Table 7. Motorist perceptions on police response and service times at 20% dissatisfaction (Unit: minute)

Time	Factor	Traditional community	Business district	Suburban area	Residential district	Factor	Age under 30	Age 31-40	Age over 40
Response time	Male	9.7	13.1	14.1	13.7	Secondary school	9.8	9.3	12.2
	Female	9.6	16.8	15.0	14.4	University	11.5	11.4	12.5
						Graduate school	17.6	9.8	16.2
Service time	Male	31.3	29.6	44.8	27.3	Secondary school	15.0	19.5	27.4
	Female	32.7	32.0	48.5	28.1	University	36.6	26.8	36.4
						Graduate school	53.0	23.3	48.5

Finally, we also wondered if the motorist perceptions were influenced by different types of accident: A2 (injured) and A3 (property-damaged only). Table 8 presented the motorist perceptions toward the police response time and service time with different types of accident, where the total 254 respondents have been randomly and equally divided into three groups. It is reasonable to postulate that the service time in investigating an A2 case should be longer than the time in investigating an A3 case. A *t*-test was used to examine the difference between A2 and A3. The result showed that, as what anticipated, motorist satisfaction and dissatisfaction perceptions on the police service time for A2 case are significantly longer than that for A3 case at a significance level of 5%. However, no significant difference between these two types of accident was found on the police response time.

Table 8. Motorist perceptions on police response and service times for different types of accident

Item	Group	80% satisfaction threshold		20% dissatisfaction threshold	
		A2	A3	A2	A3
Response time	1	7.0	5.7	12.8	11.7
	2	7.2	6.1	9.5	11.7
	3	6.0	6.4	10.8	11.2
Service time	1	29.5	9.3	45.3	23.0
	2	26.9	13.3	41.1	25.0
	3	24.7	16.7	37.5	20.0

Note: A2 refers to injured accident; A3 refers to property-damaged only accident

4. DISCUSSION AND CONCLUSIONS

In Taiwan, a motorist involved with a road traffic accident will normally call the 110 hotline for police service. Upon receiving a call, the police staff in the command center will record the motorist's information and assign the jurisdictional precinct to dispatch police manpower to the accident spot as quickly as possible. The police administrators in Taipei City used to ask their subordinated police to quickly respond to and serve for the road traffic accidents, but no rigorous methods have been attempted to determine the response time and service time. Our study provided a pragmatic approach for this purpose.

This study made use of the 110 hotline in the police command center to call back the

accident reporting motorists to interview their perceptions on the police service. It contributed to the policing literature in several ways. It is the first of its kind to utilize the 110 police hotline as a channel to inquire the previous accident reporting motorists about their opinions, rather than via a questionnaire survey on the general citizens commonly used by most literature. Because the perceptual measures typically exhibited with vagueness, we employed the fuzzy logic, in lieu of conventional crisp binary-valued logic, to measure the motorist perceptions on police services. The case study in Taipei City has explicitly disclosed the majority of motorists' expectations, which can facilitate the police to derive more effectual service and to reexamine the current practices in response to traffic accidents. According to the findings, some policy implications and directions for future studies are discussed below.

Most of the motorists who involved in an accident in Taipei City were satisfied with the police response time—the percentages of satisfaction varied from 66% to 83% depending on the administrative region. The current standards practiced by the Taipei City Police Department (TCPD) are as follows: a response time within 4 minutes is very satisfactory, 4 to 6 minutes is satisfactory, 6 to 10 minutes is acceptable, 10 to 15 minutes is dissatisfactory, and over 15 minutes is very dissatisfactory. Those arriving at the accident spot within 4 minutes will be rewarded and more than 15 minutes will be punished. The standards together with the rewarded/punished system have been practiced for years but no one could accurately explain the rationale. Our findings that "no less than 80% of the motorists would be satisfied and no greater than 20% of the motorists would be dissatisfied providing that police response time could stay within 5 to 10 minutes" may throw new light to refine the standards of response time practiced by TCPD and to review the appropriateness of police deployment.

Most motorists have not reached a consensus about how long the police should take to investigate a traffic accident. With respect to the A2 and A3 accident types, the motorists have perceived that the time needed to investigate an injured case is different from a property-damaged case. The significant difference between A2 and A3 for both motorist's satisfaction and dissatisfaction toward the police service time might explain why TCPD had no standards for the service times. Nonetheless, our findings that "no less than 80% of the motorists would be satisfied and no greater than 20% of the motorists would be dissatisfied providing that police service time could stay within 20 to 35 minutes" may add new evidence to launching standards of service times or providing ideal norms to accomplish the preliminary investigation corresponding to different types of accident for TCPD.

The accident involved motorist's satisfaction/dissatisfaction toward police not only depends on response time and service time, but also on other service quality factors such as police attitude, professionalism, impartiality, and compassion to the involved parties. The present study focused on response time and service time, which allowed the motorists to feel the efficiency in response to a traffic accident. Although this study has also touched a little upon the degrees of importance for these service quality factors, it requires further elaboration on the service quality issues relating to police attitude, professionalism, impartiality, and compassion to the involved parties so as to greatly enhance the motorist satisfaction level. Furthermore, the present study used two threshold values (80% and 20%) to define the majorities and the minorities. In fact, these thresholds should be determined by the highest decision maker such as the Mayor. Changing the threshold values would certainly lead to different outcomes, thus it would change the standards of response time and service time. If the Mayor wishes to shorten the police's response time and service time, the two threshold values must be altered (e.g., 90% and 10%); accordingly, our membership functions can easily produce a different set of standards. Future study can also develop education or on-job training programs to cultivate the police skills and knowledge in recording the accident scenes and investigating the accident cases. Of course, the cutting-edge devices with

cloud-computing technologies can also be introduced to accident scenes and investigation to greatly ameliorate the efficiency and effectiveness of police service quality.

REFERENCES

Ashcroft, J., Daniels, D. J., Hart, S. V. (2003) *Factors that Influence Public Opinion of the Police*. Research for Practice. US Department of Justice, Office of Justice Programs, National Institute of Justice, Washington, DC.

Beck, K., Boni, N., Packer, J. (1999) The use of public attitude surveys: What can they tell police managers? *Policing: An International Journal of Police Strategies & Management*, 22(2), 191-216.

Bellman, A. (1935) A police service rating scale. *Journal of Criminal Law and Criminology*, 26, 74-114.

Brown, B., Benedict, W. R. (2002) Perception of the police: Past findings, methodological issues, conceptual issues and policy implications. *Policing: An International Journal of Police Strategies & Management*, 25(3), 543-580.

Chiu, H. M. (2011) The development of the inventory of satisfaction with police service. *Police Science Bimonthly*, 42(1), 155-185.

Chu, D. C., Hung, L. S. J. (2010) Chinese immigrants' attitudes toward the police in San Francisco. *Policing: An International Journal of Police Strategies & Management*, 33(4), 621-643.

Civanlar, M. R., Trussel, H. J. (1986) Constructing membership functions using statistical data. *Fuzzy Sets and Systems*, 18(1), 1-14.

Davis, J. R. (1990) A comparison of attitudes toward the New York City police. *Journal of Police Science and Administration*, 17(4), 233-243.

Decker, S. H. (1981) Citizen attitudes toward the police: A review of past findings and suggestions for future policy. *Journal of Police Science and Administration*, 9(1), 80-87.

Dietz, A. S. (1997) Evaluating community policing: Quality police service and fear of crime. *Policing: An International Journal of Police Strategies & Management*, 20(1), 83-100.

Dietz, A. S., Watson, E. M. (1994) *Evaluating Community Policing: Citizen Rating of Quality of Police Service*. City of Austin, Police Department, Austin, TX.

Dimitru, V., Luban, F. (1986) On some optimization problems under uncertainty. *Fuzzy Sets and Systems*, 18, 257-272.

Donnelly, M., Kerr, N. J., Rimmer, R., Shiu, E. M. (2006) Assessing the quality of police services using SERVQUAL. *Policing: An International Journal of Police Strategies & Management*, 29(1), 92-105.

Frank, J., Brandl, S. G., Cullen, F. T., Stichman, A. (1996) Reassessing the impact of race on citizens' attitudes toward the police: A research note. *Justice Quarterly*, 13(2), 321-334.

Hannan, E. L. (1981) Linear programming with multiple fuzzy goals. *Fuzzy Sets and Systems*, 6, 235-248.

Hersh, H. M., Caramazza, A., Brownell, H. H. (1979) *Effects of Context on Fuzzy Membership Functions in: M. M. Gupta, R. K. Ragade, R. R. Yager: Advances in Fuzzy Set Theory and Applications*. North-Holland.

Heshmaty, B., Kandel, A. (1985) Fuzzy linear regression and its application to forecasting in uncertain environment. *Fuzzy Sets and Systems*, 15, 159-182.

Horowitz, J. (2007) Making every encounter count: Building trust and confidence in the police. *National Institute of Justice Journal*, 256, 8-11.

Kiszka, M. E. Kochanska J. B., Sliwinska, D. S. (1985a) The influence of some fuzzy

implication operators on the accuracy of fuzzy model – part I. *Fuzzy Sets and Systems*, 15, 111-128.

Kiszka, M. E. Kochanska J. B., Sliwinska, D. S. (1985b) The influence of some fuzzy implication operators on the accuracy of fuzzy model – part II. *Fuzzy Sets and Systems*, 15, 223-240.

Krusinska, E., Liebhart, A. (1986) A note on the precision of linguistic variables for differentiating between some respiratory disease. *Fuzzy Sets and Systems*, 18, 131-142.

Lanier, M. M., Davidson, W. S. (1994) Methodological issues related to instrument development for community policing assessments. *Police Studies*, 17(4), 21-40.

Maxson, C., Hennigan, K., Sloane, D. C. (2002) *Not Just a Popularity Contest*: *Factors that Influence Public Opinion of the Police*. Research for Practice. US Department of Justice, Office of Justice Programs, National Institute of Justice, Washington, DC.

Morgan, C., Murgatroyd, S. (1994) *Total Quality Management in the Public Sector*. Buckingham, Open University Press.

Nofziger, S., Williams, L. S. (2005) Perceptions of police and safety in a small town. *Police Quarterly*, 8(2), 248-270.

Parasuraman, A., Zeithaml, V. A., Berry, L. L. (1988) SERVQUAL: a multiple-item scale for measuring customer perceptions of service quality. *Journal of Retailing*, 62, 12-40.

Sakawa, M. (1983) Interactive computer programs for fuzzy linear programming with multiple objectives. *International Journal of Man-Machine Studies*, 18(5), 489-503.

Sakawa, M., Yano, H. (1986) Interactive fuzzy decision making for multiobjective nonlinear programming using augmented minimax problems. *Fuzzy Sets and Systems*, 20, 31-43.

Schafer, J. A., Huebner, B. M., Bynum, T. S. (2003) Citizen perceptions of police services: Race, neighbourhood context, and community policing. *Police Quarterly*, 6(4), 440-468.

Schwab, K. D. (1983) *Ein Auf Dem Konzept der Unscharfen Mengen Basierendes Entscheidungs Modell Bei Mehrfacher Zielset*. Peter Lang, Frankfurt.

Schwartz, D. G. (1987) Axioms for a theory of semantic equivalence. *Fuzzy Sets and Systems*, 21, 319-350.

Skogan, W. G. (1990) *Disorder and Decline*. Berkeley: University of California Press.

Skogan, W. G. (2005) Citizen satisfaction with police encounters. *Police Quarterly*, 8(3), 298-321.

Skogan, W. G. (2006) Asymmetry in the impact of encounters with police. *Policing and Society: An International Journal of Research and Policy*, 16(2), 99-126.

Sugeno, M., Kang, T. T. (1986) Fuzzy modeling and control of multilayer incinerator. *Fuzzy Sets and Systems*, 18, 329-346.

Sugeno, M., Nishida, M. (1985) Fuzzy control of model car. *Fuzzy Sets and Systems*, 16, 103-113.

Sun, I. Y., Wu, Y., Hu, R. (2013) Public assessments of the police in rural and urban China: A theoretical extension and empirical investigation. *British Journal of Criminology*, 53(4), 643-664.

Svarovski, S. G. (1987) Usage of linguistic variable concept for human operator modeling. *Fuzzy Sets and Systems*, 22, 107-114.

Tanaka, S. Uejima H., Asai, K. (1982) Linear regression model. *IEEE Transaction on Systems, Man and Cybernetics*, 12.

Tyler, T. R. (1990) *Why People Obey the Law*. New Haven, CT, Yale University Press.

Tyler, T. R. and Darley, J. M. (2000) Building a law-abiding society: Taking public views about morality and the legitimacy of legal authorities into account when formulating substantive law. *Hofstra Law Review*, 28, 707-739.

Watson, E. M. (1994) *The state of community policing in Austin, Texas*. presentation to

Community Policing Consortium cluster meeting, March 2-4, St Petersburg, FL.
Webb, V. Marshall, C. (1995) The relative importance of race and ethnicity on citizen attitudes toward the police. *American Journal of Police*, 19(2), 45-61.
Weitzer, R., Tuch, S. A. (2005) Determinants of Public Satisfaction with the Police. *Police Quarterly*, 8(3), 279-297.
Yang, M. P. (2002) *Police Manpower Requirement for Traffic Accident Handling*. Unpublished Master Thesis, Department of Traffic Science, Central Police University.
Zadeh, L. A. (1965) Fuzzy relations. *Inform and Control*, 8, 338-353.
Zadeh, L. A. (1971) Quantitative fuzzy semantics. *Information Sciences*, 3, 159-176.
Zadeh, L. A. (1972) A fuzzy set theoretic interpretation of linguistic hedges. *Journal of Cybernetics*, 2(3), 4-34.
Zadeh, L. A. (1975-1976) The concept of linguistic variable and its application to approximate reasoning. Parts I, II, III. *Information Sciences*, 8, 9, 119-249, 201-357.
Zamble, E., Annesley, P. (1987) Some determinants of public attitudes toward the police. *Journal of Police Science and Administration*, 15, 285-290.
Zeithaml, V. A., Parasuraman, A., Berry, L. L. (1990) *Delivering Service Quality*. The Free Press, New York, NY.
Zimmermann, H. J. (1978) Fuzzy programming and linear programming with several objective functions. *Fuzzy Sets and Systems*, 1, 44-55.