Development of Fire Educational Systems by Specific Core Competency Indicators based on the Career Progression Management of Fire Departments

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***Abstract*—** *Firefighting work is one of the most urgent, dangerous, and high stress types of government work. Due to state policies and financial limitations, the few new firefighting personnel in Taiwan each year have resulted in a substantial shortage in firefighting personnel.*

The hierarchical analysis method and structural equation modeling were employed to build Taiwan's entry-level firefighting personnel competency indicators. These indicators can be incorporated into the oral and written test-oriented state examination given by the Ministry of Examination or adopted by the government authority for Education and training, in order to enhance the effectiveness of screening and to recruit well-qualified personnel that meet the expectation of society.

The present study established a set of core competency indicators covering seven constructs, which in turn contain 46 factors in total. The experts ranked the importance of the seven constructs from high to low as follows: professional firefighting knowledge, firefighting work skills, fire engine and equipment operation, self-management, firefighter physical fitness, firefighting practical experience, and interpersonal skills.

Keywords*— *Firefighting Education, Core competencies, firefighting personnel competency, Structural equation model.

I. INTRODUCTION

Firefighters are responsible for public fire prevention, firefighting, disaster rescue, building safety maintenance, emergency medical service, and serving the public. They are the guardians of public safety and are firefighting heroes, meaning their interaction with the public is intense and frequent. Due to the limited manpower and frequent extreme weather-induced disasters in Taiwan, the frontline entry-level firefighting personnel are loaded with assorted tasks. Firefighting is a stressful job because of the dangerous and unpredictable nature of the work. As a result, the key objective of this study is to construct firefighting personnel core competency indicators for effective firefighting personnel Education and Training.

In 2015, there were a total of 12,264 firefighting personnel, including 919 new firefighting personnel recruited from the Level 3 state police examination (Level 3 for short) and Level 4 state police examination (Level 4 for short). In 2015, the Central Police University admitted 50 new firefighting police students, while the Taiwan Police Academy (Police Academy for short) admitted 449 firefighting students. According to the above figures, the firefighting organization is relatively a large system in Taiwan's public sector. Firefighting is a unique public sector because it is highly physically demanding, pressed for time, dangerous, and brings lots of work stress. It is therefore important to discuss the positive and negative types of personality traits and work attitudes, as well as the specific core competencies required for firefighting personnel to perform their job well. Therefore, the Ministry of Examination and the Ministry of Education, when selecting new firefighting personnel, should take the unique core competencies and provide appropriate training for personnel to meet the needs of firefighting agencies and the expectations of the general public.

Based on the above concerns, the present study reviewed both domestic as well as foreign studies related to the competencies of firefighting personnel in drawing up the required competencies.

Competencies are motivation, beliefs, values, knowledge, attitudes, and skills that are closely related to work performance. Competencies can be assessed by accepted criteria, and they belong to the employees' personal potentials that allow them to complete their work and products to expected quality. Ralelin and Cooledge (1995) [1] stressed that competencies are

associated with sensitivity, creativity, instinct, and other hard-to-observe personal attributes. Learning and relearning, an organic type of capability, are also part of the competencies. The terms "competency" and "competence" are defined as follows according to McClelland (1973) [2], Funk & Wagnalls Company (1917) [3], and Hsu and Cheng (2002) [4].

1. The condition and capability to perform the job.
2. Adequate means, sufficient.
3. Legal qualification (accepted).

According to the ideas proposed by researchers, the following are personal competencies:

1. Competencies can be divided into the personal mental state and the external knowledge and skills.
2. Competencies include unlearned (innate) and learned (acquired) parts.
3. Competencies vary by age, stage, job rank, and environment.
4. Competencies in general are associated with three aspects self-management, people, and work.

Taken together, this study considers that competencies comprise of motives, traits, self-concepts, knowledge, and skills, and that competencies are strongly associated with an individual's knowledge, techniques, capabilities, and traits. To objectively predict and understand the performance of an individual, one should employ an effective evaluation scheme to distinguish good and bad performance.

Among all competency-related theories and definitions, the most well-known competency theory is one proposed by Lyle M. Spencer and Signe M. Spencer [5] based on Sigmund Freud's iceberg model. According to Spencer & Spencer (1993), competencies are the sum of the explicit and implicit traits of an individual. See diagram below

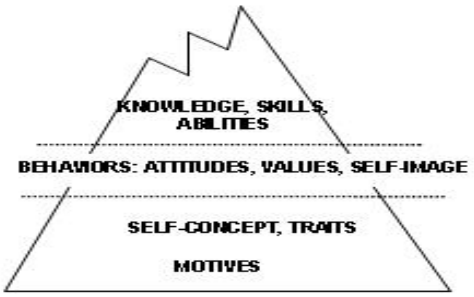

FIGURE 1. ICEBERG MODEL
Source: Competency Conceptualization (Spencer & Spencer, 1993)

Skills and knowledge are the explicit part, and they can be improved by training. As for self-concepts, motives, and traits, they are the implicit traits of an individual, i.e., at the bottom of the iceberg. These are harder to be explored and improved upon.

The term core competence was first proposed by Prahalad & Hamel in 1990 [6]. They suggested that core competence is the total of the individual skills and expertise of each organization member that are used to provide service with specific effect and value. Core competence is also referred to as an integration of knowledge, skills, and ability (KSAs).

Chang (2006) [7] proposed the following core competencies of entry-level police officers based on Taiwan's police education. See below:

1) **Good sense of morality:** It is important to have a perfect personality inside and out, practice what one preaches and be trustworthy.
2) **Correct values:** Includes self-growth, morality, work ethics, and organizational commitment.
3) **Good work attitude:** It is important to have good emotional management and a clear work target. Be humble, friendly, passionate, and enthusiastic.
4) **Good confidence:** It is critical to possess life experience, knowledge, and social skills.

5) **Sense of honor:** It is important to be willing to sacrifice oneself for the public, be introspective, have a strong sense of honor, value one's job, and know one's duty and what is right and wrong.

6) **Responsibility:** It is important to have a good sense of responsibility and perform one's job well.

7) **Extensive professional knowledge:** It is important to possess official document handling capability, English language skills, legal knowledge, information skills, basic knowledge for performing police duties, and police-related professional knowledge.

8) **Professional skills:** It is important to be good at judo, wrestling, criminal arresting techniques, grappling, fencing, taekwondo, shooting, and combat skills.

It was found that the professional knowledge and skills related to fire prevention, fire rescue, disaster prevention and fire investigation displayed by firefighting personnel, vary depending on the agency or department that they belong to. To determine the core competencies of entry-level firefighters in Taiwan, the present study examined and summarized available domestic and foreign studies on capabilities and characteristics required by entry-level firefighting personnel. The result is presented in Table 1. There are especially more capability oriented competencies, and the competencies were divided into three classes according to their attributes: self-management, relationship management, and knowledge and capability. Each class contains various personal professional competencies that fit into the class. As for the competency model for each type of firefighting organization, the content was adjusted according to the nature of the job.

TABLE 1
PROFESSIONAL COMPETENCIES OF PERSONAL CAPABILITIES/TRAITS REQUIRED BY ENTRY-LEVEL FIREFIGHTING PERSONNEL

Professional competencies required by entry-level firefighting personnel (Capabilities and traits dimension)	Capability	Self-management	Independent operation, introspection, work management, executive power, awareness of risk and safety, adaptability, adaptability to change, crisis handling, and continual learning
		Relationship management	Understanding the importance of interpersonal interaction, good at public interaction, communication and coordination, team collaboration, conflict resolution, negotiation, and persuasion and influencing skills
		Knowledge and skills	Innovative thinking, critical thinking, decision making, problem-solving, conceptual thinking, information searching, expression skills, and mathematical knowledge and skills
	Traits and attitude dimension	Motive for achievement, active and initiative, caring and empathetic, friendly, honest and righteous, serious and has a good sense of responsibility, stress coping, emotion stability, persistence and endurance	

(Source: Prepared by the study)

A questionnaire was then designed and incorporated as a reference as well as a basis for this study. The present study also set up the competency classes and competencies under each class of firefighting personnel in Taiwan. Hierarchical analysis was employed to assess how each competency is associated with others and their importance, in order to determine the relationships between professional firefighting competencies. Social science statistical analysis and structural equation analysis were performed on the firefighting personnel's work performance and implicit competency inventory for determining the correlation between the two. Findings from this study on firefighting personnel education and training can be referred to for the examination, education, and training of firefighting personnel in Taiwan in the future.

1.1 Research Scope and Limitations

The main objective of this study is to discuss frontline firefighting personnel competencies. The present study has the following scope and limitations due to time, region, and manpower resources of the present study:

1. The study subjects here were firefighting personnel selected and employed by firefighting agencies of all levels according to the criteria. The following were excluded: transferred firefighting personnel for technical purposes, firefighting personnel who had passed the junior and senior civil service examinations, volunteer firefighting personnel, firefighting substitute servicemen, and other contract personnel.
2. There are many firefighting personnel competencies, but because of limited time and resources, the present study only examined firefighting work of frontline, field-based firefighting personnel. Other firefighting personnel working in the command center and office-based firefighting personnel were not discussed in this study.
3. The expert questionnaire of this study was distributed in firefighting offices that have long working hours (two days working and one day off without compensatory days off) and a large number of firefighting personnel (2,224.6 people).
4. This study adopted a random questionnaire survey approach. Not all firefighting personnel were surveyed.

II. METHOD

2.1 Research Framework

To take both data accuracy and available time into consideration, the present study adopted a pluralistic approach to build its model. That is, the researchers of this study carried out direct interviews, questionnaire surveys, and focus group workshops to build a competency model. Results from the literature review are summarized in the conceptual framework below.

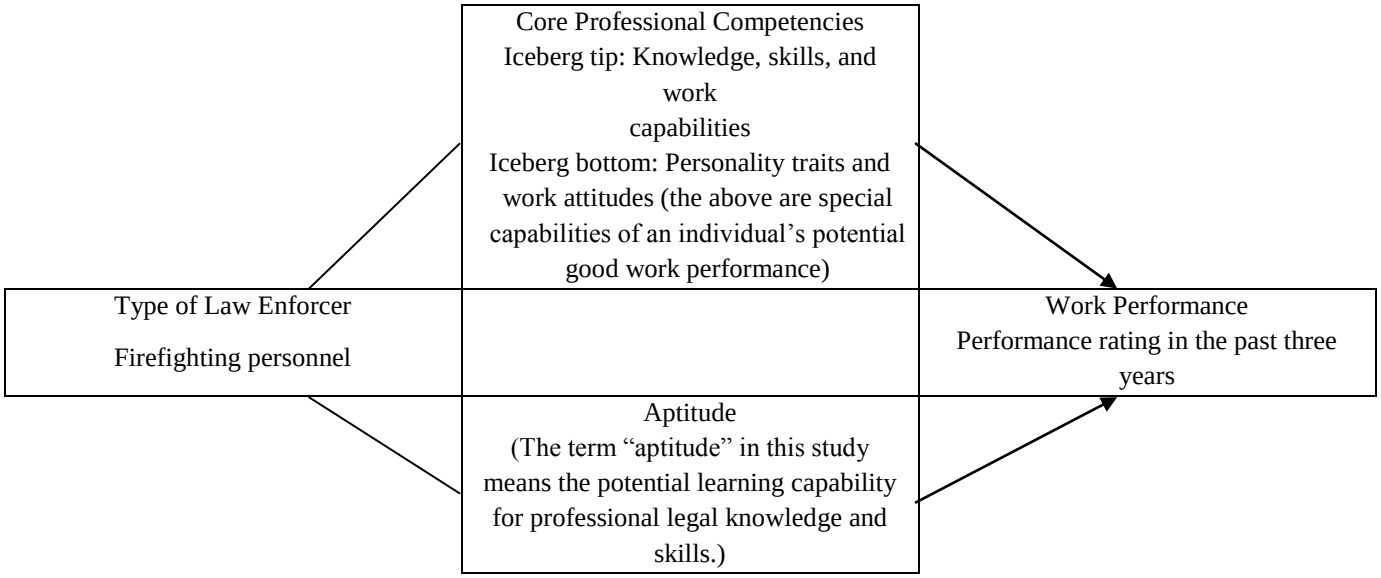

FIGURE 2. RESEARCH CONCEPTUAL FRAMEWORK
(Source: Prepared by the study)

The above diagram Figure 2. shows that firefighting personnel should be equipped with 1) knowledge, skills, and aptitude, 2) core competencies, 3) work attitudes, positive personality traits, and other personality traits; 4) lack of unsuitable negative personality traits, and 5) core competencies and personality traits that may have a significant effect and predictability on work performance and the competency appraisal results given by the management.

2.2 Research methodology overview

This study structuralized, defined, analyzed, and validated the competencies using a literature review, expert questionnaire, analytic hierarchical process (AHP), statistical analysis for social science, and structure equation modeling (SEM). The competency indicators related to the research framework are described below.

2.2.1 Initial Source of Implicit Competency Indicators

TABLE 2
INITIAL SOURCE OF FIREFIGHTERS' IMPLICIT COMPETENCY INDICATORS

Researchers	Spencer & Spencer (1993)	Wu (1999)	Lin (2001)	Taipei City Civil Servant Training Center (2004)	Li (2006)	Occupational Information Network. (2011)	The present study
Research targets	Technical/ professional personnel	High-tech industry engineers and other professionals	High-tech industry engineers and other professionals	Entry-level capabilities (for non-management, junior rank of Level 7 or below)	Head of police agencies and police stations	Municipal Fire Fighters	Firefighting personnel

Source: Prepared by the study

TABLE 3
INITIAL SOURCE OF FIREFIGHTERS' EXPLICIT COMPETENCY INDICATORS

Researchers	Lian (2010)	Occupational Information Network. (2011)	The present study	Note:
Research targets	Firefighting special search and rescue team members	Municipal Fire Fighters	Firefighting personnel	The Ministry of the Interior's firefighting service implementation guidelines; Japan's firefighting personnel selection and recruitment system

(Source: Prepared by the study)

2.2.2 Competency Classification (Level 1: Decision-making criteria)

The study divided the frontline firefighting personnel's competencies into explicit and implicit competencies based on the iceberg model. Competencies were roughly divided into a) self-management, b) interpersonal interaction, c) professional firefighting knowledge, d) firefighting techniques, f) basic physical fitness for firefighting personnel, g) fire engine and equipment operation, and g) practical firefighting experience.

2.3 SEM Assumption:

In the social sciences, causal models arouse interest because of their ability to explain theoretical relationships among variables. Since these models usually use concepts that are intangible (George & Kaplan,1998) [8], researchers associate observed variables with these hypothetical constructs, which are called latent variables (MacLean & Gray, 1998) [9]. Structural equation modeling (SEM) is an important tool used to reveal linear relationships and effects among observed and latent variables (MacCallum & Austin, 2000) [10].

The firefighter personnel's implicit mental competency self-reporting questionnaire developed in this study assumed that implicit competencies and work performance are correlated. A linear structural diagram showing the basic assumption is presented below:

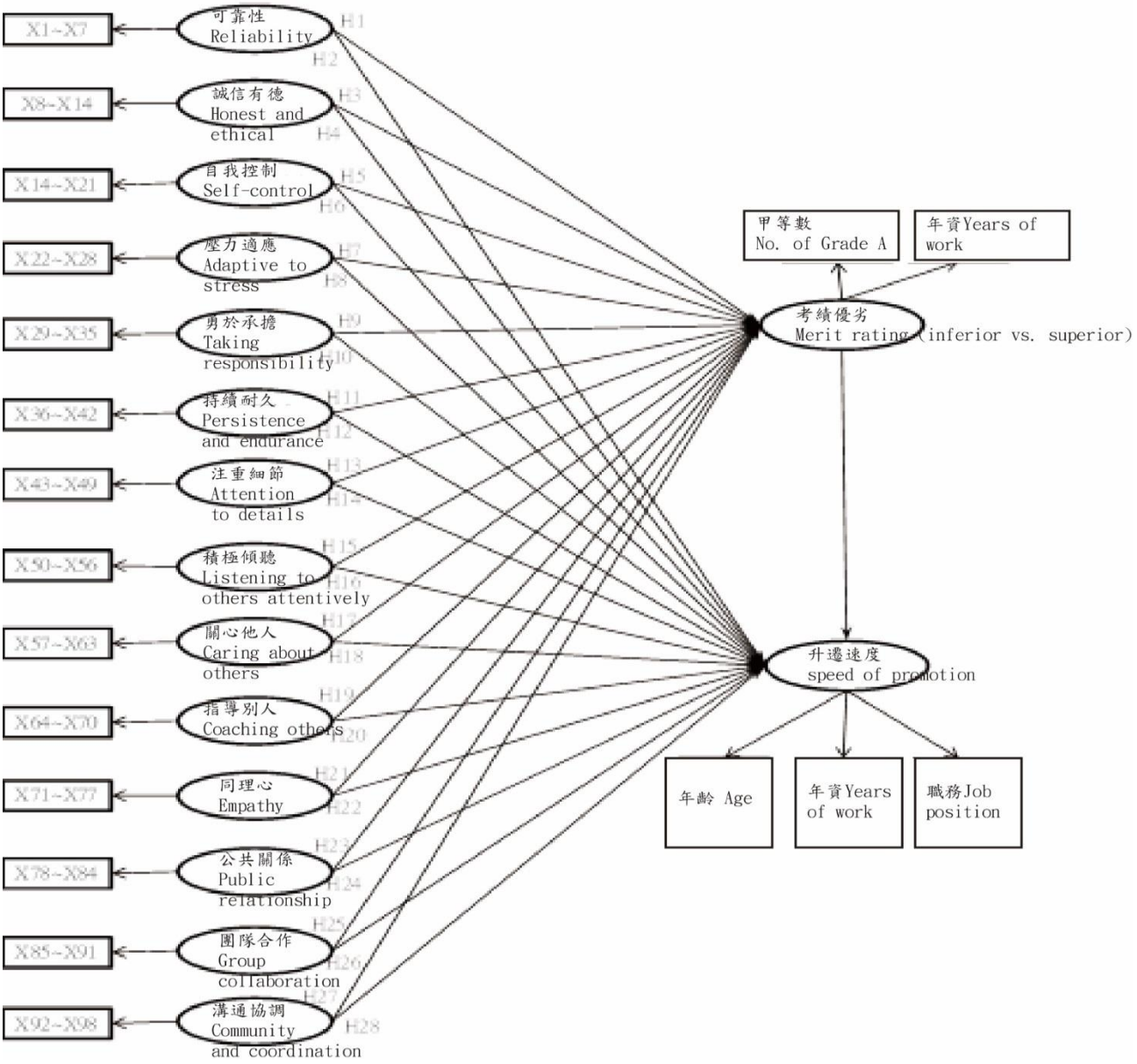

FIGURE3: THE STUDY'S LINEAR STRUCTURAL DIAGRAM OF THE BASIC ASSUMPTIONS

Source: Prepared by the study

(Note: X_{01}-X_{98} are scores from the self-reported questionnaire questions)

III. QUESTIONNAIRE DESIGN AND ANALYSIS

Sample size is important when statistical power of an analysis is considered in covariance-based methods, especially in SEM. Some experts propose a minimum sample of 10 cases per item (Hair et al., 2011) [11] or to use the ratio of indicators to a latent variable in determining the minimum sample (Marsh etal., 1998 [12]; Boomsma, 1982) [13]. The rule of 10 observations per indicator was found to be biased. How- ever, as ample of 200 or greater is considered to bead equate for SEM analysis (Kline, 2011) [14]. Recently, Westland (2012) [15] proposed a calculation of minimum sample based on three indicators: standard statistical power, effect size, and level of significance.

The respondents of the interview and questionnaire of this study were senior firefighting personnel with superior or inferior merit ratings and their supervisors (management). For good firefighting personnel, their morals and ethics should be taken into consideration, and their excellent merit rating should be given by not only their supervisor but also the ethics and service managers. The definition of senior personnel with superior or inferior merit rating in this study is as follows. Personnel with superior rating are those rated A in the appraisal over the past three years and have never been reprimanded over the past five

years. As for personnel with inferior ratings, they are those with an appraisal rating of B or lower over the past three years. Regarding the roster of the study population, it was provided by all firefighting agencies.

3.1 Expert Questionnaire Samples

TABLE 4
PROFILE OF EXPERTS FOR REVIEWING THE COMPETENCY INDICATORS

Age	Characteristics	No. of People	%
Age	20-30	3	18.75%
	31-40	3	18.75%
	41-50	5	31.25%
	51 or above	5	31.25%
Job Title	Squad leader	3	18.75%
	Branch head	8	50.00%
	Commander	2	12.50%
	Section chief	3	18.75%
Years of Work	0-5	3	18.75%
	6-10	0	0.00%
	11-15	2	12.50%
	16-20	3	18.75%
	21-25	3	18.75%
	26 or above	5	31.25%
Education	Master's degree	2	12.50%
	Bachelor's degree	6	37.50%
	Junior college	5	31.25%
	Others	3	18.75%
Fireman Education Background	Central Police University	13	81.25%
	Police Academy	3	18.75%
	State exam	0	0.00%

(Source: Prepared by the study)

3.2 Result and Analysis

3.2.1 Profiles of Sampled Experts

TABLE 5
HIERARCHICAL ANALYSIS OF PROFILES OF SAMPLED EXPERTS

Type	Characteristics	County and City Firefighting Agency	Central Agency	Education Agency for Recruitment and Selection
Years of Work	5-10 years	3	0	0
	10-15 years	2	0	0
	15-20 years	2	0	0
	More than 20 years	9	3	3
	Associate professor	0	0	1
Job Position	Director	0	0	1
	Group leader	2	2	0
	Special committee member	0	1	0
	Section chief	3	0	0
	Technical specialist	1	0	0
	Chief	1	0	0
	Commander	2	0	0
	Squad Leader	0	0	1
	Branch Head	2	0	0
	Squad Leader	5	0	0
Education	Master's or above	1	2	3
	Bachelor/associate degree	13	1	0
	Others	2	0	0

(Source: Prepared by the study)

3.2.2 Table of relative weights analysis of competency indicators

TABLE 6
RELATIVE WEIGHT ANALYSIS OF FRONTLINE, ENTRY-LEVEL FIREFIGHTING PERSONNEL COMPETENCY INDICATORS

Criteria	Weights	Rank	Factor	Weights	Rank
a. Self-management	0.152	4	a1 Reliability	0.205	2
			a2 Honest and ethical	0.205	1
			a3. Self-improvement and emotion control	0.154	4
			a4 Adaptability to stress	0.179	3
			a5 Taking responsibility	0.051	7
			a6 Persistence and endurance	0.127	5
			a7 Attention to detail	0.079	6
b. Interpersonal Interaction	0.064	7	b1 Listening to others attentively	0.065	7
			b2 Caring about others	0.124	4
			b3 Coaching others	0.083	5
			b4 Empathy	0.149	3
			b5 Public relationship	0.069	6
			b6 Group collaboration	0.285	1
			b7 Communication and coordination	0.225	2
c. Firefighting Professional Knowledge	0.191	1	c1. Legal knowledge	0.168	4
			c2. Firefighting rescue and prevention	0.385	1
			c3. Fire engines	0.191	3
			c4. Disaster prevention and rescue	0.193	2
			c5. Social science	0.062	5
d. Firefighting Work Skills	0.178	2	d1. Language and application	0.063	5
			d2. Fire safety inspection	0.178	3
			d3. Disaster rescue and victim search	0.321	1
			d4. Swimming	0.087	4
			d5. Emergency rescue techniques	0.248	2
			d6. Fire investigation	0.052	6
			d7. Serving the public	0.051	7
e. Firefighter Basic Physical Fitness	0.141	5	e1. Muscle strength	0.149	4
			e2. Activity capability	0.231	2
			e3. Agility	0.191	3
			e4. Heart and lung function	0.277	1
			e5. Vision	0.086	5
			e6. Hearing	0.066	6
f. Firefighting Engine and Equipment Operation	0.165	3	f1. Rescue vehicles and tools	0.234	2
			f2. Personal protection gear	0.253	1
			f3. Equipment used for destruction	0.116	5
			f4. Communication equipment	0.083	6
			f5. Medical equipment	0.140	3
			f6. Rescue equipment	0.132	4
			f7. Positioning equipment	0.042	7
g. Firefighting Practical Experience	0.107	6	g1. Disaster prevention promotion	0.133	4
			g2. Fire safety inspection	0.148	3
			g3. Disaster rescue	0.295	1
			g4. Emergency rescue	0.243	2
			g5. Business operation	0.072	5
			g6. Fire investigation	0.059	6
			g7. Serving the public	0.050	7

(Source: Prepared by the study)

3.2.3 Analysis of Sample Characteristics

TABLE 7
SAMPLES FOR SELF-REPORTED IMPLICIT MENTAL COMPETENCY QUESTIONNAIRE

Type	Characteristics	No. of people	%
Gender	**Male**	**202**	**90.6**
	Female	**21**	**9.4**
Work place	National Fire Agency, Ministry of the Interior	8	3.6
	Taichung Port Fire Service of National Fire Agency of Ministry of the Interior	1	.4
	Kaohsiung Port Fire Service of National Fire Agency of Ministry of the Interior	1	.4
	Taipei City Fire Department	21	9.4
	New Taipei City Fire Department	38	17.0
	Keelung City Fire Department	4	1.8
	Taoyuan County Fire Department	8	3.6
	Hsingchu County Fire Department	3	1.3
	Hsingchu City Fire Department	4	1.8
	Taichung City Fire Department	19	8.5
	Changhua County Fire Department	9	4.0
	Nantou County Fire Department	8	3.6
	Chiayi County Fire Department	6	2.7
	Chiayi City Fire Department	3	1.3
	Tainan City Fire Department	19	8.5
	Kaohsiung City Fire Department	18	8.1
	Pingtong County Fire Department	7	3.1
	Taigong County Fire Department	4	1.8
	Huilian County Fire Department	6	2.7
	Yilan County Fire Department	27	12.1
	Chinmen County Fire Department	5	2.2
	Penghu County Fire Department	4	1.8
Education	Others	13	5.8
	College (associated degree)	116	52.0
	University (bachelor's degree)	66	29.6
	Master's or above	28	12.6
Background	Others	5	2.2
	Personnel from the state examination	33	14.8
	Police Academy graduates (including the police program)	164	73.5
	Central Police University graduates (Four-year program)	20	9.0
	Graduates from the Central Police University post-graduate programs	1	.4
	Squad member	150	67.3
Job Position	Squad Leader	28	12.6
	Middle and high level administrative personnel	45	20.2
	Inferior (Grade A ratio: Less than 1/2) (not superior)	49	22.0
Merit Rating	Average (Grade A ratio: Between 1/2 and 3/4) (not superior)	67	30.0
	Superior (Grade A ratio: More than 3/4)	107	48.0
Total		223	100.0

Factor	Variables	Factor loading eigenvalues	Cronbach α
a1 Reliability	X01 X02 X03 X04 X05 X06 X07	0.470-0.750 eigenvalues =2.810	Cronbach's Alpha 0.732
a2 Honesty and ethics	X08 X09 X10 X11 X12 X13 X14	0.439-0.734 eigenvalues =2.990	Cronbach's Alpha 0.767
a3 Self-improvement and emotion control	X15 X16 X17 X18 X19 X20	0.463-0.732 eigenvalues =2.102	Cronbach's Alpha 0.625
a4 Adapting to stress	X22 X23 X24 X25 X26 X27 X28	0.513-0.771 eigenvalues =2.852	Cronbach's Alpha 0.748
a5 Taking responsibility	X29 X30 X31 X32 X33 X34 X35	0.564-0.726 eigenvalues =2.977	Cronbach's Alpha 0.770
a6 Persistence and endurance	X36 X37 X38 X39 X40 X41 X42	0.470-0.750 eigenvalues =2.810	Cronbach's Alpha 0.855
a7 Attention to details	X43 X44 X45 X46 X47 X48 X49	0.428 -0.800 eigenvalues =2.657	Cronbach's Alpha 0.706
b1 Listening to others attentively	X50 X51 X52 X53 X54 X55	0.600 -0.810 eigenvalues =3.150	Cronbach's Alpha 0.812
b2 Caring about others	X57 X58 X59 X60 X61 X62	0. 516-0.872 eigenvalues =3.486	Cronbach's Alpha 0.853
b3 Coaching others	X65 X66 X68 X69 X70	0.728 -0.831 eigenvalues =3.004	Cronbach's Alpha 0.839
b4 Empathy	X71 X72 X73 X74 X75 X76 X77	0.531 -0.749 eigenvalues =2.947	Cronbach's Alpha 0.766
b5 Public relationship	X78 X79 X80 X81 X82 X83 X84	0.555 -0.803 eigenvalues =3.470	Cronbach's Alpha 0.826
b6 Group collaboration	X85 X86 X87 X88 X89 X90 X91	0.491 -0.830 eigenvalues =3.637	Cronbach's Alpha 0.838
b7 Communication and coordination	X92 X93 X94 X95 X97 X98	0.614 -0.788 eigenvalues =2.996	Cronbach's Alpha 0.796

Source: Prepared by the study

Chi-square and t-test results of implicit competencies and firefighting work performance (merit rating and job promotion) items:

TABLE 8
CHI-SQUARE AND T-TEST RESULTS OF IMPLICIT COMPETENCIES AND FIREFIGHTING WORK PERFORMANCE (MERIT RATING AND JOB PROMOTION)

Implicit competency	Work performance	Chi-square P	Chi-square result	t-test P	t-test result
A1	Merit rating	.014*	Sig.	.000***	Highly Sig.
	Promotion	.006**	Quite Sig.	.000***	Highly Sig.
A2	Merit rating	.004**	Quite Sig.	.000***	Highly Sig.
	Promotion	.000***	Highly Sig.	.000***	Highly Sig.
A3	Merit rating	.027*	Sig.	.001**	Quite Sig.
	Promotion	.011*	Sig.	.000***	Highly Sig.
A4	Merit rating	.292	ns	.005**	Quite Sig.
	Promotion	.029*	Sig.	.000***	Highly Sig.
A5	Merit rating	.000***	Highly Sig.	.000***	Highly Sig.
	Promotion	.003**	Quite Sig.	.000***	Highly Sig.
A6	Merit rating	.004**	Quite Sig.	.026*	Sig.
	Promotion	.078	ns	.007**	Quite Sig.
A7	Merit rating	.041*	Sig.	.001**	Quite Sig.
	Promotion	.003**	Quite Sig.	.000***	Highly Sig.
B1	Merit rating	.115	ns	.109	ns
	Promotion	.002**	Quite Sig.	.001**	Quite Sig.
B2	Merit rating	.010*	Sig.	.018*	Sig.
	Promotion	.001**	Quite Sig.	.000***	Highly Sig.
B3	Merit rating	.325	ns	.026*	Sig.
	Promotion	.001**	Quite Sig.	.000***	Highly Sig.
B4	Merit rating	.004**	Quite Sig.	.004**	Quite Sig.
	Promotion	.000***	Highly Sig.	.000***	Highly Sig.
B5	Merit rating	.050*	Sig.	.032*	Sig.
	Promotion	.044*	Sig.	.015*	Sig.
B6	Merit rating	.024*	Sig.	.010*	Sig.
	Promotion	.092	ns	.009**	Quite Sig.
B7	Merit rating	.030*	Sig.	.000***	Highly Sig.
	Promotion	.731	ns	.002*	Sig.

Source: Prepared by the study; (Note: *Significant p <.05, **Quite sig. p <.01, Highly significant p <.001)***

3.3 SEM Goodness of Fit Analysis

See Figure 3 for the SEM diagram. The results of the goodness of fit indices are shown in Table 9.

TABLE 9
SEM GOODNESS OF FIT RESULTS

Type	Index	Value	Evaluation Criteria	Results
Absolute Goodness of Fit Index	(GFI) Goodness of fit index (GFI)	0.373	>0.8	Not good
	Adjusted goodness of fit index (AGFI)	0.345	>0.8	Not good
	Standardized root mean square residual (SRMR)	0.244	<0.1	Not good
	Root mean square error of approximation (RMSEA)	0.082	<0.08	Close to good
Relative Normed Fit Index	Non-normed fit index (NNFI), Tucker-Lewis index (TLI)	0.401	>0.9	Not good
	Normed fit index (NFI)	0.305	>0.9	Not good
	Comparative fit index (CFI)	0.416	>0.8	Not good
Parsimonious Normed Fit Index	Parsimonious normed fit index (PNFI)	0.297	>0.5	Not good
	Parsimony Goodness-of-Fit Index (PGFI)	0.406	>0.5	Close to good
	Chi-square test (^{2}/d.f.)	2.509547	<3	Good

(Source: Prepared by the study)

According to **Error! Reference source not found.**, the goodness to fit did not reach the criteria for "good". One possible reason is that there are too many variables, and therefore some basic concepts were modified. Factor analysis was adopted and then the values of the indicators were totaled. For merit rating, the ratio of grade A over the past years was adopted, and for the speed of promotion, it was denoted by the job position divided by the sum of years of work and age (i.e. job position / (years of work+ age)). The revised model was then analyzed again in Figure 4.

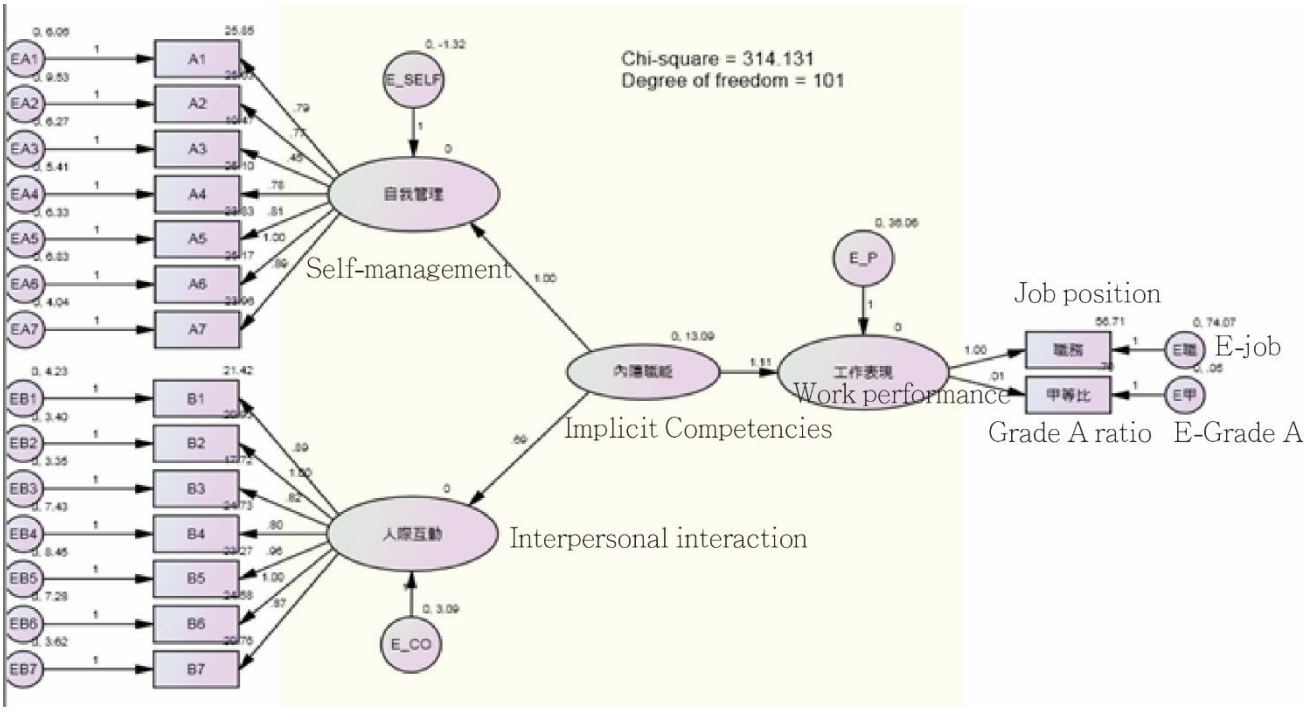

FIGURE 4. RESULT FROM ENTERING REVISED SEM INTO AMOS
(Source: Extracted by the study)

3.4 Result of Revised Goodness of Fit Index Results

TABLE 10
RESULT OF REVISED SEM GOODNESS OF FIT

Type	Index	Value	Evaluation Criteria	Results
Absolute Goodness of Fit	index (GFI)	0.840	＞0.8	Good
	Adjusted goodness of fit index (AGFI)	0.785	＞0.8	Close to the benchmark
	Standardized root mean square residual (SRMR)	0.064	＜0.1	Good
	Root mean square error of approximation (RMSEA)	0.097	＜0.08	Close to the benchmark
Relative Normed Fit	Non-normed fit index (NNFI), Tucker-Lewis index (TLI)	0.877	＞0.9	Close to the benchmark
	Normed fit index (NFI)	0.856	＞0.9	Close to the benchmark
	Comparative fit index (CFI)	0.897	＞0.8	Good
Parsimonious Normed Fit	Parsimonious normed fit index (PNFI)	0.720	＞0.5	Good
	Parsimony Goodness-of-Fit Index (PGFI)	0.624	＞0.5	Good
	Chi-square test (^{2}/d.f.)	3.100	＜3	Close to the benchmark

Source: Prepared by the study

IV. SUMMARY

According to **Error! Reference source not found.**, the goodness of fit of the revised model generally reached the criteria for "good", and those that did not meet the criteria earlier were also closer to the benchmark, suggesting that the goodness of fit of the revised model was acceptable. Hence, there is a cause and effect relationship between work performance and self-management and interpersonal interaction.

V. DISCUSSION

5.1 Applying the Hierarchical Analysis Result on Training Planning Analysis

Analysis and comparison of the radar chart of Taiwan's firefighting personnel education and training hours arrangement

5.1.1 Criteria hierarchical analysis of explicit competency

According to Figure 5 Radar Chart of Hierarchical Analysis of Knowledge and Skill Factors of Explicit Competencies of Firefighting Personnel Education, the Central Police University and the Police Academy are more focused on professional firefighting knowledge, skills, and related education training, while training on fire engine and equipment operation was more neglected. In terms of the state police examination programs, more emphasis was placed on the operation of fire engines and related equipment. To pass the state police examination programs, the candidates should be equipped with adequate knowledge and education, and therefore, their professional fire knowledge was weighted less.

A suggestion here is to rearrange the courses according to the above findings or to emphasize the more neglected training in the in-service education, such as in the year-round training and the education and training for new firefighters.

5.1.2 Hierarchical analysis of knowledge and skill factors of explicit competencies

See Figure 6. Radar Chart of Hierarchical Analysis of Knowledge and Skill Factors of Explicit Competencies of Firefighting Personnel Education

(1) In terms of legal knowledge and education, legal knowledge was weighted more by the Police Academy than the Central Police University. In contrast, the experts did not weigh legal knowledge as that important. As for the state police examination programs, the relative weight of legal knowledge was similar to the viewpoint of the experts.

(2) As for fire prevention and rescue knowledge, its relative weight given by the Central Police University was much higher, which may be because the police university is responsible for cultivating not only firefighters but also other related personnel. Moreover, the school is also involved in research.

(3) For disaster prevention knowledge, its relative weight given by the Central Police University was quite high due to the serious disasters that have happened frequently in Taiwan and caused the general public to be more aware of disaster prevention and rescue.

(4) For fire prevention and safety inspection work techniques, its relative weight given by the Central Police University was much higher than by other units due to the university's emphasis on research and the general public's awareness.

(5) For disaster and victim rescue and emergency medical services and techniques, its relative weight given by the state examination programs was significantly higher than others, and this result is in agreement with the expert's point of view.

(6) For fire disaster investigation and service for the public, all education units gave a relatively low weight, and this result was consistent with the viewpoints of the experts. One possible explanation is that fire investigation is more professional, and only few firefighting personnel are involved in the area. As for serving the public, the result was quite different from that of fire investigation. Although the duty of serving the public for firefighting personnel is not a legally assigned duty, the extensive range of services provided by firefighting personnel for the public makes such a duty controversial: Is serving the public the responsibility of firefighting personnel? No consensus has been reached, and in this study, the relative weight given by experts was somehow low.

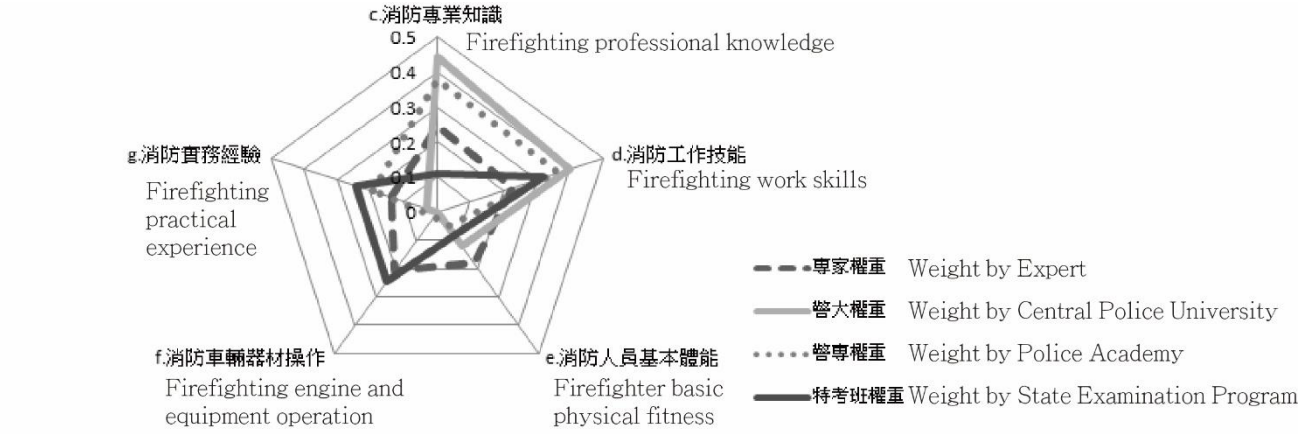

FIGURE 5. RADAR CHART OF HIERARCHICAL ANALYSIS OF THE EXPLICIT COMPETENCY CRITERIA OF FIREFIGHTING PERSONNEL EDUCATION
(Source: Prepared by the study)

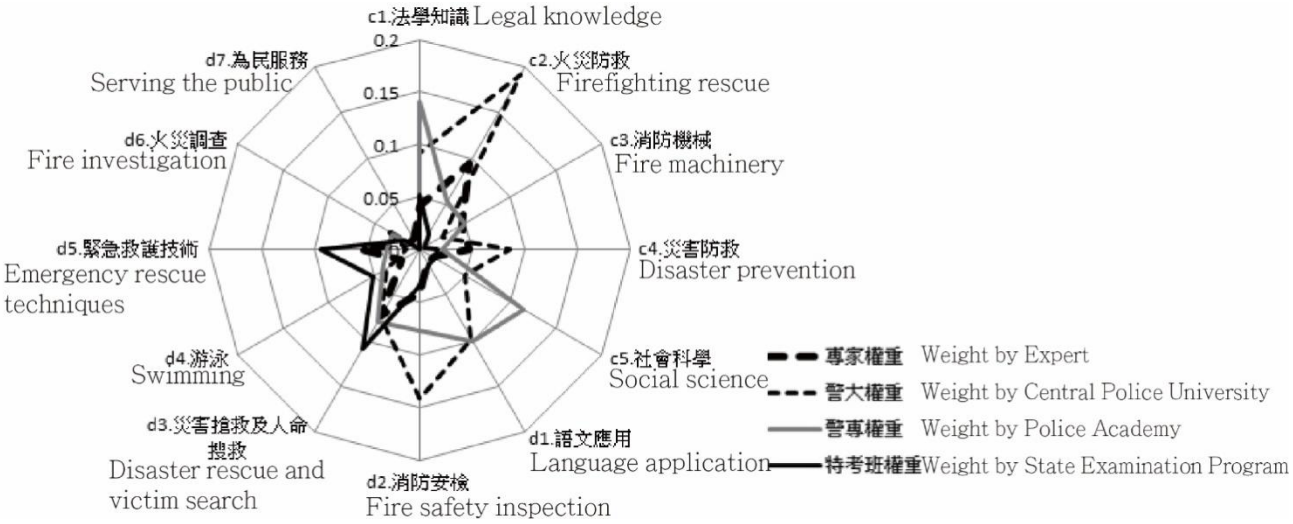

FIGURE 6. RADAR CHARTS OF HIERARCHICAL ANALYSIS OF KNOWLEDGE AND SKILL FACTORS OF EXPLICIT COMPETENCY OF FIREFIGHTING PERSONNEL EDUCATION
Source: Prepared by the study

5.2 For firefighting personnel education and training in the future, some firefighting personnel

competencies can be acquired or improved through education and training. Therefore, for Central Police University students, Police Academy students, and Levels 3 and 4 state police examinees, the following thirteen competencies should be the focus of their training: continuous learning, social interaction, adaptability to change, risk awareness, crisis management, group collaboration, adaptability, conflict handling, crisis handling, service attitude, stress coping, and obedience. For graduates from Central Police University and Police Academy, as well as examinees passing the state police examination during the law-enforcement internship period, the following thirteen competencies should be focused on: executive power, motivating and cultivating subordinates, risk awareness, crisis handling, crisis management, adaptability to change, leadership, decision making, problem-solving capability, service attitude, and stress coping. For Central Police University and Police Academy students, the results of the above competency training should be evaluated before their graduation and after their internship. For candidates selected from the state police examination, they should have a competency evaluation after training as well as after internship. As for the method of evaluation, they can use the psychological inventory or other pluralistic evaluation methods.

For the Central Police University students and the Police Academy students during their study period and for Level 3 and 4 police candidates from the state police examination during their training period, the examination and tests should be more

pluralistic; for example, including written tests, oral tests, physical exams, physical fitness tests, mental tests, background and integrity tests, and lie detection tests to eliminate those who are not suitable for law enforcement.

5.3 Management Connotation of Firefighting Personnel Screening and Selection

The present study comprised of three stages of analyses for generating the method for screening and selecting frontline firefighting personnel. It can be found that the shared and critical professional competence behavioral indicators had relatively good reliability and identifiability for differentiating between incompetent and competent personnel effectively as well as indirectly revealing the capabilities, aptitudes, and personality traits that firefighting personnel should possess. The present study established seven major constructs and the respective behavioral indicators for examination or education agencies to refer to. The information here provides a concrete theoretical foundation for developing mental test questions or establishing a model for screening and selecting new firefighting personnel well equipped with the core competencies and personality traits.

The frontline firefighting personnel's shared and core professional competency structure established in this study covers seven constructs: leadership management capability (five competencies), self-management capability (four competencies), relationship management capability (three competencies), law-enforcement capability (six competencies), personality traits (four competencies), work attitudes (five competencies), and professional aptitudes (five aptitudes). In total, there are 28 competencies and five professional aptitudes.

From the perspective of human resource management and development, these 46 competencies and seven professional aptitudes contain two parts: one is capabilities that can be enhanced by training and the other is personality traits that cannot be trained. The capabilities that can be enhanced are those competencies that are shapeable and can be developed and changed by education and training. These types of competencies do not need to be considered when screening for new students but should be included in the school curriculum for long-term development and cultivation. According to the data analysis result, leadership management capability, self-management capability, relationship management capability, and law enforcement capability belong to this category of competencies, and schools can use this competency model to include these competency components into existing courses and to coordinate with assorted internship activities to help students develop these competencies in school. As for the competencies of personality trait behaviors and work attitude constructs, these cannot be easily trained.

VI. CONCLUSION

In general, the work contents of firefighting personnel differs depending on their task arrangement and work nature, but there are also tasks, such as 24-hour on-call and handling of emergencies or accidents, that are shared by all firefighting personnel. As for the source of firefighting personnel, most of them are graduates from the Central Police University or the Police Academy, while others are hired after passing the Level 3 or 4 state police examinations.

In terms of work knowledge, firefighting personnel should be aware of firefighting related laws and regulations as well as firefighting and rescue knowledge. For police officers transferred to the firefighting unit, their work should be focused on the following nine classes: disaster prevention and management, fire disaster prevention planning and implementation, hazardous materials and substance management and planning, disaster rescue planning and implementation, emergency rescue planning and implementation, fire disaster survey planning and implementation, planning and implementation of education and training, public force utilization planning and implementation, and disaster rescue command planning and implementation. The required knowledge comprises of the following six types: laws and regulations, fire disaster, disaster prevention and rescue, social science, firefighting related machines, and emergency rescue. The types of skills required are: water-related lifesaving, fire rescue, emergency rescue, mountain disaster rescue, and fire engine and equipment related skills. Some other necessary competencies are disaster prevention dissemination, stand-by/on-call, fire safety inspection, water source investigation, fire rescue and drills, on-duty, equipment maintenance, emergency rescue, mountain rescue and search, water-related lifesaving, providing public service, and disaster prevention and management.

It is especially important for firefighting personnel to acquire knowledge and concepts related to serving the public. For Level 3 and 4 personnel, they can receive the same knowledge and education for work. Nevertheless, Level 3 personnel should also work on developing their leadership knowledge and application skills.

For work skills, it is unavoidable for firefighting personnel to be confronted with challenges and certain risks associated with their work. As a result, all firefighting personnel should meet the physical requirements. As for professional skills such as

Taekwondo, techniques for arresting criminals, and combined firefighting skills, they are all important. There are some differences depending on the work content; for example, for fire prevention personnel, the focus should be on water-related lifesaving, fire rescue, emergency rescue, mountain disaster rescue, and fire engine and equipment operation. As for personnel who have passed the Level 3 or 4 state examinations, their work skill requirements are quite similar.

According to the viewpoints of the experts in this study, the core competency indicators of entry-level firefighting personnel at the benchmark level arranged in descending order are: firefighting work skills, fire engine and equipment operation, self-management (capability), firefighting personnel basic physical fitness, and firefighting practical experience. As for the less valued competency by the experts in this study, that was interpersonal interaction (capability). All firefighting personnel require a high mechanical aptitude and spatial-related perceptual capability in order to do the job well.

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