AN OCCUPATIONAL SURVEY OF REFRIGERATION TECHNICIANS AIMING AT DETERMINING PSYCHOMOTOR COMPETENCIES IN TURKISH VOCATIONAL HIGHER EDUCATION SYSTEM

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ABSTRACT

In this study of "Occupational Survey of Refrigeration Technicians" in which the "Task Inventory Questionnaires" have been developed, we aim at determining the vocational psychomotor competencies (skills) of refrigeration technicians for effectively carrying out the occupational duties in labor-life. In the first phase of the study, for implementing that purpose, by means of job/task analysis, it has been determined some fundamental 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 these competencies determined for refrigeration technicians 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, in the third phase of the study, some recommendations were made for development of refrigeration technician education.

Key words: Occupational survey, psychomotor, refrigeration technicians, vocational, education.

INTRODUCTION

People spend most of their adult life in an activity we call work. If "work" is a reality of our life, then it should be an integral part of our total education system. Widely speaking, Vocational Technical Education (VTE) is a process providing an adoption between work and the individual (Sezgin, 1996 ; 293). There is no doubt that to equip individuals with qualifications assisting them in becoming more employable is one of the fundamental objectives of VTE. 'Satisfactory completion of curriculum should result in the competencies for employment at entry -or higher - level positions in the field of the study' (Larson,1972; 109). 'The matching of vocational programs with appropriate manpower needs always has been a major challenge. Such a system, properly functioning, reflects the delivery of youth and adults ready and willing to take existing jobs' (Schaefer & Law, 1973; 1305).

What type of vocational competencies and attitudes should the individual have in order to execute his job effectively? In order to give a correct answer to this question, the job should be separated into learnable components. According to Skindle (1981; 197) competencies are expressed in terms of specific activities that a person performs in an occupation. They indicate what a person is able to accomplish. A competency is a skill (or a group of skills) which must be mastered at minimal levels of performance prior to employment in an entry-level position with the world of work.

It is widely accepted that the process of separating the job into the learnable segments is referred to as "job/task analysis". The reliability of job analysis, which is one of the most important inputs of curriculum constructing process, depends on the evaluation of the competencies revealed in the job analysis by the staff being employed in the industry. In this study, firstly, by use of the job-analysis method, a number of psychomotor competencies for refrigeration technicians have been obtained. Then, these competencies have been evaluated for their degrees of frequency, importance, and difficulty by the selected group of technical staff being employed in the refrigeration industry. This research aims at improving and testing the validity of the competencies in the curriculums being applied in the programs of Air Conditioning and Refrigeration at Vocational Higher Schools conducted by the Technician Training Project in Turkey.

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.

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 of 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

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.

Respondents' background

The background of respondents based on their ages, the vocational institutions from which they graduated, their vocational seniority, and professional status, with the size of enterprise and activity area in which they work, are below tabulated.

Table 1. Distribution of respondents' ages

AGE/YEAR	f	%
25 and younger	1	2.78
26-30	13	36.11
31-35	11	30.56
36-40	7	19.44
41 and above	4	11.11
TOTAL	36	100

Table 2. Distribution of Vocational Institutions which the respondents graduated from

GRADUATED VOCATIONAL INSTITUTIONS	f	%
Technical and Vocational High School	11	30.56
Vocational School of Higher Education	12	33.33
Center For Apprenticeship Education	4	11.11
Other	9	25
TOTAL	36	100

Table 3. Distribution of respondents' vocational seniority

VOCATIONAL SENIORITY/YEAR	f	%
Less than 5 years	2	5.56
5-9 years	12	33.33
10-14 years	13	36.11
15-19 years	3	8.33
20 years and above	6	16.67
TOTAL	36	100

Table 4. Distribution of the number of the employees in the enterprises in which respondents work

NUMBER OF THE EMPLOYEES	f	%
9 and less employees	8	22.22
10-19 employees	7	19.44
20-29 employees	1	2.78
30-49 employees	5	13.89
50 and above employees	15	41.67
TOTAL	36	100

Table 5. Distribution of the activity area of the enterprises in which respondents work

ENTERPRISES' ACTIVITY AREA	f	%
Service	4	11.11
Manufacturer	27	75
Other	5	13.89
TOTAL	36	100

Table 6. Distribution of respondents' professional status in participating companies

DUTIES	f	%
Owner of the company	7	19.44
Higher Technician	12	33.33
Foreman	2	5.56
Technician	10	27.78
Qualified worker	1	2.78
Other	4	11.11
TOTAL	36	100

Conclusions on the background of the respondents

1. About 50 % of the respondents are in the 30-40 age group, that is to say, they are in the most active period of their working life.
2. It is observed that 63.89 % of the respondents have a vocational education at least to high school level.
3. It can be concluded that the respondents have enough vocational experience to evaluate the degrees of frequency, importance, and difficulty of the task statements in TIQ's.
4. 58.33 % of the respondents are working in enterprises which have 49 or fewer employees. 41.67 % of the respondents are working in enterprises which have 50 or more employees. It can be concluded that big and small scaled enterprises are represented in nearly equal members in the survey.
5. The majority of the respondents are from manufacturing and service areas.
6. 61.11 % of the respondents are technicians and higher technicians.

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 spreadsheet on *Microsoft Excel*. 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 each group of competency, a sequence number was given to all questions for the degree of frequency, importance and difficulty. The correlation between the degrees of frequency-importance ($\mathbf{r}_{F\ I}$), frequency-difficulty ($\mathbf{r}_{F\ D}$), and importance-difficulty ($\mathbf{r}_{ID}$), for each

question (task statement) was calculated in order to determine whether there is a connection between the degrees of frequency, importance and difficulty.

RESULTS AND DISCUSSION

Degrees of frequency, importance, and difficulty for psychomotor competencies

In Table 7, 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 ($\mathbf{r}_{FI}$), frequency-difficulty ($\mathbf{r}_{FD}$), and importance-difficulty ($\mathbf{r_{ID}}$) were given for each psychomotor competency.

Degrees of frequency for psychomotor competencies

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 most frequently executed competency for 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." The standard deviations of evaluations for the degrees of frequency of psychomotor competencies vary between 1.055 and 0.701.

Degrees of importance for psychomotor competencies

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, the psychomotor competencies "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 by the respondents were taken regarded respectively as second, third, and fourth most frequently executed competencies. 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 fundamental tasks for refrigeration technicians. The standard deviations of evaluations for the degrees of importance of psychomotor competencies vary between 0.910 and 0.615. The psychomotor competency "Service condensers." has the minimum standard deviation, while "Install external drive compressors." has the maximum standard deviation among all the psychomotor competencies.

Degrees of difficulty for psychomotor competencies

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 at the "Fairly" hard degree of difficulty. Besides this,"Measure temperature." psychomotor competency is evaluated on a difficulty level close to "very little" difficulty.

Table 7. 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		
		Seq.of Means	Mean (x)	St.Dev. (s)	Seq.of Means	Mean (x)	St.Dev. (s)	Seq.of Means	Mean (x)	St.Dev. (s)	r_{FI}	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	.906	17	2.944	.715	21	2.111	.747	.713	.070	.119
6	Swage tubing using approved methods on a refrigeration system.	11	2.667	.926	17	2.944	.791	20	2.139	.639	.676	.225	.298
7	Flare tubing using approved methods on a refrigeration system.	11	2.667	.926	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	16	2.972	.654	25	2.000	.676	.443	.293	.194
12	Repair cracks and leaks in evaporators.	24	2.306	.980	16	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	.096	.308
15	Install a capillary tube to a refrigeration system.	25	2.278	.882	16	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	.770	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	.919	8	3.194	.786	24	2.028	.560	.505	.062	.052
20	Measure amperage.	4	2.944	.893	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	.874	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	.046
30	Test thermostat.	14	2.583	.906	9	3.167	.845	18	2.194	.525	.429	.115	.054
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
32	Detect leaks by leak detecting devices.	7	2.806	.822	13	3.056	.826	26	1.972	.845	.606	.198	.084
33	Charge correct amount of refrigerant to a refrigeration system.	2	3.000	.828	1	3.444	.735	6	2.556	.652	.470	.317	.245
34	Add oil to a refrigeration system.	27	2.222	.898	15	3.000	.894	7	2.528	.696	.249	.036	.138
35	Replace filter-drier on a refrigeration system.	21	2.389	.964	14	3.028	.878	20	2.139	.593	.527	.103	.267
36	Check refrigerant charge.	4	2.944	.754	10	3.139	.723	18	2.194	.467	.381	.113	.171
37	Add refrigeration to a commercial refrigeration system.	18	2.472	.736	16	2.972	.654	19	2.167	.697	.265	.009	.136
38	Check oil level on a refrigeration system.	25	2.278	.815	20	2.889	.887	13	2.333	.793	.518	.206	.257
39	Maintain a cooling tower.	35	1.944	.791	27	2.667	.828	13	2.333	.632	.538	.095	.218
40	Maintain condenser.	17	2.500	.910	14	3.028	.654	12	2.389	.599	.504	.052	.045
41	Install condensing units.	16	2.528	.878	11	3.111	.708	8	2.500	.507	.500	.160	.159
42	Install evaporator to a refrigeration system.	11	2.667	.862	11	3.111	.785	9	2.472	.609	.690	.036	.246
43	Install tubing to a refrigeration system.	8	2.778	.898	7	3.222	.760	5	2.583	.649	.702	.082	.309
44	Test for leaks on a refrigeration system.	4	2.944	.860	3	3.333	.756	7	2.528	.56	.776	.122	.315
45	Evacuate a refrigeration system.	3	2.972	.845	2	3.361	.683	11	2.417	.604	.712	.135	.249
46	Make initial start securely on a refrigeration system.	3	2.972	.774	6	3.250	.770	4	2.611	.645	.539	.207	.374

47	Service condensing units.	11	2.667	.793	16	2.972	.696	10	2.444	.607	.656	.139	.233
48	Remove refrigerant from a refrigeration system.	26	2.250	.770	16	2.972	.736	11	2.417	.692	.365	.013	.192
49	Remove service valves from a refrigeration system.	28	2.194	.822	29	2.611	.838	15	2.278	.659	.653	.056	.201
50	Remove compressor from a refrigeration system.	19	2.444	.809	21	2.889	.820	9	2.472	.774	.593	.020	.085
51	Install external drive compressors to a refrigeration system.	29	2.167	.971	31	2.500	.910	9	2.472	.560	.356	.061	.140
52	Service hermetic compressors.	31	2.111	.919	32	2.444	.809	12	2.389	.549	.624	.138	.179
53	Service condenser.	23	2.333	.862	26	2.722	.615	16	2.250	.604	.342	.220	.424
54	Repair receivers.	36	1.861	.762	31	2.500	.775	15	2.278	.513	.412	.028	.359
55	Install water cooled condensers to a refrigeration system.	30	2.139	.931	22	2.861	.683	11	2.417	.554	.391	.0510	.233
56	Service water valves.	35	1.944	.924	28	2.639	.833	7	2.528	.696	.678	.002	.338
57	Adjust water valves.	34	1.972	.910	28	2.639	.867	11	2.417	.604	.675	.022	.241
58	Service direct expansion evaporators.	25	2.278	.944	25	2.750	.841	14	2.306	.710	.666	.125	.084
59	Test TXV's.	27	2.222	.959	22	2.861	.833	5	2.583	.692	.504	.143	.343
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
61	Install compressor to a refrigeration system.	11	2.667	.926	11	3.111	.854	17	2.222	.681	.554	.302	.055
62	Install overload-relay connection to hermetic monophase compressors.	12	2.639	.833	8	3.194	.710	7	2.528	.654	.508	.255	.019
63	Install electrical connections on 3 phase motor compressors.	7	2.806	.856	13	3.056	.754	4	2.611	.766	.770	.143	.038
64	Service solenoid valves.	22	2.361	.931	28	2.639	.833	14	2.306	.749	.689	.411	.228
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
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
67	Check the capacitors.	29	2.167	.878	23	2.806	.822	13	2.333	.717	.165	.318	.356
68	Check the compressor amperage while running.	9	2.722	.944	13	3.056	.826	14	2.306	.624	.679	.148	.022
69	Service evaporator fan motors.	13	2.611	.871	18	2.917	.841	18	2.194	.525	.657	.170	.232
70	Service condenser fan motors.	16	2.528	.810	24	2.778	.797	21	2.111	.622	.585	.050	.051
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
72	Install the components of an electric defrost system.	23	2.333	.793	23	2.806	.749	7	2.528	.774	.401	.124	.083
73	Install window air conditioner.	33	2.028	1.055	27	2.667	.894	23	2.056	.715	.404	.149	.119
74	Install a split type air conditioner.	34	1.972	1.000	28	2.639	.867	19	2.167	.845	.450	.039	.084
75	Service window type air conditioner.	35	1.944	.984	29	2.611	.803	22	2.083	.732	.442	.086	.154
76	Service a split type air conditioner.	36	1.861	.990	30	2.528	.878	17	2.222	.866	.580	.070	.180
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
78	Troubleshoot frost problems on evaporators.	21	2.389	.766	22	2.861	.639	8	2.500	.655	.172	.114	.239
79	Troubleshoot a lack of capacity on evaporators.	20	2.417	.806	22	2.861	.683	7	2.528	.560	.212	.069	.048
80	Clean evaporator surface.	15	2.556	.909	22	2.861	.723	24	2.028	.609	.425	.281	.009
81	Clean condenser surface.	13	2.611	.903	17	2.944	.791	29	1.861	.639	.529	.349	.210
82	Straighten fins.	20	2.417	.937	18	2.917	.770	27	1.917	.604	.406	.265	.108

CONCLUSION

The results obtained from the survey are:

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. Task inventories related to specific applications of refrigeration technology should be prepared through job analysis techniques.

2. For a higher validity, task inventories for refrigeration technicians should be based on a nation-wide survey throughout Turkey.

3. Educational programs on refrigeration technology should be developed in a manner that satisfies the task requirements in the refrigeration industry.

4. Skill exams for refrigeration technicians should be designed according to job analysis.

5. 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.

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