.222	1.017	12	3.083	.906	1	2.778	.760	.599	.103	.235
29	Install thermostat to a refrigeration system.	9	2.722	.914	8	3.194	.749	19	2.167	.697	.373	.165	.040

Table 1 (Continued)

	VOCATIONAL SKILLS (psychomotor competencies)	Evaluation of psychomotor competencies											
		Degree of Frequency			Degree of Importance			Degree of Difficulty			Correlation		
		Sequence of Means	Mean (x)	St.Dev. (s)	Sequence of Means	Mean (x)	St.Dev. (s)	Sequence of Means	Mean (x)	St.Dev. (s)	r_{FI}	r_{FD}	r_{ID}
2,30	Test thermostat.	14	2.583	.906	9	3.167	.845	18	2.194	.525	.429	.115	.054
2,31	Install 4 way solenoid valve to a refrigeration system.	26	2.250	.906	18	2.917	.906	4	2.611	.766	.443	.309	.322
2,32	Detect leaks by leak dedecting devices.	7	2.806	.822	13	3.056	.826	26	1.972	.845	.606	.198	.08[illegible]
2,33	Charge correct amount of refrigerant to a refrigeration system.	2	3.000	.828	1	3.444	.735	6	2.556	.652	.470	.317	[illegible]
2,34	[illegible] refrigeration system.	27	2.222	.899	15	3.000	.894	7	2.528	.696	.249	.036	[illegible]
2,35	[illegible] ier on a refrigeration system.	21	2.389	.964	14	3.028	.878	20	2.139	.593	.527	103	[illegible]
2,36	[illegible] ant charge.	4	2.944	.754	10	3.139	.723	18	2.194	.467	.381	11[illegible]	[illegible]
2,37	Add [illegible] gration to a commercial refrigeration system.	18	2.472	.736	16	2.972	.654	19	2.167	.697	.265	.00[illegible]	[illegible]
2,38	Check oil level on a refrigeration system.	25	2.278	.815	20	2.889	.887	13	2.333	.793	.518	206	25[illegible]
2,39	Maintain a cooling tower.	35	1.944	.791	27	2.667	.828	13	2.333	.632	.538	.095	.218
2,40	Maintain condenser.	17	2.500	.910	14	3.028	.654	12	2.389	.599	.504	.052	.045
2,41	Install condensing units.	16	2.528	.878	11	3.111	.708	8	2.500	.507	.500	.160	.15[illegible]
2,42	Install evaporator to a refrigeration system.	11	2.667	.862	11	3.111	.785	9	2.472	.609	.690	.036	.240
2,43	Install tubing to a refrigeration system.	8	2.778	.898	7	3.222	.760	5	2.583	.649	.702	.082	.309
2,44	Test for leaks on a refrigeration system.	4	2.944	.860	3	3.333	.756	7	2.528	.56[illegible]	.776	.122	.315
2,45	Evacuate a refrigeration system.	3	2.972	.845	2	3.361	.683	11	2.417	.604	.712	.135	.249
2,46	Make initial start securely on a refrigeration system.	3	2.972	.774	6	3.250	.770	4	2.611	.645	.539	.207	.374
2,47	Service condensing units.	11	2.667	.793	16	2.972	.696	10	2.444	.607	.656	.139	.233
2,48	Remove refrigerant from a refrigeration system.	26	2.250	.770	16	2.972	.736	11	2.417	.692	.365	.013	.192
2,49	Remove service valves from a refrigeration system.	28	2.194	.822	29	2.611	.838	15	2.278	.659	.653	.056	.201
2,50	Remove compressor from a refrigeration system.	19	2.444	.809	21	2.889	.820	9	2.472	.774	.593	.020	.085
2,51	Install external drive compressors to a refrigeration system.	29	2.167	.971	31	2.500	.910	9	2.472	.560	.356	.061	.140
2,52	Service hermetic compressors.	31	2.111	.919	32	2.444	.809	12	2.389	.549	.624	.138	.179
2,53	Service condenser.	23	2.333	.862	26	2.722	.615	16	2.250	.604	.342	.220	.424
2,54	Repair receivers.	36	1.861	.762	31	2.500	.775	15	2.278	.513	.412	.028	.359
2,55	Install water cooled condensers to a refrigeration system.	30	2.139	.931	22	2.861	.683	11	2.417	.554	.391	.0510	.233
2,56	Service water valves.	35	1.944	.924	28	2.639	.833	7	2.528	.696	.678	.002	.338
2,57	Adjust water valves.	34	1.972	.910	28	2.639	.867	11	2.417	.604	.675	.022	.241
2,58	Service direct expansion evaporators.	25	2.278	.944	25	2.750	.841	14	2.306	.710	.666	.125	.084
2,59	Test TXV's.	27	2.222	.959	22	2.861	.833	5	2.583	.692	.504	.143	.343

Table 1 (Continued)

	VOCATIONAL SKILLS (psychomotor competencies)	Evaluation of psychomotor competencies											
		Degree of Frequency			Degree of Importance			Degree of Difficulty			Correlation		
		Sequence of Means	Mean (x)	St.Dev. (s)	Sequence of Means	Mean (x)	St.Dev. (s)	Sequence of Means	Mean (x)	St.Dev. (s)	r_{FI}	r_{FD}	r_{ID}
2,60	Install a plate type heat exchanger to a refrigeration system.	34	1.972	.878	28	2.639	.899	6	2.556	.735	.566	.069	.053
2,61	Install compressor to a refrigeration system.	11	2.667	.926	11	3.111	.854	17	2.222	.681	.554	.302	.055
2,62	Install overload-relay connection to hermetic monophase compressors.	12	2.639	.833	8	3.194	.710	7	2.528	.654	.508	.255	.019
2,63	Install electrical connections on 3 phase motor compressors.	7	2.806	.850	13	3.056	.754	4	2.611	.766	.770	.143	.038
2,64	Service selenoid valves.	22	2.361	.931	28	2.639	.833	14	2.306	.749	.689	.411	.228
2,65	Check the continuity on electric circuits of a refrigeration system by using ohmmeter.	7	2.806	.920	11	3.111	.854	21	2.111	.820	.610	.181	.104
2,66	Identify terminals of a hermetic monophase compressor by using an ohmmeter across the compressor terminals.	11	2.667	.793	12	3.083	.841	15	2.278	.566	.343	.021	.010
2,67	Check the capacitors.	29	2.167	.878	23	2.806	.822	13	2.333	.717	.165	.318	.356
2,68	Check the compressor amperage while running.	9	2.722	.944	13	3.056	.826	14	2.306	.624	.679	.148	.022
2,69	Service evaporator fan motors.	13	2.611	.871	18	2.917	.841	18	2.194	.525	.657	.170	.232
2,70	Service condenser fan motors.	16	2.528	.810	24	2.778	.797	21	2.111	.622	.585	.050	.051
2,71	Install the components of a hot gas defrost system.	27	2.222	.832	24	2.778	.760	9	2.472	.736	.532	.057	.142
2,72	Install the components of an electric defrost system.	23	2.333	.793	23	2.806	.749	7	2.528	.774	.401	.124	.083
2,73	Install window air conditioner.	33	2.028	1.055	27	2.667	.894	23	2.056	.715	.404	.149	.119
2,74	Install a split type air conditioner.	34	1.972	1.000	28	2.639	.867	19	2.167	.845	.450	.039	.084
2,75	Service window type air conditioner.	35	1.944	.984	29	2.611	.803	22	2.083	.732	.442	.086	.154
2,76	Service a split type air conditioner.	36	1.861	.990	30	2.528	.878	17	2.222	.866	.580	.070	.180
2,77	Properly connect all the electrical components of a domestic refrigerator.	35	1.944	1.040	29	2.611	.803	19	2.167	.845	.418	.206	.014
2,78	Troubleshoot frost problems on evaporators.	21	2.389	.766	22	2.861	.639	8	2.500	.655	.172	.114	.239
2,79	Troubleshoot a lack of capacity on evaporators.	20	2.417	.806	22	2.861	.683	7	2.528	.560	.212	.069	.048
2,80	Clean evaporator surface.	15	2.556	.909	22	2.861	.723	24	2.028	.609	.425	.281	.009
2,81	Clean condenser surface.	13	2.611	.903	17	2.944	.791	29	1.861	.639	.529	.349	.210
2,82	Straighten fins.	20	2.417	.937	18	2.917	.770	27	1.917	.604	.406	.265	.108

Degrees of frequency, importance, and difficulty for psychomotor competencies

In Table 1, the calculated values of means, and standard deviations for psychomotor competencies are tabulated. In this table, a sequence number was also given for each psychomotor competency depending on the values of their calculated means. In the last three columns of the table, the correlations between the degrees of frequency-importance ($r_{F\ I}$), frequency-difficulty ($r_{F\ D}$), and importance-difficulty (r_{ID}) were given for each psychomotor competency.

Conclusion:

1. The number of psychomotor competencies (skills) related to the refrigeration technician as determined through job analysis are 82. There is a consensus on the issue by specialists in the refrigeration sector, that the refrigeration technician should have these skills.

2. The calculated means of the degrees of frequency for psychomotor competencies vary between 3.139 and 1.722. According to the calculated means, the psychomotor competency "Measure by ruler." is the competency most frequently needed by refrigeration technicians. This competency is followed by the psychomotor competencies "Charge correct amount of refrigerant to refrigeration system.", "Test for leaks on a refrigeration system." and "Evacuate a refrigeration system."

3. The calculated means of the degrees of importance for psychomotor competencies vary between the values of 3.444 and 2.361. The psychomotor competency "Charge correct amount of refrigerant to a refrigeration system." is regarded as the most important by the respondents. Following this competency, "Evacuate a refrigeration system." and "Test for leaks on a refrigeration system." are regarded as the second and third most important psychomotor competencies by the respondents. These three competencies were regarded by the respondents as the second, third, and fourth most frequently needed competencies respectively. Therefore, these three competencies ; "Charge correct amount of refrigerant to a refrigeration system.", "Evacuate a refrigeration system." and "Test for leaks on a refrigeration system." appear to be among the basic fundamental tasks for refrigeration technicians.

4. The calculated means of the degrees of difficulty for psychomotor competencies vary between the values of 2.778 and 1.444. The psychomotor competency "Install oil pressure switch to a refrigeration system." is evaluated as close to the "Fairly" hard degree of difficulty. Besides this, the psychomotor competency "Measure temperature." is evaluated on a difficulty level close to "very little".

5. There is a positive correlation for psychomotor competencies between the degrees of frequency, importance, and difficulty.

Recommendations:

As a result of the findings of the research, the following recommendations have been suggested:

1. Another surveys aiming at determining vocational knowledge and occupational habits should be executed in order to clerify the whole competencies that refrigeration technicians should have
2. Task inventories related to specific applications of refrigeration technology should be prepared through job analysis techniques.
3. For a higher validity, task inventories for refrigeration technicians should be based on a nation-wide survey throughout Turkey.
4. Educational programs on refrigeration technology should be developed in a manner that satisfies the task requirements in the refrigeration industry.
5. Skill exams for refrigeration technicians should be designed according to job analysis.
6. Occupations related to refrigeration technology should be accredited at a national level, and modular programs appropriate to each level of occupation should be developed through job analysis.

REFERENCES

Ammerman, Harry L. Performance Content for Job Training Vol.2: Stating the tasks of the job. The Center fof Vocational Education. The Ohio State University, Columbus, Ohio (1977)

Dipova, M.; Bulgurcu, H.; Işık, N.; Hoşöz, M. & Bulut B. İklimlendirme-Soğutma Teknikerliği Öğretim Programı Dökümanı. YÖK/Endüstriyel Okullar Proje Başkanlığı. Ankara (1995)

Doğan, Hıfzı. Ülkemizde Endüstrileşme ve Teknik Eğitim. Ankara Üniversitesi Eğitim Fakültesi Yayınları No 64. A.Ü. Basımevi. Ankara. (1977)

Işık Nurettin. An Occupational Survey Of Refrigeration Technicians. Unpublished M.A Thesis in Educational Sciences. University of Gaziantep Institute of Social Sciences. Gaziantep. (1998)

Sezgin İlhan. Mesleki ve Teknik Eğitimde Program Geliştirme. Gazi Büro Kitabevi. Ankara. (1996)

Sezgin İlhan. Elektrik Ark Kaynakçılığı Araştırması. M.E.B. Mesleki ve Teknik Eğitim Araştırma ve Geliştirme Merkezi (METARGEM) Başkanlığı. Yayın No.5, Milli Eğitim Basımevi. Ankara. (1996)

Skindle, D. John. The Premise and Limitations of Competency Based Instruction In Ketty B. Greenwood (Ed.) Contemporary Challenges for Vocational Education p. 197. American Vocational Association. Arlington, Virginia. (1981)