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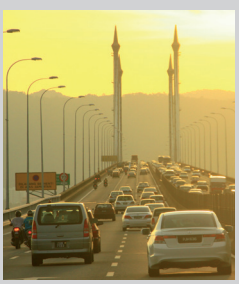

Research Report

A Study on Automotive Tint Glazing in Malaysia

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Abstract

The level of Visible Light Transmission (VLT) for front windscreen and other windows of vehicles have not been reviewed since its first implementation in Malaysia. The Ministry of Transport (MOT) has taken the initiative through its formalized committee to review the relevancy of existing VLT specifications, propose recommendations and acquire feedbacks from related stakeholders and consumers through a two-day seminar which was held from 2nd to 3rd June 2014. As part of the committee, MIROS was given the responsibility to review the effects of window tinting on driver's visual performance and thermal comfort, gauge the public perception on the usage of window tinting and existing law in Malaysia, and investigate the current scenario of VLT compliance on the ground. Overall, reducing the level of VLT (darker tinting) may affect the visual performance particularly for older drivers, but have minimal effect in reducing the cabin temperature as infrared rejection plays a more significant role than VLT in reducing the heat penetration into the vehicle. Though most of the surveyed respondents had their vehicles tinted, knowledge on existing law in terms of allowable VLT specification and amount of fine if violated was very low. Apart from that, most of the volunteered vehicles inspected for VLT compliance did not comply with the existing VLT specification. Further observation revealed that there might be some misinterpretations by the tinted shops and consumers on the final VLT value when the tinted film is attached onto the existing glasses which already have built-in VLT level. After taking into consideration all the findings, potential recommendations are proposed at the end of this report for consideration by the related authorities.

1.0 Introduction

Window tint film, typically applied to vehicle windows and windscreens, is commonly offered as an after-market product by dealers and independent operators. Automobile window tinting has the effect of darkening the windows' appearance and the visibility indicator is measured as Visible Light Transmission (VLT). VLT is defined as the percentage of solar visible light (daylight) transmitted through a glazing system in which the lower the VLT percentage, the darker the tint.

Generally, the automobile tinting laws are set by authorities to ensure the darkness of window films does not pose hazard to motorists. Since the films (or tints) reduce the VLT through vehicle windows, limit must be set for the VLT to assist motorists to perceive hazards when they are seen through the windows of other vehicles. The VLT requirements in automobile tinting laws vary between countries.

In some countries for example in Canada and United States, the laws are set at the provincial or state level (IWFA, 28 April 2003; FMCSA, n.d.; GOV.UK, 19 September 2014). In Belarus, any kind of window tinting for all vehicle windows was completely illegal except for vehicles of certain officials (Kraina, 2 February 2006). There are also few countries which prohibit window tinting for certain windows on vehicle only, for instance Italy and New Zealand (Ministry of Infrastructure and Transport Italy, 21 May 2005; NZTA, September 2010). Table 1 summarizes the VLT requirements for several countries worldwide.

As for Malaysia, the existing law (at the time of this study was conducted) specifies minimum permissible VLT levels of 70% for the front windscreen (FWS) and 50% for all other windows

(all side windows (SW) and rear windscreen (RWS)) (RTD, 16 November 2012). Since then, the VLT requirement has not been revised and there has been a considerable debate among the public and tint accessory shops on pros and cons of reducing the VLT levels. This has triggered the government to relook this issue.

The Ministry of Transport (MOT) Malaysia has formed a committee consists of several government agencies including Malaysian Institute of Road Safety Research (MIROS) to review the relevancy of existing VLT specifications in terms of its impacts to the enforcement activities by the authorities, road safety, ergonomics and security, and propose a new policy for window tinting in Malaysia.

MIROS has been given the task to provide inputs in relation to road safety, ergonomics and public perception. The findings obtained from this study were presented during a two-day workshop held by MOT from 2nd to 3rd June 2014 at Holiday Inn, Glenmarie, Shah Alam.

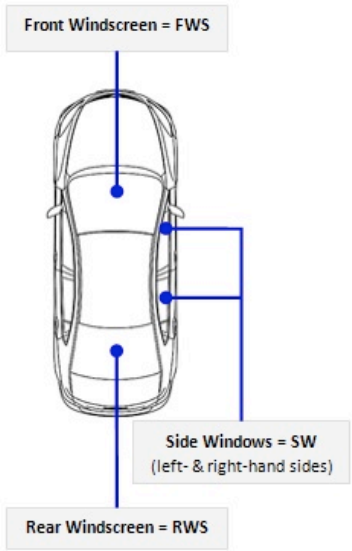
1.1 Research Objectives

Generally, the objective of this study is to provide a basis for clarification of governmental future policies and directives regarding the use of automotive tint glazing.

Specifically, four objectives are aimed for the study:

a. To review established literatures on the effect of window tinting towards drivers' visual performance.
b. To investigate the effect of window tinting towards vehicle occupants' thermal comfort.
c. To gauge public perception on window tinting usage and existing law in Malaysia.
d. To determine the status of VLT compliance of tinted vehicles in Malaysia.

Table 1 Comparison of VLT requirements for vehicle tint laws between countries



Country		Visible Light Transmission (VLT)		
		FWS	SW	RWS
	Malaysia	70%	50%	50%
	Belarus	Illegal		
	Canada	Vary between provinces. For FWS: Max. 15cm (e.g. Quebec, Ontario), Min. = 7.5cm (Brit. Colombia) & Illegal for N. Brunswick		
	India	70%	50%	70%
	Italy	Illegal	Illegal for 1st; No limit for 2nd & so on	No limit
	Malta	Depth ≤100mm of depth of WS	70% for 1st; 30% for 2nd & so on	-
	Australia	Vary between states. Min. 75% for FWS & Min. 35% for 1st & 2nd SW.		
	New Zealand	Illegal	35%	35%
	Russia	75%	75% on 1st	-
	Singapore	70%	70% for 1st; 25% for 2nd & so on	25%
	UK	75%	70% for 1st	-
	US	Vary between states. Max. 70% (e.g. New York, California) & Min. 20% (New Mexico) for 1st SW.		

*Note: FWS = Front Windscreen; RWS = Rear Windscreen; SW = Side Windows; FSW = Front Side Windows; RSW = Rear Side Windows

(Sources: Extracar, 2012; FMCSA, n.d.; GOV.UK, 19 Sep 2014; IWFA, 28 Apr 2003; Kraina, 2 Feb 2006; Ministry of Infrastructure and Transport Italy, 21 May 2006; Nanolux, 2014; NZTA, Sep 2010; Paultan, 29 Sep 2012; RMS, 3 Jul 2003; RTD, 16 Nov 2012; UK Window Tints, n.d.; WFAANZ, 2014; Window Tint, 2014)

2.0 Effect of Automotive Tinting on Visual Performance

It is commonly perceived that at certain VLT level, visual performance of drivers are substantially affected, that is their ability to see through windscreens and windows, to detect or get informed of the potential hazards or the directions they are moving towards to, may be reduced. Therefore, to understand further regarding the VLT effects on visual performance, relevant literatures were referred to for some insights. Among the interests covers; VLT level and performance, its limiting level, associations with visual performance relative to drivers' visual information and also on the road safety issues. Additional concerns include consumption of glazing as medium of getting traffic information. Nonetheless, since this study is exploratory in nature and does not in any way provides intervention or tries to affect changes in the glazing systems such as the windscreen rake angles, then comment on such matter is explicitly reserved.

2.1 VLT Level and Visual Performance

Visible Light Transmittance (VLT) refers to the amount of visible light that passes through a glazing system and could be simply measured (Tuchinda et al., 2006). In this case the glazing refers to the vehicle windows, usually made of glass, such as the front and rear windscreens and also the side windows. The higher VLT level-measured in percentage is associated to the higher amount of visible light that pass through the glass and into the vehicle interior space. High VLT level is generally favourable since visual cues are primarily responsible for approximately 95% of driving-related inputs (Shinar & Schieber, 1991). Hence, what would be the optimal or accepted level of VLT, without compromising road safety?

2.2 Optimal VLT Level

Optimal VLT shall not affect visual performance of car occupants, especially drivers in comprehending their travel path. If the VLT impedes the response time to objects or hazards recognition, then it may increase the risk of accident. Ideally, clear un-tinted glazing which provides maximal transmittance would be the preferred option, as highlighted by Shi et al., (2008) that visual acuity and glare response were not affected at VLT level of 75% both for the young age group (mean 26 years) and also the aged group (mean 74 years). The study utilized standard coloured glass without additional tint material (Waetjen et al., 1991). In other words, standard windscreens has already had reduced VLT without affecting visual performance.

However, as glazing technology and knowledge advances, improved and better techniques have been adopted such as the consumption of variety of tint level and colours combinations. Interestingly, such adoption comes with potential implications. For instance, with regards to driver visual performance decline, a review by Sayer & Traube (1994) indicated that VLT has a linear effect on driver visual performance, where a reduction of VLT from 100 to 50% may potentially result in a reduction of visual performance between 10 to 20%.

Correspondingly, Waetjen et.al. (1991) supported this observation by stressing that a reduction of 9% in VLT level (90% reduced to 81%) has resulted in the drop of recognition distance by 3 to 4 meters. Similarly, Burns (1999) addressed that a decrease in visual performance was prevalent for elderly drivers at VLT 63% and 35%. Hence, considering the worst case scenario concerning elderly drivers driving during twilight or at night, VLT 35% or less on car front and side windows may compromise road safety (Freedman et al., 1993).

In the event of car backing or reversing manoeuvre, Freedman et.al (1993) in his work contemplated that VLT less than 70% for rear windscreen are possibly risky for elderly drivers (ages 75+) (LaMotte

et al., 2000). The study iterated that lower luminous contrast of the target objects and their surroundings would increase the risk further. Such observation was strongly supported by Haber (1955) whom stated that the relative visibility loses may be as high as 30 to 45 percent.

2.3 Other VLT issue

In certain circumstances in traffic environment, there exist needs for other road users, such as pedestrians and cyclists, to look through vehicle windows for vital traffic cues. In other words these users exploit the see-through windows, for information beyond the ordinary mechanism of unobstructed visual confrontation, as depicted in Figure 1. In details, Proffitt et al. (1995) shows that the VLT 35% of front side windows could substantially reduce the external viewers' traffic cues to check the presence of pedestrians, cyclists or other road users. In brief, similar principle applies in situation where when two cars are facing in opposite directions, waiting to turn at traffic islands in the middle of a main road or at the intersections or when cars lined up (Proffitt et al, 1995). Furthermore, such situation is foreseen to become worse during low ambient lighting.

Figure 1 Image of cyclist as seen through un-tinted windows (left) and tinted windows with 35% VLT (Proffitt et.al, 1995)

Correspondingly, low VLT of 35% on all windows (except the windscreen) reduces the ability of outsiders to see into the vehicle interior. A study by Proffit et al. (1993) revealed that heavily tinted windows might pose concerns about the safety of the enforcement officers. For instance, in situation where the enforcement officers need to approach a stopped vehicle with heavy tint, it may increase the level of caution because they can hardly see the occupants in the vehicle. This may impede the officer's ability to detect weapons, contraband, or threatening acts by the drivers or passengers (Virginia State Police, 1988). In the study, 81% of the respondents were not able to recognize objects in heavily tinted cars. In brief, heavy tint at certain VLT level on windows possibly creates unnecessary security and safety risks to enforcement personnel and to the surroundings.

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3.0 Effect of Automotive Tinting on Thermal Comfort

In reducing cabin temperature, a few methods have been suggested;using sunshades, enhance vehicle ventilation (window rolled down or solar powered ventilator) and window tint. Window tinting as a permanent measure was claimed to be more effective in reducing interior cabin temperature, provides privacy to the users and enhance the asthetical value of vehicle (Proffitt et al., 1994). Thus, to further investigate the effect of window tinting on the cabin temperature, an experimental study was conducted.

3.1 Methodology

Perodua Myvi, a national car model, was selected as the test vehicle as it is one of the highest selling cars in Malaysia. Apart from that, this model was chosen due to its smaller size as the temperature increment inside the car can be observed more rapidly (Grundstein et al., 2010). To avoid any potential effects of body color although it has been proven that it has negligible effect (Manning and Ewing, 2009) and also type of tint used to the resulting temperature, only vehicles with dark color and equipped with tint film in the range of RM200 to RM400 were chosen.

Finally, four vehicles with different VLT specifications, as shown in Table 2, were selected for the experiment. To measure the ambient temperatures for each test vehicle, four sets of temperature recorder were installed at the centre of the test vehicles, in between driver and passenger seats. The test subjects were pre-conditioned at the same temperature before readings were taken. Readings on the temperature recorders were taken every one minute after the ambient temperature was in steady state at 30°C.

Table 2 VLT specifications of test vehicles

VLT Type	FWS (%)	SW & RWS (%)
I	70	70
II	70	50
III	60	50
IV	50	35

* FSW – Front Side Window, RSW – Rear Side Window, RW – Rear Windscreen

The selection comprised of four different type of VLT configuration. Type I complied with the UN Regulation whereas Type II complied with the existing Malaysian law which has lower VLT requirement on SW and RW as compared to UN Regulation. Vehicle with Type III did not comply with Malaysian requirement because of lower VLT rating for front windscreen. Lastly, neither front windscreen, side windows nor rear windscreen for Type IV complied with either UN Regulation or Malaysian law.

The experiment was conducted at MIROS' car park on 23rd May 2014 between 11:30 am and 12:00 pm. The weather was sunny with temperature of 24°C to 32°C (Intellicast, 2014). The test vehicle faced East-West orientation to ensure maximum sun load on car windscreen and windows (Jasni & Nasir, 2012). All the test vehicles were parked close to each other as in typical open car park setting. In addition, all windows were shut to limit the ventilation and maximize the vehicle heating (Grundstein et al., 2010; Al-Kayiem et al., 2010).

3.2 Result and Discussion

Figure 2 shows the difference in vehicle cabin temperatures for every minute. Initially, the cabin temperature for each tested vehicle increased rapidly. However, the temperature became constant after 15 minutes of measurement. The temperature readings also showed the saturated temperature after long hours of parking. Temperature reading in four hours showed that the cabin temperature for all vehicles was saturated at 38°C to 42°C.

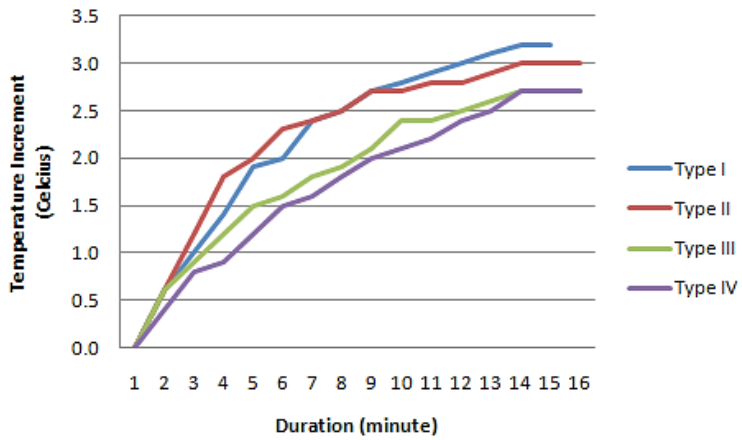

Figure 2 Cabin temperature increment over time

A minimal temperature difference was observed among the test vehicles. Comparing the final cabin temperature of two most extreme samples (Type I and Type IV), only about 0.5°C of temperature difference was recorded which is consistent with the finding from Southall et al. (1999) where tinted windshield made a vehicle about 0.5°C to 1°C cooler in motion while approximately 2°C to 3°C cooler than non-tinted windshield in parked parking situation.

As sunlight transmitted through the vehicle windows, a portion of it is transmitted as heat which is absorbed by window glass and later transmitted into interior and exterior (Proffitt et al., 1994). Sun energy comprises visible light, infrared radiation and ultraviolet radiation with typical distribution of 43%, 54% and 3% respectively. These three elements of sun energy must be filtered out to make an efficient window tint.

In the experiment, window tint on all cars which only filter visible light element had merely minimal cooling effects despite the variation of VLT value. Although visible light may be sufficiently filtered, heat was still transmitted to car cabin as a result of infrared and ultraviolet element.

4.0 Public Perception on Automotive Tinting

In order to gauge public perception on tinting practices and their awareness on existing legislation, a survey was conducted. The methodology used, finding and discussion are explained in the following subsections.

4.1 Methodology

A total of 1,000 respondents were selected for this study. The number of sample was calculated based on the 583,060 of registered vehicle for year 2013. Data were collected via a self-administered questionnaire in three locations. The selected locations were Seremban rest and service area (RnR), Kajang and Putrajaya areas.

The questionnaire consists of five main sections; (i) information and reasons for tinting, (ii) knowledge on existing law and violation penalty, (iii) VLT preferences for front windscreen and side windows, and (v) demographic profiles. A field survey was carried out from 26 – 28 May 2014. Only drivers who owned driving licenses at the time of survey were interviewed.

In order to identify public preference of which tinting level to choose from in part (iii), the respondents were given several flash cards which uninamously indicate different VLT levels for front windscreen and side windows. The VLT value for each flash card was not revealed to the respondents in order to avoid any bias. All of the collected data was coded and then analyzed (descriptive analysis) using Statistical Package for the Social Sciences (SPSS) version 20.0.

4.2 Result and Discussion

Of the total 1,000 respondents surveyed, 341 were females and 659 male. All of the respondents were aged between 18 and 71 years old with mean age of 37 years old. More than half of the respondents (63.1%) have tertiary education background and have an income of more than RM 2,000 (62.4%). Among all of the respondents, only 5.4% have been penalized for tinted violation. Table 3 shows the demographic profiles of the respondents.

Table 3 Demographic profiles of respondents

Factor	n	%
Gender		
Male	659	65.9
Female	341	34.1
Age Group		
18 – 25 years old	146	14.6
26 – 35 years old	426	42.6
36 – 45 years old	194	19.4
46 – 55 years old	159	15.9
> 56 years old	75	7.5
Mean : 37 years old		
Range : 18 – 71 years old		
Income level (n=953)		
Less than RM 2,000	358	37.6
RM 2,001 – RM 4,000	406	42.6
More than RM 4,000	189	19.8
Penalized for tinted violation		
Yes	54	5.4
No	946	94.6

Education level		
UPSR	12	1.2
PMR	40	4.0
SPM	317	31.7
STPM	337	33.7
Bachelor Degree	226	22.6
Master Degree	62	6.2
PhD	6	0.6

In addition, 72.5% of the respondents have their vehicles tinted. As shown in Figure 3, the main reasons for tinting their vehicles were hot weather with 67.8%, followed by security reasons (25.3%), reducing glare (20.9%) and for privacy purpose (6.8%). In other words, most of the respondents perceived that by installing window tinting, it can reduce heat penetration due to hot weather situation in Malaysia.

Furthermore, relatively high number of the respondents were either unsure or did not know about the existing VLT specifications for private vehicles in Malaysia. Only 24.0% of the total respondents knew the legal specifications for front windscreen and other windows (Figure 4).

The respondents were also asked to indicate whether they knew the amount of penalty charged for installing tinted glass that do not comply with regulation. A total of 69.0% knew about the penalty imposed while another 31.0% states vice versa. Out of 543 respondents that claimed they knew about the penalty imposed, 453 of them answered correctly with RM 300 compound enforced.

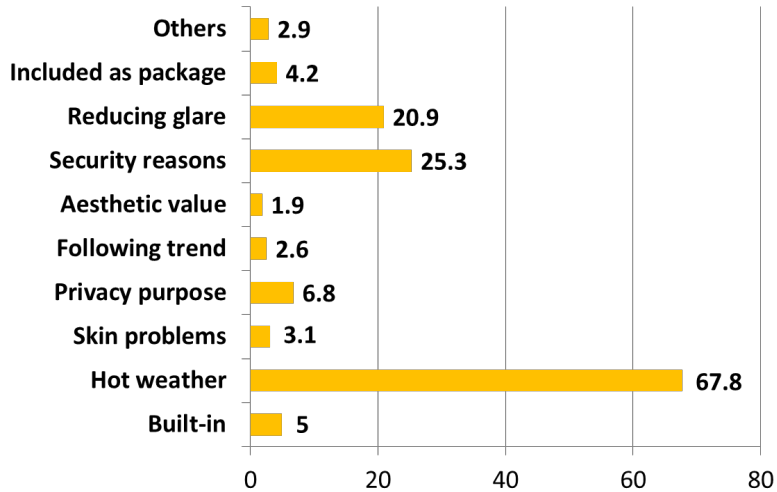

Figure 3 Reasons for vehicle tinting

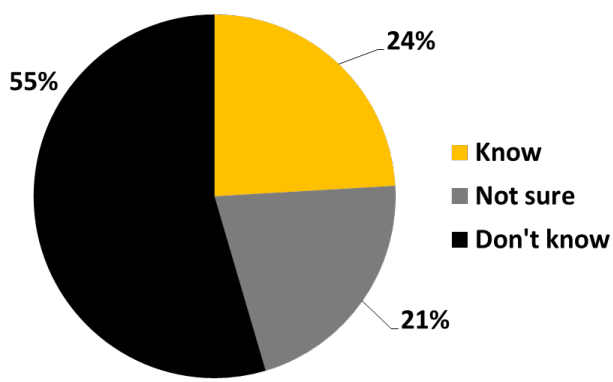

Figure 4 Respondents' knowledge on VLT specification in Malaysia

When the respondents were asked on their perception of tinted glass usage for front windscreen, the majority (44.5%) favoured 60% of VLT for their vehicle. Only 24.2% of the respondents favoured the approved VLT specification of 70%. In response to preference of tinted side windows, most of those surveyed (29.2%) indicated that 45% as their favourable VLT specification for their vehicle. It is slightly higher than the approved VLT specification of 50% with 254 respondents.

5.0 Status of VLT Compliance

A random inspection was performed to investigate the current situation of VLT compliance of tinted vehicles on the ground. The methodology used, finding and discussion are explained in the following subsections.

5.1 Methodology

A calibrated VLT tester was loaned from Road Traffic Department (JPJ). Prior to data collection, training on the technical know-how and operation of the VLT tester was conducted by a trained JPJ officer. Inspections were performed at parking areas around Kajang, Selangor (Figure 5). Several parking spots were identified and each vehicle entering the spots was approached for participation. Only vehicles with tinting and drivers who were willing to participate were included in the data collection. Within two-day period, there were 73 vehicles which were inspected.

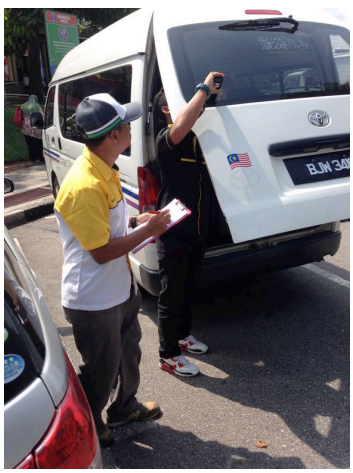

Figure 5 VLT inspection on one of the respondents' vehicles

5.2 Result and Discussion

Overall, about 60% and 50% of the inspected vehicles was not complied with the specifications set in the law on front windscreen (VLT at 70%) and other windows (VLT at 50%) respectively (Figure 6 and Table 4). If at least the VLT level at one of the windows was not complied, the incompliance percentage would be higher at 71%. Although more data is needed to statistically represent the population, the current data already shows worrying figures.

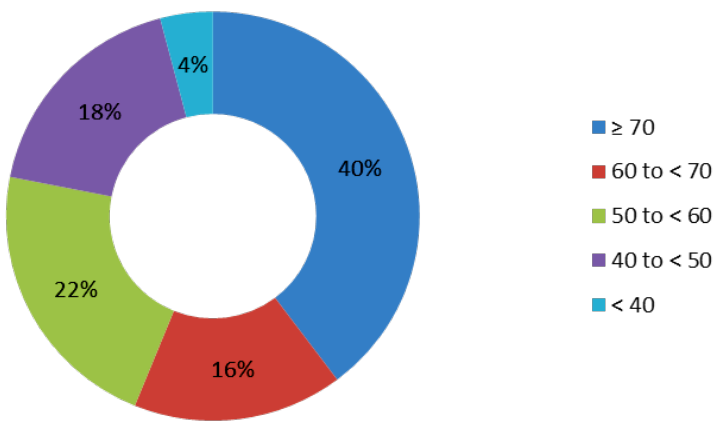

Figure 6 The level of VLT compliance for front windscreen of 73 inspected vehicles

Table 4 The level of VLT compliance for side windows and rear windscreen of 73 inspected vehicles

VLT (%)	FSW [n (%)]	RSW [n (%)]	RW [n(%)]
≥ 50	37 (50.7)	37 (50.7)	39 (53.4)
40 to < 50	19 (26.0)	18 (24.7)	16 (21.9)
30 to < 40	10 (13.7)	8 (11.0)	7 (9.6)
< 30	7 (9.6)	10 (13.6)	11 (15.1)

* FSW – Front Side Window, RSW – Rear Side Window, RW – Rear Windscreen

In addition, communications with the respondents during the inspections revealed that most of them (52 out of 73) were assured by the tinted shops that their VLT specifications have met the requirements set by the regulation and even

being given warranty. Nevertheless, when their vehicles were inspected, only 10 vehicles complied with the legal requirement. There could be misinterpretations by some accessory shops whether intentionally or not on the regulations being setup, by assuming that the existing regulation only applies for the tinted film, not the combination between tinted film and existing glasses.

The existing glasses installed in vehicles usually contain some level of VLT value as manufacturers tend to incorporate the legal need of installing factory glasses with allowable VLT value. Most of the factory glasses fitted into the vehicles is in the VLT range of 70% to 85% and it is not very common to have VLT more than 90% (Johnson Window Films, 2014). As for Malaysia, the VLT requirement has to confirm with requirement set by the UN Regulation No. 43 which has been gazetted and enforced in Malaysia since 2012. Therefore, attaching a film onto the existing glasses with prior VLT value would further reduce the final VLT level.

6.0 Conclusion and Recommendation

A summary of the findings of the study are outlined as follows:

1. Scientific evidences have suggested that further drops in VLT level may affect visual performance since both variables are linearly related. In the case of elderly drivers, their visual performance would be seriously affected both at VLT at 63% and 35%, and would decline substantially if the surroundings of the target objects have low luminance contrast.
2. Excessively tinted VLT of 35% may further reduce the visual source of traffic cues to road users. However, how much such information associates with their response or reaction in traffic situation remains to be uncovered. In addition, low windows VLT of 35% has also been linked to increased safety and security risks to enforcement personnel when performing their checks on vehicles.
3. There is very minimal effect of reduced VLT on the thermal comfort of vehicle occupants based on the vehicle static experiment which is also supported by established studies. Instead of darker tinting with lower VLT (i.e. visible light rejection), infrared rejection plays a more significant role in reducing the heat penetration into the vehicle.
4. Almost three quarter of the respondents surveyed tinted their vehicles primarily because of perceived hot weather, perceived glare reduction and for security purposes. Although most of them knew that there is a regulation for tinted glasses in Malaysia, their awareness and knowledge on the specifications and amount of fine if violated were still very low.
5. Based on the VLT inspection, a relatively high proportion of the tested vehicles failed to comply with the specifications set in the regulation. Further observation revealed that

there might be some misinterpretations by the tinted shops and the public (whether intentionally or not) on the requirements setup in the regulation. Automotive tinting is an unregulated industry in this country. Generally, the tint specifications provided to consumers and the present testing carried out by the tinted shops cannot be properly verified. This may compromise the overall quality in terms of vehicle light transmission (VLT), untraviolet (UV), infrared (IR), adhesive materials, distorting color or shape, life span, and others.

Based on the findings of the study, the following approaches and recommendations have been formulated for consideration by the related authorities:

1. Regulate the installation of tint film in Malaysia and establish a standardized protocol which covers not only the aspect of visible light, but also on ultraviolet (UV), infrared (IR),and other related testing.
2. Establish an effective system that can be utilised as the main source of reference for enforcement on the ground by Domestic, Trade, Cooperatives and Consumerism Ministry (KPDNKK) and Road Transport Department (JPJ).
3. Establish a mechanism to effectively provide related tinting information on regulation and other initiatives to consumers.

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Research Report

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