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## A Preliminary Study of Local Behaviour, Perceptions and Willingness to Pay Towards Better Water Quality in Pasir Mas, Tanah Merah, and Jeli, Malaysia

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# A Preliminary Study of Local Behaviour, Perceptions and Willingness to Pay Towards Better Water Quality in Pasir Mas, Tanah Merah, and Jeli, Malaysia

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**Abstract.** Issues of water quality in Kelantan are often debated by various parties and have gained widespread media coverage. A study is carried out to assess behaviour of users in consuming water, their perceptions and willingness to pay for obtaining better water quality unit at home. Three districts in Kelantan namely; Pasir Mas, Tanah Merah, and Jeli were selected for the study. Questionnaire for 43 respondents in selected districts, interviewing local people, taking water samples, and sending for laboratory analysis were conducted. Shapiro-Wilk test and Spearman test were applied to analyse the results. It was shown that 46.5 % of the users for all drink have more than one source of water at home. Treated water supplied by Air Kelantan Sendirian Berhad was chosen by users as their main source for drinking. A closer look on users' perception regarding water quality reveals that users were neutral about water quality from tap water (treated water supplied by local management) but they express optimistic on water's quality from tube well. However, laboratory analysis of water from alternative sources proved otherwise. 83.7 % of 43 respondents willing to have water filter at home, and the willingness is proportional to the income of the user. These findings are essentials for household water management when multiple sources of water were used. This highlight the need study for water treatment industrial players to provide an efficient yet affordable water solution for the consumers.

## 1. Introduction

Kelantan is blessed with Kelantan River basin with 248 km flowing over more than 85 % of the state. Air Kelantan Sendirian Berhad (AKSB) is the sole water provider in Kelantan since 1995. The company applies Iron and Manganese removal system as well as ozone to treat the water [1]. However, leakage of distribution and main pipes are the biggest challenges. There were 10,437 complaints from users regarding the leakage of distribution pipe and 192 complaints about leakage of main pipes [2]. A total of MYR 2 billion was spent to supply treated water for covering 85% users. The Federal government granted MYR 603 million to the State government, but the grant was only able to cover 64 % of the users in Kelantan [3]. Obstacles in supplying clean water is a long-standing issue as the State government faces financial challenges in providing funds to improve the piping system and coverage [2]. Ministry of Health Malaysia issued to Water Quality Standard to monitor water quality as in Table 1.



**Table 1.** Drinking Water Quality Standard.

<b>Parameter</b>	<b>Maximum/Acceptable Value (mg/Liter) (unless otherwise stated)</b>
Turbidity	5 NTU
pH	6.5 – 9.00
Combined chlorine	0.2-5.0
Iron (Fe)	0.3
Manganese (Mn)	0.1

Source: Engineering Service Division, Ministry of Health Malaysia [9].

The audit report revealed a violation of water quality in water treatment plants (WTP) against the standard occurred 64 times for turbidity, 24 times for pH and 7 times for combined chlorine. The violation occurred due to damaged plant equipment such as leakage filtration tank's valve, leakage of ultra-filtration and sand filter tanks, and spilt polymeric filter media. The damage of the treatment plant's equipment occurred due to the production of treated water that exceeded the capacity. This because of the growing population and supplying water out of the targeted area [1]. Hence, consistent maintenance for plants' equipment is important to prolong the performance of the equipment.

As reported by the Economic Planning Unit in the 10<sup>th</sup> Malaysia Plan, Kelantan has only 59.5 % coverage of treated water in urban areas while 63.4 % in rural areas. Users in Kelantan prefer underground water as their main water source despite treated water supplied by the government. About half of the population in the north of Kelantan use underground water. Furthermore, the 11<sup>th</sup> Malaysia Plan states that the Federal Government determines to increase clean and treated water coverage in Kelantan. The effort for expanding alternative water supply systems in rural areas was carried out by tailoring the systems to local requirements [4]. However, untreated underground water compromises public health. So, this question arises -are users willing to pay to use the filtration system as domestic equipment to obtain clean water? This answer is important to help the industry find a better solution that effective yet affordable.

Hence, the objective of this study is to assess the behaviour of users in consuming water, perception of users in Kelantan towards water quality and their willingness to pay for filter unit to use in their home.

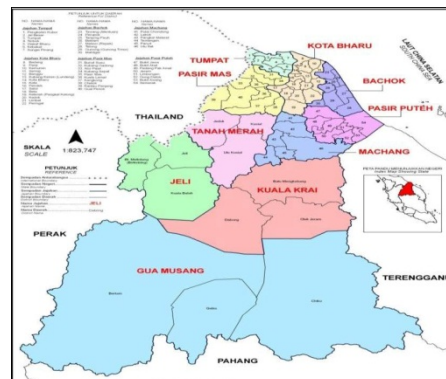
## **2. Methods**

### *2.1 Research location*

The state of Kelantan is located at the northeast of Peninsular Malaysia known as of east coast territory as bounded to the South China Sea in the northeast, Terengganu in the east, Pahang in the south, Perak in the west and Thailand in the north as presented in Figure 1. Three districts were selected; Pasir Mas, Tanah Merah and Jeli. The selection was carried based on preliminary survey to identify focused area with most water shortage and water turbidity problem.

### *2.2 Distribution of questionnaires*

This was a cross-sectional study involving 43 respondents with systematic sampling. The respondents were from Pasir Mas (N= 14), Tanah Merah (N=15), and Jeli (N=14). The approaches to get respondents to answer questionnaires were invitation through email, random distribution of questionnaires in focused area, and home visit arrangement. The questionnaires included 4 sections, i.e. Socio-economic demography information, background of user's water consumption, perceptions against quality of water from current water sources, and willingness to pay and use water filter. There were four attributes in willingness to pay section, and the answers were provided in likert scale. The respondents were also interviewed while answering the questionnaires.



**Figure 1.** Map of Kelantan, Source: Department of Statistical Malaysia [8]

### 2.3 Water sampling

The details of the sampling sites are given in Table 2. Each sample was kept in a 1.5L polyethylene bottle and sealed tightly. The collected samples were labelled with the date and location of sampling. The samples were sent to AKSB laboratory for analysis.

**Table 2.** Details of the sampling sites.

Sample	Coordinate of location	District	Sources of Water
PM1	N 6 °03 08.6 E 102 ° 0639.6	Pasir Mas	Well
PM2	N 6 °03 09.2 E 102 ° 0639.5	Pasir Mas	Well
TM3	N 5 °4856.8 E 102 ° 0757.1	Tanah Merah	Well
TM4	N 5 °5035.3 E 102 ° 0728.0	Tanah Merah	Tube Well
JL5	N 5 °7666.7 E 101 ° 8681.0	Jeli	River
JL6	N 5 °7616.4 E 101 ° 8624.5	Jeli	River

### 2.4 Data analysis

Comparison for user's perceptions on quality of water from current water sources was conducted based on median (Mdn) and inter range quartile (IQR). Data for correlation between willingness and income were analysed by using the Statistical Package for Social Science (SPSS) version 22 at significant level  $p < 0.05$ . Pearson test was used to determine correlation between behaviour of consumption and level of income. The statistical analysis for willingness to pay adopted Shapiro-Wilk test, as well as Spearman test to determine the normality of distribution and correlation respectively.

## 3. Results and discussions

### 3.1 Socio-economic demography studies

Based on socio-economic demography characteristic as shown in Table 3, most of the respondents are female (79.1%,  $n=34$ ). The questionnaires were spread among respondents with various level of income and jobs such as teacher, student, lecturer, cleaner, restaurant's worker, and housewife. About half of the respondents earn income below MYR 950 (46.5%,  $n=20$ ). The economic viability of the local population is a vital factor in determining the market for domestic water filter technology.

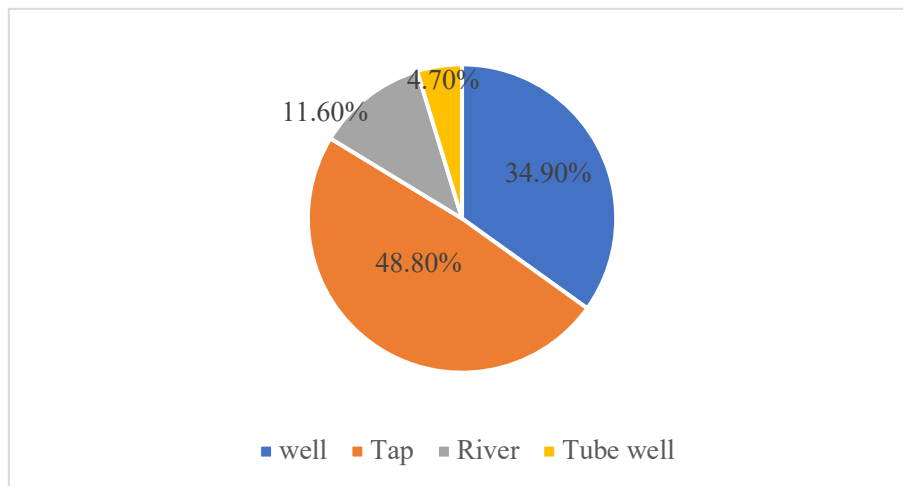
**Table 3.** Socioeconomic demography characteristics of respondents in Pasir Mas, Tanah Merah, and Jeli.

Characteristics	Frequency	Percentage (%)
<b>Gender</b>		
Male	9	20.9
Female	34	79.1

Characteristics	Frequency	Percentage (%)
<b>Age</b>		
Below 35 years old	26	60.5
Above 35 years old	17	39.5
<b>Education level</b>		
PhD/Master	7	16.3
Bachelor	26	60.5
Secondary level	9	21.0
<b>Income</b>		
Below MYR 950	20	46.5
MYR 960 –	-	-
MYR3, 860	11	25.6
MYR 3, 860 –	-	-
MYR 8, 319	10	23.3
Above MYR 8, 319	2	4.7

### 3.2 Sources of water for daily consumption

Based on Figure 2, 48.8 % of respondents use tap water (treated water supplied by AKSB), 34.9 % well, 11.6 % river, and 4.7 % tube well. Sources of water that answered by respondents are varieties. People from the hilly area such as Jeli and northern part of Tanah Merah are taking advantage of direct access to river flown from the hills. Meanwhile, people who live nearby town of Tanah Merah and Pasir Mas are taking advantage of alluvial underground water by forming either well or tube well for high depth. The result portrays that users prefer treated water provided by AKSB. So, it is an opportunity to introduce water filter so that users of raw water able to consume treated water.



**Figure 1.** Sources of water for daily consumptions

### 3.3 Behaviour of consumer in Usage of Water

Table 4 reveals that respondents with income less than MYR 950 had neither use water filter nor vending machine to have treated water.

**Table 4.** Behavior of Consumer in Usage of Water According to Income.

Income	Percentage of Users According to Behaviour of Consumptions (%)			
	Water Filter User (WF)	Vending Machine User (VM)	Both Water Filter (WF) and Vending Machine (VM) Users	None
• <b>Below MYR 950</b>	11.6	11.6	0	23.3
• <b>MYR 960 - MYR 3, 860</b>	4.7	4.7	7	9.3
• <b>MYR 3,860 - MYR 8, 319</b>	11.6	4.7	4.7	2.3
• <b>Above MYR 8, 319</b>	4.7	0	0	0

Based on Pearson test, (Figure 3) the preferred way of obtaining treated water is proportional to the individual's financial position with ( $p < 0.05$ ). Users' preferences in choosing water filter depending on the cost of water filter and filter unit that are easy to install [5]. This implies the cost of water filter will significantly affect the campaigns for sustainable development goal – to achieve equitable access to safe and affordable drinking water for all by 2030.

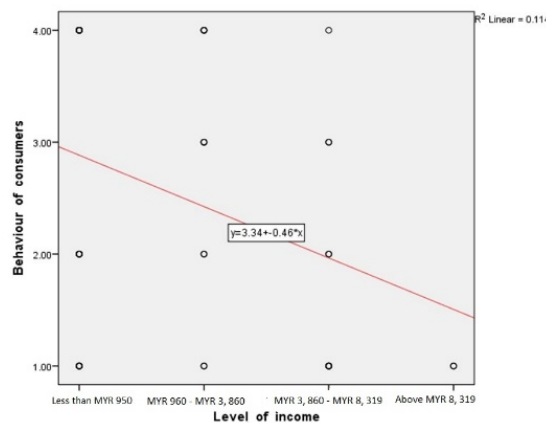
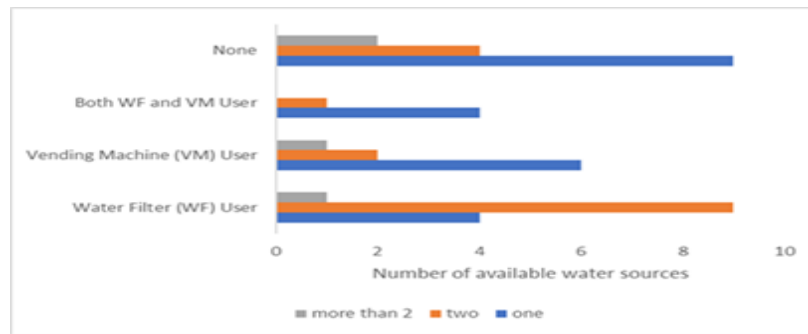
**Figure 3.** Correlation between level of income and behavior of consumer.

Figure 4 shows that respondents who had neither use water filter nor vending machine are those having more than 2 sources of water. On the contrary, respondents who use both a water filter and vending machine are having at most 2 types of water sources only. So, it shows that the number of water sources at home affect the behaviour of consumers. However, the quality of raw water is sceptic due to vulnerability to pollution.

Figure 5 indicates that WF users choose tap water (treated water supplied by AKSB) for drinking (20.93%,  $n=9$ ) and domestic use (25.58%,  $n=11$ ), meanwhile water from well is used for irrigation (9.3%,  $n=4$ ). Based on interviews, the capacity of available water filter in the market in filtering water from well dug on land originating from paddy field is limited. So, the available commercial filter unit used at home requires water supplied by AKSB. The VM users also choose tap water for drinking (6.98%,  $n=3$ ), water from well for domestic use (13.95%,  $n=$ ), and irrigation (11.63%,  $n=5$ ). Apart from having clean water, usage of the vending machine to get clean water becomes the norm for people who live in an area with water pollution and shortage crisis. Residents living at higher altitude go through constant water shortage due to the restricted capacity of the pump at the water treatment

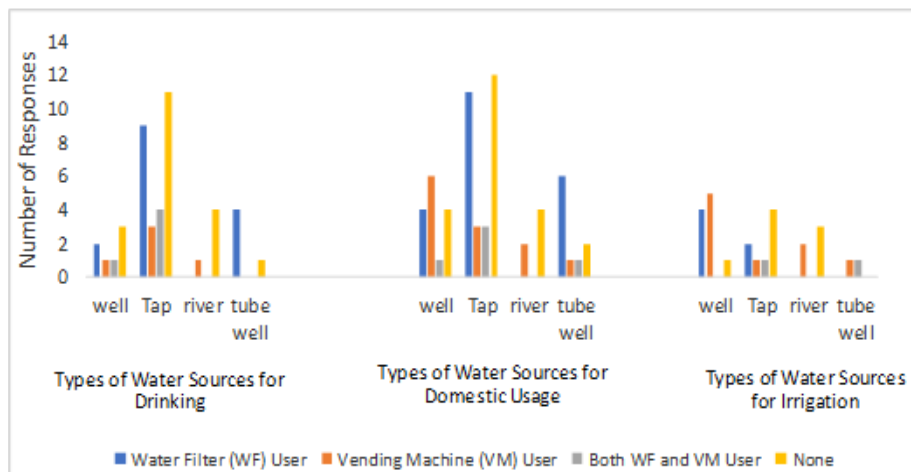


**Figure 4.** Number of available water sources in household according to types of user; water filter user (WF), vending machine user (VM), both WF and VM user, and use that neither use water filter nor vending machine (none)

plant. So, people in such area will usually purchase water at a nearby vending machine at lower ground. Besides, rupture and leakage of distribution pipes are frequent problems in Kelantan. Residents in the affected area obtain clean water from the vending machine for storage.

Both WF and VM use tap water for drinking (9.3%, n=4) and domestic usage (6.98%, n=3) while water from the well for irrigation (11.63%, n=1). Respondents who neither use water filter nor vending machine (none) use tap water for drinking (25.58%, n=11), domestic use (27.91%, n=12), and irrigation (9.3 %, n=4).

Hence, 62.79% of users prefer to tap water for drinking compared to other sources. Respondents that neither uses water filter nor vending machine to have clean treated water depend solely on treated water supplied by AKSB. However, problems that occur in water treatment plant such as filter malfunction lead to violation of water quality standard and risk users' health..



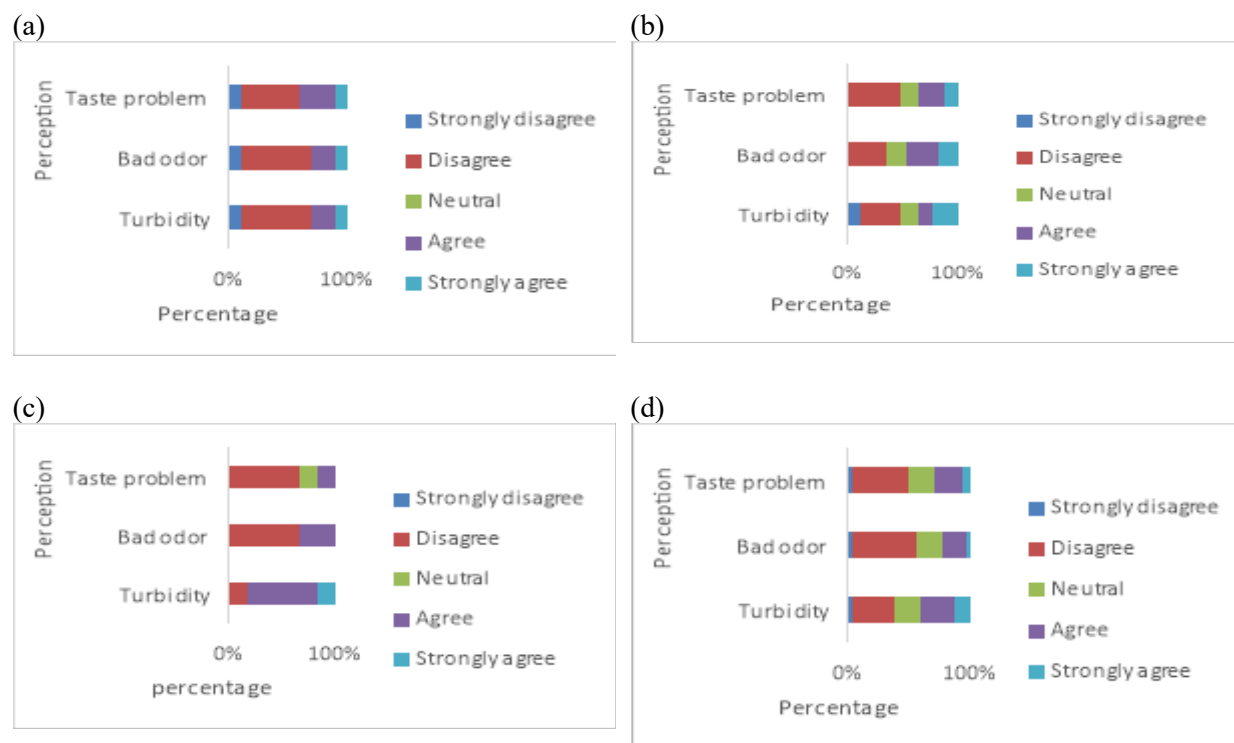
**Figure 5** Types of water sources and usage among users (WF, VM, Both WF and VM, and None).

### 3.4 Perception of users towards different types of water sources

Water quality affects the daily life of a user, so users' perceptions based on Likert scale are recorded (Figure 6). Figure 6 (a) shows opinion regarding quality of water from well. Respondents (35.30%, n=6) express disagreement for water turbidity, but an equal number (35.30%, n=6,) indicates that they agree or strongly agree (Mdn=3, IQR=2). Quality of water from well is different based on users' experience. Based on an interview, water from well dug on alluvial soil (place originated from paddy field) tends to become turbid and getting worst during draught. Meanwhile, other respondents have

been using water from well dug on loam soil (place originated from rubber tree plantation) obtain clean water.

Respondents' perceptions on tap water ( Figure 6 (b)) express disagreement for water turbidity (34.40%, n=11) but other respondents are at equal number (40.60 %, n=13) are agree or strongly agree (Mdn=3, IQR =2). Turbidity in tap water normally occurs during monsoon season and festival season.



**Figure 6.** Users' perceptions on water's quality according to types of water sources (a: well, b: tap water, c: river, d: tube well).

Based on Figure 6( c) respondents (66.67%, n=5) that use raw water from the river indicate agreement with a turbidity of the water (Mdn=4, IQR = 1). Besides, (60%, n=7) of respondents that use tube well as a source of water (Figure 6 (d))express disagreement for water turbidity (Mdn=2, IQR=0). Tube water is obtained by 'bore' technique and drilled up to 60 ft deep.

The results expose users of raw water from river face turbidity issue compared to other users. The health of users of river water is at risk notably through monsoon season as overflow causes the river to flood along with the spread of the pathogen. Therefore, application of water filter will not be only able to filter out the harmful bacteria but also control the concentration of ions such as manganese and iron.

### 3.5 Laboratory analysis

Samples of drinking water from different types of water sources were collected from selected location (Table 5). This is to evaluate the quality of water samples compared to the perceptions of respondents.

**Table 5** Physical properties of samples collected from Pasir Mas, Tanah Merah, and Jeli.

Samples	Water Sources	Turbidity (NTU)	pH	Fe (mg/L)	Mn (mg/L)
PM1	Well	0.54	6.05	0.02	0.02
PM2	Well	4.32	6.05	0.13	0.06



TM3	<b>Well</b>	<b>8.38</b>	<b>5.30</b>	<b>1.62</b>	<b>0.05</b>
TM4	<b>Tube well</b>	<b>39.10</b>	<b>5.13</b>	<b>4.56</b>	<b>0.13</b>
JL5	River	1.95	6.72	0.1	0.01
JL6	River	1.50	6.76	0.09	0.01

*\*Bold letters: Violate Drinking Water Quality Standard*

Based on Table 5, the results reveal that underground water either from well or tube well contains a higher concentration of iron and Mn compared to surface water (river). S3, S4 violate acceptable turbidity for drinking water and concentration of iron. The quality of water from the tube well contradicts to respondents' perceptions (Figure 5 (d)). As an interview with the owner of the tube well (S4), the recovered water looked clean without turbidity on the very first time but turned cloudy and turbid after storage. Excessive extraction of water from underground affect the quality of the water [6]. However, the management of water sources of the country focuses on surface water. Excessive use of underground water not only affects the water quality of the underground water itself but also the depth of river water. Thus, attention for underground water ought to be applied to conserve our country's hidden asset.

### 3.6 Willingness of to pay and have a water filter at home

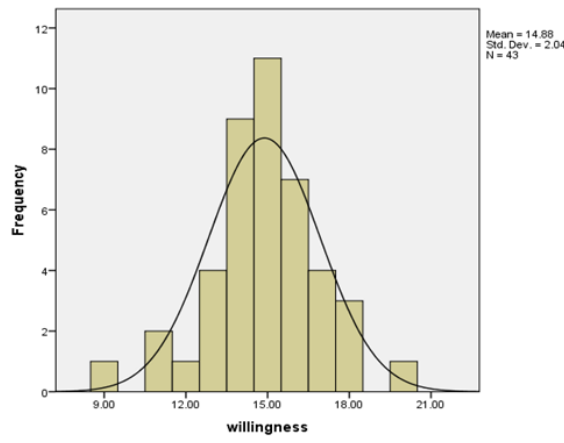
Respondents were making decision based on attributes given in the survey as given in Table 6.

**Table 6.** Willingness to pay and have water filter at home according to level of income.

Attributes	Level of Income	% Willing	% Undecided	% Not Willing
<b>Willing to pay for water filter due to health awareness</b>	Below MYR 950	0	0	10
	MYR 960- MYR 3,860	90.9	0	9.1
	MYR 3,860- MYR 8,319	80	20	0
	Above MYR 8,319	100	0	0
<b>Preference of low cost for maintaining water filter</b>	Below MYR 950	75	15	10
	MYR 960- MYR 3,860	81.82	0	18.18
	MYR 3,860- MYR 8,319	80	20	0
	Above MYR 8,319	100	0	0
<b>Preference of buying clean water from vending machine rather than pay for water filter</b>	Below MYR 950	45	40	15
	MYR 960- MYR 3,860	18.18	54.55	27.27
	MYR 3,860- MYR 8,319	60	30	10
	Above MYR 8,319	50	50	0
<b>Water filters available in the market are reliable</b>	Below MYR 950	30	60	10
	MYR 960-	45.45	54.55	0

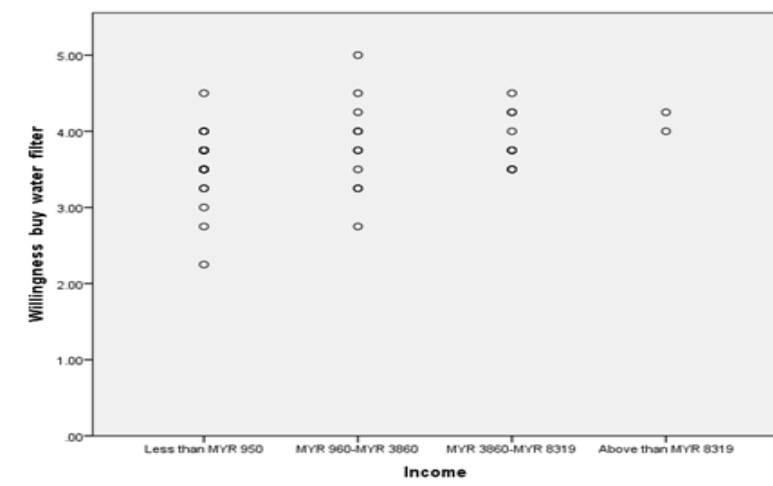
MYR 3,860			
MYR 3, 860-	60	30	10
MYR 8, 319			
Above MYR 8, 319	100	0	0
319			

Figure 7 represents the distribution of the population for answering willingness to purchase water filter corresponds to income. Based on the Shapiro-Wilks test, the distribution of the population ( $p > 0.05$ ) so it validated that the data comes from a normally distributed population.



**Figure 7.** Distribution of willingness to have a water filter at home among respondents

Figure 8 indicates the population in Kelantan are inclined to pay water filter. The population in Kelantan desires better supply of treated water therefore they are willing to pay for the higher price of water [7]. However, this solution will burden lower income user, therefore, introducing water filter system with less costly rate seems promising. Based on Spearman’s test, willingness to purchase water filter amongst respondents is correlated to income ( $p < 0.05$ ). So, having an affordable water filter at home is a long-term investment for good health.



**Figure 8.** Correlation between income and willingness to purchase a water filter

**4. Conclusion**

From this study, the behavior, perception of residence and their willingness to have better water quality are known. The questionnaires, interview with the community and laboratory analysis expose that:

- The laboratory analysis revealed that water from well (S3) and tube well (S4) are violating the standard. The analysis for tube water contradicts perceptions of the user. It is a signal for the authorities to give attention to the management of underground water. The enforcement of surface and underground water should not be treated as separated entities as both are valuable national assets
- The Spearman test shows that the income of the respondents is proportional to the willingness of paying and having a water filter at home. It is a challenge to the water treatment industry to provide efficient and affordable water filter for raw water at a high level of turbidity.

As a conclusion, an effort to improve water quality is significant for water security in Kelantan and also to achieve government's mission in the 11<sup>th</sup> Malaysia plan.

### Acknowledgements

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