

An Investigation Utilising Fuzzy Logic Control of the Issues Experienced by Tamil Nadu Police Personnel as a Result of their Long Hours at Work

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Abstract

In this study, we will examine the physical and mental challenges that Tamil Nadu Police personnel face as a result of their long working hours. The workplace environment has a significant impact on people's physical and mental health. In general, long working hours are defined as weekly overtime hours that exceed regular working hours. Major factors affecting both physical and mental challenges had been identified by experts in the police department and union officials. Physical challenges included working overtime, working without basic needs, and doing multiple jobs, while mental challenges included dealing with a crisis, meeting duty completion targets, and having disagreeable duties. In this study, we use the Fuzzy Logic Control (FLC) methodology to try to find some meaningful solutions to the challenges faced by Tamil Nadu police personnel by incorporating the above-mentioned variables into our FLC model. By defining rule bases for the above-mentioned physical and mental factors using FLC, we were able to identify feasible ways to reduce their physical and mental challenges.

Keywords: Difficulties faced by Police personnel, long working Hours, Fuzzy Logic Control (FLC), Physical challenges and mental challenges.

Introduction:

We aim to analyse the psychological and physical difficulties that Tamil Nadu Police officers encounter as result of their extended workdays in this study. One of the most significant departments tasked with upholding law and order in society is the police department. Extra hours worked each week beyond regular business hours referred to as long working hours. People all over the world deal with long working hours because many jobs require overtime. Many work environments confront the problem of overtiredness. However, the risk factor is significantly higher for law enforcement. In the midst of a 16-hour shift, police officers may have to respond to tense situations in addition to answering late-night calls. Some overtime work is unavoidable.

Literature Review:

Stuti Jalan et.al (2020) have analysed the constable's effects on the job most stressed due to workload, and environmental stressors due to commuting long distances. The police personnel is facing a lack of basic amenities like drinking water, clean toilets and refreshments in the field of work

[12]. D.Bhuvaneswari et al (2019) has examined and noted that police officers experience stress and caught between the increasing demands of the public and the pressures of their jobs. It has also noted that police officers commit suicide as result of the stress of their daily jobs. [2]. M.Shunmuga Sundaram et al (2012) analysed the main objectives of the frequency of occurrence of occupation stress among police officers [12]. Apurva Kumar Pandya et al (2020) have examined the challenges in policing in India finding the problem faced by the police force, the nature of work nature and how the health risks affect the police personnel [1]. C.Ugwu et al (2014) has studied the number of vehicles travelling between the traffic lights, and the difference happening between the two sensors and also evaluated the problem by Fuzzy Logic model control system for traffic congestion [15]. K.Kaleeswari et al (2018) have analysed water treatment plants in the Indian scenario by Fuzzy Logic based Control Model [8] [9]. P.Sona et al (2018) analysed and discussed the Inventory model in supply chain management using Fuzzy Logic based Control Model [13].

Problems:

Several factors were analysed which affects the police personnel due to long working hours both physically and mentally and further the factors were sub-divided as given below based on the expert's opinion. We list the factors as follows,

Factors affected by the police personnel PHYSICALLY due to long working hours. [LWHs]

- Working overtime(W1)
- Working without basic needs (W2)
- Performing multiple works (W3)

Factors affected by the police personnel MENTALLY due to long working hours. [LWHs]

- Duty Completion Target. (D1)
- Dealing with the crisis (D2)
- Disagreeable Duties (D3)

Working Overtime (W1):

Every job has overtime for employees. Specifically, the working hours of police officers are not fixed. Most of the time, police officers work longer shifts than their regular duty hours. They were unable to articulate their need for more time at work. By the scheduled time, they ought to be prepared to take on any extra work. There are fewer expectations for set work hours in many departmental divisions. Extended shift work can have detrimental effects on one's physical, mental, and social well-being. Law enforcement officers are required to work three shifts; however, because of the police department's understaffing, each officer is accustomed to working 12-hour shifts, which leaves them exhausted and inefficient.

Working without basic needs (W2):

Police officers are people who serve the public in a variety of capacities and contexts. When performing bandobast protection duties, the constabulary is an essential part of the police force. During that period, the absence of basic amenities such as clean restrooms, adequate food, and drinking water frequently had an impact on police officers. When compared to other departments that provided assistance and services in that same situation, the public perceives that individuals in COVID-19 suffered more. It is reasonable to anticipate a well-maintained workspace.

Performing multiple works (W3):

Police officers work multiple jobs at their places of employment. Activities connected to an investigation, such as registering crimes, visiting crime scenes, providing security, and handling and transporting offenders to courts for judicial or police custody and trial. Several works are preventing crime, maintaining peace and security, patrolling, surveillance and checking mischievous person characters. They have duties to complete, such as gathering information on the activities of workers, politicians, and criminals. Due to the demands of their jobs, police officers do not have the leisure to develop their personal lives outside of work. Spending time with their family members is non-existent.

Duty completion target (D1):

Preventing law and order is the police's primary responsibility. Police officers need to understand how to carry out their duties effectively, remain composed at all times, and refuse to give up their lives in order to save others. Every job has completion goals for duties. During that time, the police department has to finish and complete the case files. There will be some duty completion targets in the department. Late in their shifts, police officers must finish arrests, appear in court off-duty, and help manage crowds. In many cases, the extra hours not handled or distributed to the entire workforce. To keep law and order theft record files up to date, resolve traffic cases on a daily or weekly basis, and confirm the applicants' passports. As a result, when working during duty hours, they stressed about finishing their tasks.

Dealing with a crisis (D2):

Given their professional nature, the police officer ought to step up and handle the situation. They perform tasks like rescuing individuals from crises and the outbreak of war or external aggression, as well as internal disorders like communal riots, conflicts between different classes, castes, and sects, and other conflicts. They also provide shelter, rehabilitation, and other services. Most crises occur during times of famine, flooding, fires, and epidemics. One of the most crucial groups of people who worked during COVID-19 was the police. Like this, they must also be on the ground and coordinate the specific

circumstances with legislators in the event of a natural disaster.

Disagreeable duties (D3):

Police officers frequently pose a serious risk to themselves while planning and carrying out counterinsurgency operations while operating undercover in hazardous environments. Managing and controlling traffic, handling large crowds of people in public, and paying close attention to complaints all contribute to high levels of workplace stress, which in turn causes a high rate of mental illnesses and suicides among police officers. It is necessary for the police to replace the anti-social elements' outdated weapons with more modern ones in order to safeguard society. The work environment for police officers is repetitive, devoid of fresh challenges, and they frequently deal with abusive and unsupportive supervisor behaviour. They always have work to do, indoors as well as outdoors. However, the secondary ones typically see in their work.

Methodology - Fuzzy Logic Control (FLC):

Lotfi A. Zadeh (1965) first presented the membership function in the first paper on fuzzy sets. To determine whether a variable's true value falls between 0 and 1, fuzzy logic is applied. The fuzzy system in Fuzzy Controllers made up of inputs that stand in for "conditions" and outputs that stand in for "actions." However, we expect that the output will also have to be crisp set if the input is crisp set. Fuzzy propositions converted into fuzzy relations by the fuzzy inference module using fuzzy logic techniques. Fuzzification, Rule-

base, Fuzzy, and Defuzzification modules are the four steps that make up the fuzzy relation, which uses a rule base to find a crisp solution or value. A fuzzy logic control system has become one of the most successful technologies because it closely resembles human decision-making and generates precise solutions. For the socially related type of problem, the FLC tool is more applicable and also to find the key factors for the particular solution.

Mathematical Formulation:

Fuzzy TECH 5.81 d software professional editions have been using the programme, which suggests using a fuzzy logic controller to analyse and find solutions. A fuzzy inference engine is created by framing the conditions and rules for each input using fuzzy tech software and fuzzy logic to extract the print screen of each result from the data shown in the figure. The parameters are selected as linguistic variables proposed with the support of verbal terms on the three levels and they are given by (low, medium, high).

Construction of Fuzzy Logic Control (FLC) in LWHs:

Fuzzy logic controller (rule-based expert system) is constructed basically, which combines, fuzzy set theory and control theory. The recommended proposal of fuzzy inference system is exposed in Fig (1.1). Six inputs and two outputs are within our suggested fuzzy inference system and then the two outputs are taken as inputs to get the final output value.

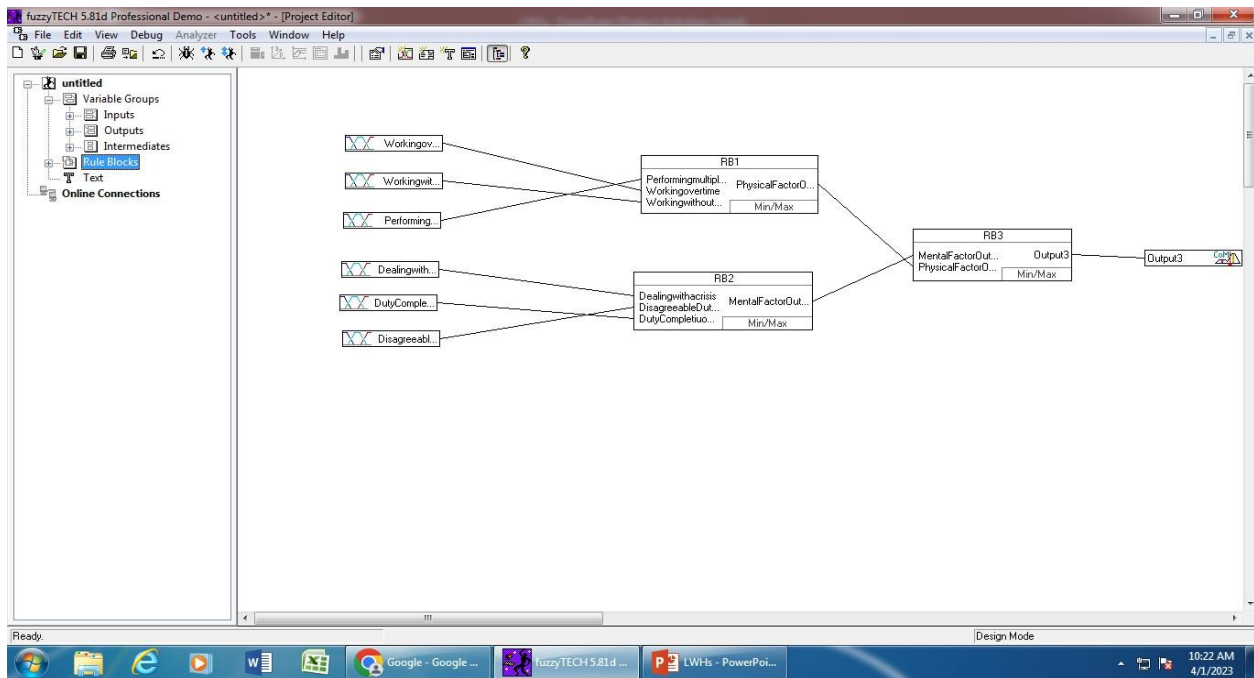


Fig 1.1 Fuzzy Inference Engine for Suggested problem

The membership function of the input variable „working overtime“ is constructed by three linguistic fuzzy sets {low, medium, high} from 0 to 24 per day working time with the derived unit as hours and the corresponding membership function is shown in Fig(1.2)

The membership function of the input variables such as Working without basic needs, is constructed by three linguistic variables {low, medium, high} from 0 to 1 and shown in Fig(1.2).

The membership function of the input variable „Performing multiple task“ is constructed by three linguistic fuzzy set {low, medium, high} from 0 to 8 expected number of work in the police personnel work and the corresponding membership function is shown in Fig(1.2)

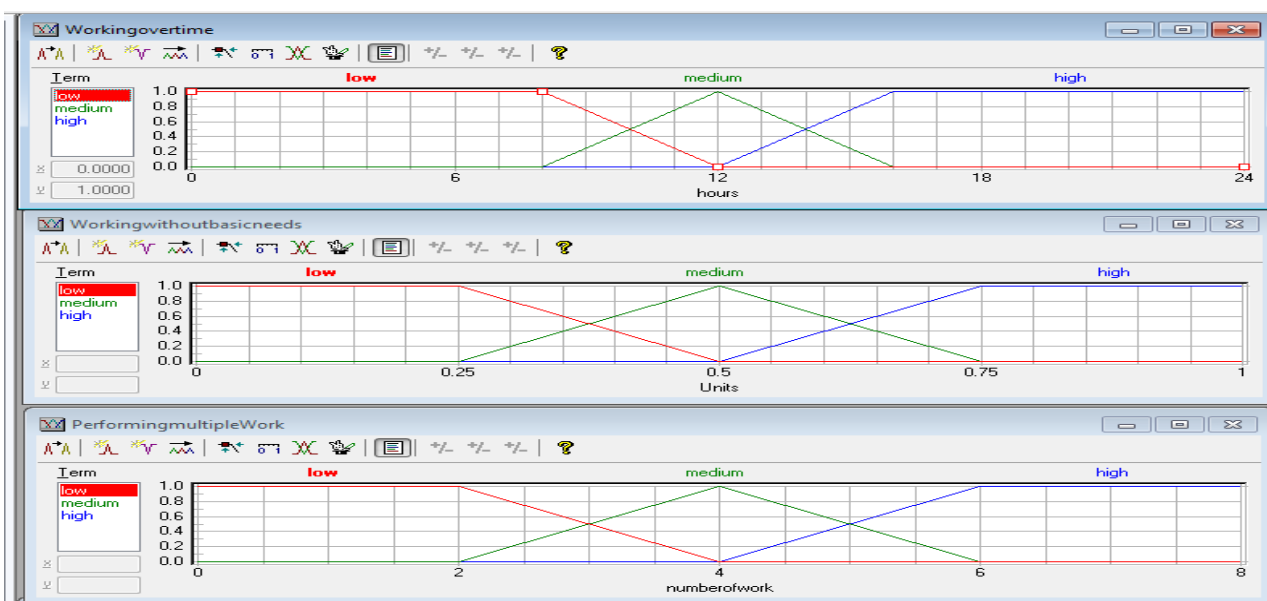


Fig 1.2 Effects of Physical factors affected due to LWHS

The membership function of the remaining input variables such as Dealing with a crisis, Duty completion target, and Disagreeable duties are

constructed by three linguistic variables {low, medium, high} from 0 to 1 and also be constructed.

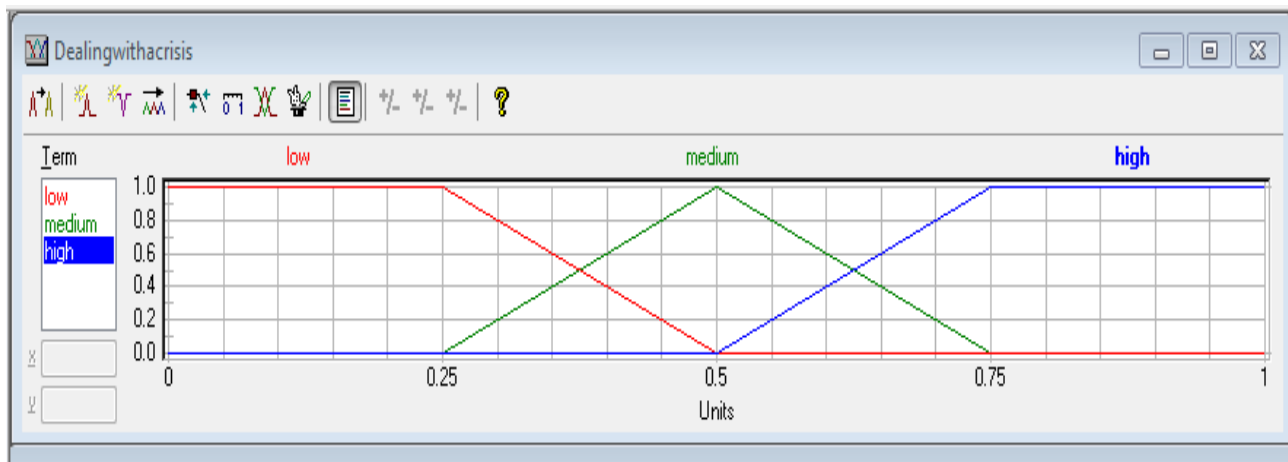


Fig 1.3 Effects of Mental factors affected due to LWHs

Rule Base 1:

The rule base for the police personnel affected by physical factors is given as follows, suppose the working overtime is High, working without basic needs is medium and performing multiple works is

high then the factors affected by police personnel physically is high. In the same way, the remaining rules can be understood easily as shown in Table (1.1).

Table 1.1 Rule base for physical factor affected due to LWHs

#	Performing multiple work	Working overtime	Working without basic needs	THEN	Physical Factor Output
1	low	low	low	1.00	low
2	low	low	medium	1.00	low
3	low	low	high	1.00	medium
4	low	medium	low	1.00	medium
5	low	medium	medium	1.00	medium
6	low	medium	high	1.00	medium
7	low	high	low	1.00	medium
8	low	high	medium	1.00	medium
9	low	high	high	1.00	high
10	medium	low	low	1.00	medium
11	medium	low	medium	1.00	medium
12	medium	low	high	1.00	medium
13	medium	medium	low	1.00	medium
14	medium	medium	medium	1.00	medium
15	medium	medium	high	1.00	medium
16	medium	high	low	1.00	medium
17	medium	high	medium	1.00	medium
18	medium	high	high	1.00	high
19	high	low	low	1.00	medium
20	high	low	medium	1.00	medium
21	high	low	high	1.00	high
22	high	medium	low	1.00	medium
23	high	medium	medium	1.00	medium
24	high	medium	high	1.00	high
25	high	high	low	1.00	high
26	high	high	medium	1.00	high
27	high	high	high	1.00	high
28					
29					
30					

Rule Base 2:

The rule base for the police personnel affected by mental factors shown in Table (1.2). Suppose the Dealing with a crisis is low, the Duty completion target is in High, and Disagreeable duties are low then the factors affected by the police personnel mentally are low. Similarly, the remaining rules can be understood easily.

Table 1.2 Rule base for mental factor affected due to LWHs

#	IF	THEN
1	Dealingwithacrisis low	MentalFactorOutput low
2	DisagreeableDuties low	MentalFactorOutput low
3	DutyCompletionTarget low	MentalFactorOutput low
4	Dealingwithacrisis low	MentalFactorOutput medium
5	DisagreeableDuties low	MentalFactorOutput medium
6	DutyCompletionTarget low	MentalFactorOutput medium
7	Dealingwithacrisis low	MentalFactorOutput high
8	DisagreeableDuties low	MentalFactorOutput high
9	DutyCompletionTarget low	MentalFactorOutput high
10	Dealingwithacrisis medium	MentalFactorOutput low
11	DisagreeableDuties medium	MentalFactorOutput low
12	DutyCompletionTarget medium	MentalFactorOutput low
13	Dealingwithacrisis medium	MentalFactorOutput medium
14	DisagreeableDuties medium	MentalFactorOutput medium
15	DutyCompletionTarget medium	MentalFactorOutput medium
16	Dealingwithacrisis medium	MentalFactorOutput high
17	DisagreeableDuties medium	MentalFactorOutput high
18	DutyCompletionTarget medium	MentalFactorOutput high
19	Dealingwithacrisis high	MentalFactorOutput low
20	DisagreeableDuties high	MentalFactorOutput low
21	DutyCompletionTarget high	MentalFactorOutput low
22	Dealingwithacrisis high	MentalFactorOutput medium
23	DisagreeableDuties high	MentalFactorOutput medium
24	DutyCompletionTarget high	MentalFactorOutput medium
25	Dealingwithacrisis high	MentalFactorOutput high
26	DisagreeableDuties high	MentalFactorOutput high
27	DutyCompletionTarget high	MentalFactorOutput high
28		
29		
30		

Rule Base 3:

The rule base for the factors affected by the police personnel due to the long working hours as shown in Table (1.3). Suppose the factors

affected physically are high and the factors affected mentally are medium then the factors affected by police personnel due to long working hours are high.

Table 1.3 Rule base for the police personnel affected due to LWHs

#	IF	THEN
1	MentalFactorOutput low	PhysicalFactorOutput low
2	MentalFactorOutput medium	PhysicalFactorOutput medium
3	MentalFactorOutput high	PhysicalFactorOutput high
4	MentalFactorOutput low	PhysicalFactorOutput medium
5	MentalFactorOutput medium	PhysicalFactorOutput medium
6	MentalFactorOutput high	PhysicalFactorOutput medium
7	MentalFactorOutput low	PhysicalFactorOutput high
8	MentalFactorOutput medium	PhysicalFactorOutput high
9	MentalFactorOutput high	PhysicalFactorOutput high
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Result and Discussion:

The following figures illustrated the factors that affected both physical and mental based on some data.

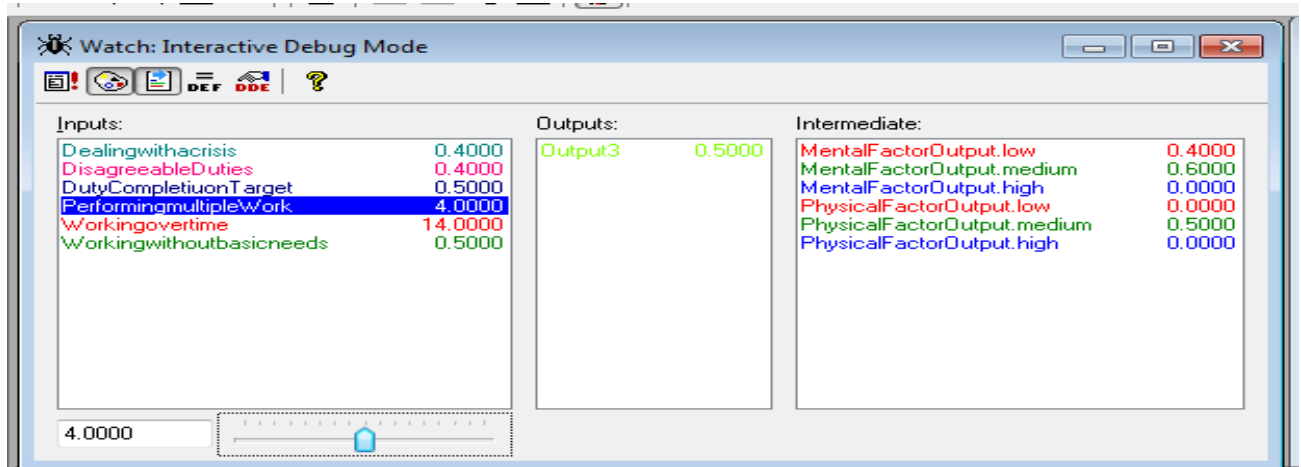


Table 1.4 Effects of various parameters affected by police personnel due to LWHs (a)

In the above table parameter shown in the left column such as Working Overtime, working without basic needs, performing multiple works, Dealing with a crisis, Duty completion target, and Disagreeable duties are the factors that affected both physical and mental given as input values. From the above input values, we get the output 1 with low to medium and output 2 with medium

.so it represents the output 3 is 0.5000.

Membership values of the parameters were mentioned clearly in the rule base. If any changes made in input values shows different results. Output 1 results were obtained by using physical factors and Output 2 results were obtained using mental factors.

Table 1.5 Effects of various parameters affected by police personnel due to LWHs (b)

The screenshot shows the 'Watch: Interactive Debug Mode' window. The title bar includes a bug icon and the text 'Watch: Interactive Debug Mode'. Below the title bar is a toolbar with icons for a list, a circular arrow, a document, 'DEF', 'ODE', and a question mark. The main area is divided into three panels: 'Inputs:', 'Outputs:', and 'Intermediate:'. The 'Inputs:' panel lists six variables with their values: 'Dealingwithacrisis' (0.4000), 'DisagreeableDuties' (0.4000), 'DutyCompletionTarget' (0.5000), 'PerformingmultipleWork' (3.0000), 'Workingovertime' (12.0000), and 'Workingwithoutbasicneeds' (0.3000). The 'Outputs:' panel shows 'Output3' with a value of 0.5000. The 'Intermediate:' panel lists six intermediate values: 'MentalFactorOutput.low' (0.4000), 'MentalFactorOutput.medium' (0.6000), 'MentalFactorOutput.high' (0.0000), 'PhysicalFactorOutput.low' (0.0000), 'PhysicalFactorOutput.medium' (0.5000), and 'PhysicalFactorOutput.high' (0.0000). At the bottom left, there is a text box containing '12.0000' and a slider control.

Inputs:		Outputs:	Intermediate:		
Dealingwithacrisis	0.4000	Output3	0.5000	MentalFactorOutput.low	0.4000
DisagreeableDuties	0.4000			MentalFactorOutput.medium	0.6000
DutyCompletionTarget	0.5000			MentalFactorOutput.high	0.0000
PerformingmultipleWork	3.0000			PhysicalFactorOutput.low	0.0000
Workingovertime	12.0000			PhysicalFactorOutput.medium	0.5000
Workingwithoutbasicneeds	0.3000			PhysicalFactorOutput.high	0.0000

In the above table, if the police person working time 12 hours attains medium remaining input values are low then the final output shows the result medium. The result of the long working

hours output be the medium of each person can work in the police job with the comfortable factors.

Table 1.6 Effects of various parameters affected by police personnel due to LWHs (c)

Watch: Interactive Debug Mode

Inputs:		Outputs:	Intermediate:	
Dealingwithacrisis	0.5000	Output3 0.6875	MentalFactorOutput.low	0.0000
DisagreeableDuties	0.5000		MentalFactorOutput.medium	1.0000
DutyCompletionTarget	0.5000		MentalFactorOutput.high	0.0000
PerformingmultipleWork	5.0000		PhysicalFactorOutput.low	0.0000
Workingovertime	17.0000		PhysicalFactorOutput.medium	0.5000
Workingwithoutbasicneeds	0.5000		PhysicalFactorOutput.high	0.5000

In the above table , If the persons working time 17 hours and performing multiple works as the number of work is 5 are affected by physical factors and Duty completion becomes 0.5000, it

shows the result in output 3 is High 0.6875. From the result of the long working hours affecting the police persons both physical and mental stress is High.

Table 1.7 Effects of various parameters affected by police personnel due to LWHs (d)

Inputs:	Outputs:	Intermediate:
Dealingwithacrisis 0.3000	Output3 0.3125	MentalFactorOutput.low 0.8000
DisagreeableDuties 0.3000		MentalFactorOutput.medium 0.2000
DutyCompletiouTarget 0.5000		MentalFactorOutput.high 0.0000
PerformingmultipleWork 3.0000		PhysicalFactorOutput.low 0.5000
Workingovertime 9.0000		PhysicalFactorOutput.medium 0.5000
Workingwithoutbasicneeds 0.3000		PhysicalFactorOutput.high 0.0000

From the above table working overtime is 9 hours, performing multiple works is 3 and the Duty completion target is 0.5000 it represents the Output 3 is low to medium with the value 0.3125. Output 1 is low to medium at the value of 0.8000 to 0.2000 and Output 2 is low to medium at the value of 0.5000 to 0.5000.

From this result, the long working hours output affect the police personnel by the factors mentioned above. It gives the situation to the persons working in the department with less physical and mental stress.

In this manner, we mention seven more cases of input data selected out of twenty four cases which impact more changes in the result and we get some meaningful results as given in the following Table (1.8).

Table 1.8 Output Results for the police personnel affected due to LWHs

Factors		case1	case2	case3	case4	case5	case6	case7
Input	Working Overtime	10.5000	14.0000	16.0000	14.0000	9.0000	16.0000	11.0000
	Performing multiple work	2.0000	4.0000	5.0000	5.0000	3.0000	5.0000	4.0000
	Working without basic needs	0.3000	0.3000	0.3000	0.5000	0.3000	0.3000	0.3000
	Dealing with a Crisis	0.4000	0.4000	0.3000	0.4000	0.3000	0.3000	0.3000
	Duty Completion Target	0.6000	0.7000	0.5000	0.5000	0.5000	0.6000	0.6000
	Disagreeable Duties	0.2000	0.4000	0.3000	0.4000	0.3000	0.3000	0.3000
Output	Output1 (Physical Factor)	0.4000(L) 0.6000(M)	0.2000(L) 0.6000(M)	0.8000(L) 0.2000(M)	0.4000(L) 0.6000(M)	0.8000(L) 0.2000(M)	0.6000(L) 0.4000(M)	0.6000(L) 0.4000(M)
	Output2 (Mental Factor)	0.3750(L) 0.6250(M)	0.5000(M)	0.5000(M) 0.5000(H)	0.5000(M) 0.5000(H)	0.5000(L) 0.5000(M)	0.5000(M) 0.5000(H)	0.5000(M)
	Output 3	0.3558	0.5000	0.6071	0.6875	0.3125	0.6666	0.5000

Note: L- Low, M- Medium, H-High, LWHs-Long Working Hours Conclusion:

In this study, we conclude from the preceding cases that the factors related to physical stress are working overtime and doing multiple tasks, and the factors related to mental stress are Duty Completion Targets play an important role in the final output, which is the stress level of police personnel. As a result, measures have been taken to keep the aforementioned factors within critical limits in order to keep the stress level manageable.

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