

Investigating environmental impacts of betel nut (*Areca catechu*) wastes disposal based on human behavior in Port Moresby PNG

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Abstract. The consumption of Areca catechu (betel nut) in combination with Piper betel and lime (calcium hydroxide) in Papua New Guinea has been a daily consumable commodity among the country's population. Due to the increase usage of betel nut, more wastes tend to be deposited into the city's environment making the city very filthy. The disposal of wastes along with its end by-products has become a major problem for the environment due to uncontrolled human behavior and ignorance. The city of Port Moresby has seen a lot of wastes from betel nut husks and salivary spittle being spewed all over public places. The uncontrolled wastes disposal and carelessness of the people has significantly affected the outlook of the surrounding environment. Even though, laws were put in place to manage wastes, people do not care of the impacts and continue to ignore the laws. The study was undertaken to understand human behavior and characteristics towards improper waste management and determine the level of wastes derived from the use of betel nut. The study was conducted using simple random sampling and stratified sampling methods through interviews for qualitative data collection. The results revealed that ignorance and carelessness exist within the population in managing betel nut wastes. The results also indicate that banning the sale and trading of betel nut may lead to social and economic problems for most of the unemployed population in Port Moresby. Therefore, it requires a better approach from the government and the city authorities to develop and implement workable win-win solution to the problems faced by the city residence as well as managing their wastes from the use of betel nut.

Keywords: *Areca catechu* (betel nut), betel quid, *Piper betel*, *Calcium hydroxide* (lime) waste management, waste disposal, environmental degradation

1. Introduction

Papua New Guinea (PNG) is among several countries in the Pacific region that consume betel nut. Betel nut or *Areca* nut is a fruit that grows on *Areca* palms mostly in lowland and coastal areas in almost all tropical regions of the world (Baker and Dransfield 2006:50; Ross *et al.* 2008:391). Mustard (*Piper betel*) and lime (*Calcium hydroxide*) obtained from burning sea shells are consumed with betel nut forming the combination called *betel quid*. The manner in which betel nuts are being consumed differs in many places and countries. In the Federated States of Micronesia, the betel quid is usually wrapped and placed in the mouth whilst in PNG and the Solomon Islands the betel nut and mustard are placed separately in the mouth (WHO, 2012).

Mustard is a creeping vine that are used in combination with lime for chewing. The lime, which is made from burning sea shells into white dry powder is usually packed in air tight plastic bags ready for sale and used by betel nut consumers (WHO IARC, 2004). Mustard leaves, fruits and barks can be used together with betel nut and lime in chewing to give a red coloring in the mouth. *Areca* nut chewing is taught to have been the major cause of health and environmental problems in the country. It is in fact a major contributor towards spreading of tuberculosis in PNG. As well as a major contributor towards dephasing of public property as well as contributing to environmental degradation among other wastes in the main urban center (Yatmani *et al.* 2022). The adverse impacts from continuous chewing of betel nut is very devastating in terms of health, social, environmental and economic aspects (Arija *et al.* 2022). The consumption

of betel quid and the disposal of wastes contributes to environmental degradation in all major urban centers in the country.

Betel quid consumption has been a major pass time addictive substance used every day in Papua New Guinea due to its stimulants effects. It is believed that the trend of betel nut consumption may continue at an unprecedented rate given the increase in the population within the city. People started chewing betel nut as young as 8 years old and beyond. Shetty *et al.* (2013) stressed that the health impacts such as oral cancer has never been an issue for the people in the past but is now becoming a major environmental problem.

The use of betel nut for its stimulants was described by Staples and Bevacqua (2006) as a '*major health risk*' considering the continuous ignorance from the users. They further revealed that people consuming betel nut were very much ignorant by taking unreasonable risks. Several studies that were undertaken have revealed a staggering incidences of oral cancer due to the continuous usage of betel nut (Gupta & Ray, 2004; and WHO IARC, 2003). The study conducted by Gupta and Ray (2004) have discovered high rate of oral cancer related to the use of betel nut. However, most of the study tends to focus mainly on health impacts with limited research done on environmental impacts. Therefore, this study was undertaken to determine the human behavior and characteristics towards improper waste management and the environmental impacts in the city of Port Moresby.

2. Method

A qualitative survey or interview was undertaken within the city of Port Moresby for the collection of primary data as well as using other sources to collect secondary data. A population based survey was incorporated and used in this study for sampling. For survey, qualitative approach was undertaken to determine social behavior of the people and was used to understand the human behavior and characteristics towards managing betel nut wastes. In the qualitative data collection, a standardized questionnaire was prepared and used for the interviews.

The method of sampling designed involved both *simple random sampling* and *stratified sampling* methods respectively. The stratified sampling technique incorporate *stratified purposive sampling* technique that applies to preselected group of people that are easier to reach who chew betel nut only (Patton, 1990). Both simple random and stratified sampling was used in the survey using a prepared questionnaire targeting working class people, unemployed or job seekers, self-employed or small medium enterprise (SME) owners and students. These groups of people selected were approached randomly in the survey.

2.1. Study site

The study was conducted within the city of Port Moresby, Papua New Guinea. The actual interviews or survey conducted was undertaken randomly between the months of January to March 2023.

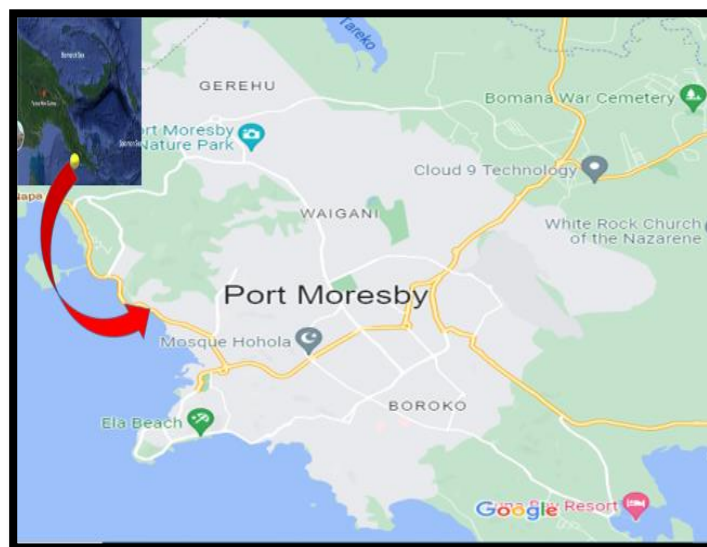


Figure 1. Map of Port Moresby City

3. Result and Discussion

3.1. Demographic response

The cumulative number of respondents involved in the survey comprised of a total of 300 people residing within the city. Respondents were approach both in public and residential places for interview. The demographic details of respondents as per the age group range indicate that almost half of the population (45%) sampled were between the age of 15 to 30 years. This indicate a large proportion of the population were young people in their prime life who turned out to be the frequent users of betel nut. Approximately, 28.3% of the respondents were between the age range of 30 to 45 years' old which falls right behind young people. That indicates that more people over the age of 30 years consume betel nut. The smallest groups of people involved in the usage of betel nut were older people (19%) and school age children below the age of 15 that makes up 7.7% of the overall sampled population. This indicates that all age groups do involved in the consumption of betel nut. The only difference is that more people over the age of 15 consume more betel nut than school children and older people.

So out of the total population in N.C.D, 300 respondents make up the sampled population that were involved in the survey which equates to 0.05% of the total Port Moresby's urban residents. Among the people interviewed, 45% (135) were females and 55% (165) were males of all age groups. The study also tried to determine the educational level of the respondents involved in the survey. The number of respondent's educational level indicate that a large proportion of the population have completed, currently attending or have left schooling at the secondary education level. This group comprised of 46.3% (139) of respondents that include both genders. For those respondents that have completed, still attending educational institution or have left primary education makes up 29% (87). The study also revealed that the other group of people have either completed, currently attending or have left their studies at a college or trade school level makes up 18.7% (56). The least number of people interviewed were those that have completed university, attending university or have left university studies which makes up 6% (18). The study determined that no one was found to have zero level of education which also shows that all interviewees have attended education institution at least once in their lifetime.

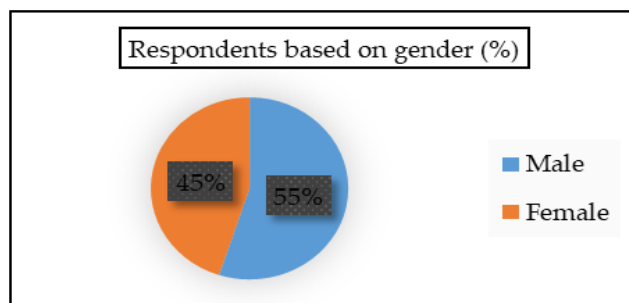


Figure 2 Respondents based on gender who participated in the survey

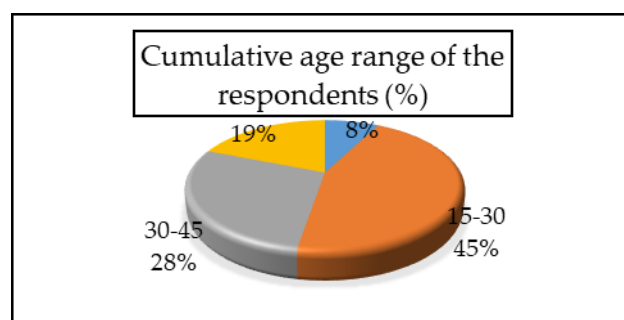


Figure 3 Respondents age range who participated in the survey

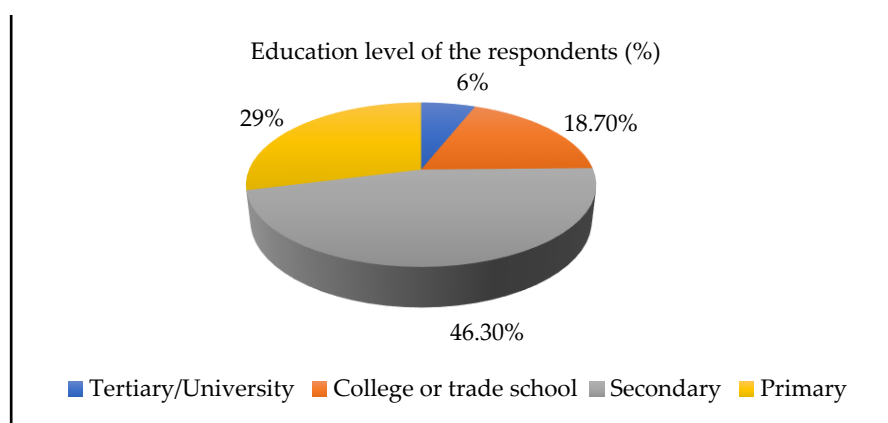


Figure 4 Indicate the education level of the respondents

The survey also revealed a staggering difference between those people employed and unemployed based within the city. The findings revealed that about 39% (115) of the people were unemployed or currently on the look-out for jobs. Only 23% (69) of the respondents were identified as being in some form of formal employment both in public sector (government departments) and in private sector (businesses and non-governmental organizations). At least 23% (70) of the respondents revealed their status as being full time and or part time students. The survey also revealed that 15% (46) of the people interviewed were identified to be involved in some form of small medium business enterprises (SME). These were the group of people identified as self-employed who were involved in conducting small businesses within the city.

In terms of employment status, 23% (70) revealed their status as being full time students and or part time students studying in various educational institutions in Port Moresby. Other respondents revealed that 15% (46) of the people were identified to have been involved in some form of small medium business enterprises (SME). These were the group of people identified as self-employed and were involved in conducting small businesses within the city. Among those self-employed people, many of them were directly found to have been involved in betel nut trade both in wholesale and retail. Now we can picture the trend here that due to high unemployment rate and less job opportunities, most people were directly involved in betel nut business. As a result of increased betel nut trade, more wastes are being disbursed into the environment.

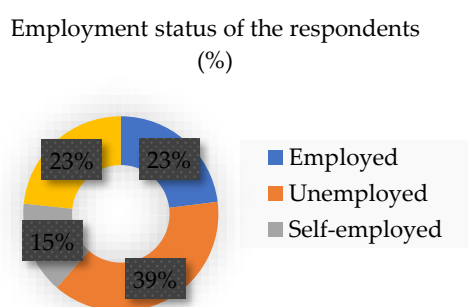


Figure 5 The employment status of the respondents

3.2. Betel nut consumption details

A question was asked for the respondents to comment on their behavior towards the consumption of betel nut. The findings revealed that 56.3% (49) of males and 47.3% (38) of females out of 87 indicate being addicted to betel nut chewing. At least 68 people indicate chewing betel nut as a pass time activity that makes up 57.4% (39) males and 42.6% (29) females. These respondents were found to be less addicted to betel nut consumption and consume betel nut on few occasions as a hobby.

The findings revealed that other people could not resist chewing if betel nut was offered to them. These group makes up 56% (61) males and 44% (48) females from a total of 109 people. The smallest number of people interviewed indicated that they chew betel nut just because their peer group or friends were chewing. This group makes up 38.9 % (14) males and 61% (22) females from a total of 36 people interviewed. The study also revealed that among all the people interviewed, no one was forced to chew betel nut as everyone consume betel nut at their free will.

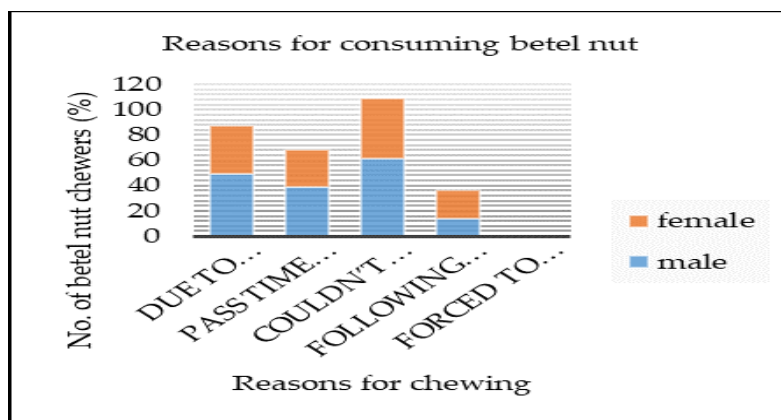


Figure 6 Respondents reasons for betel nut consumption

The survey did tries to determine the rate of betel nut consumed by each participant. The study revealed that only 8% (24) of the sampled population inclusive of both male and female chewed betel nut within less than a year. For those that have chewed betel nut for over a year but not exceeding 5 years constituted to 22.3% (67) which was slightly above those that have chewed within or less than a year. And for those people that have chewed betel nut over 5 years but less than 10 years constituted to 32% (96) that makes up a large portion. This group of people were identified to be those that were young people in their prime life. Another group of respondents makes up 29.7% (89) that have chewed betel nut for over 10 years but less than 15 years where those identified to be over 30 years of age. About 8% (24) indicate chewing betel nut for over 15 years or more which indicate that these people were mostly addicted to chewing and are found to be older people. For those people who consume betel nut for over 10 years can easily be classified as those that are next in line to be addicted within the next few years. The people who took betel nut consumption as a pastime activity can easily be grouped into those that have chewed betel nut less than a year ago.

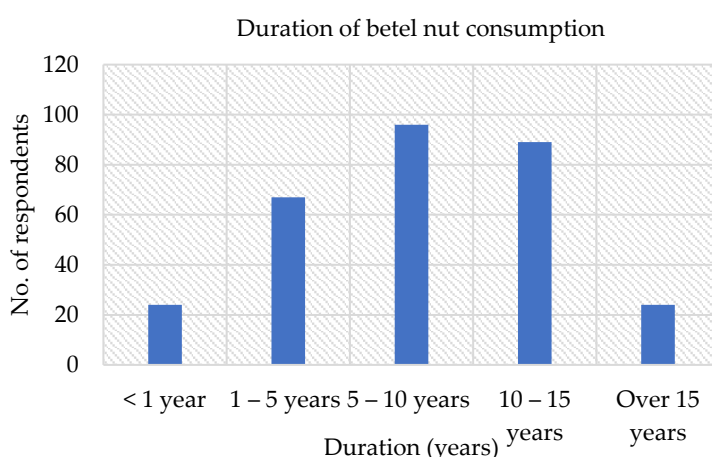


Figure 7 Graphical representation of respondent's duration (years) of betel nut consumption

The survey investigated the number of times each respondent consumes betel nut in a day. According to the survey, respondents were asked to respond on the number of times betel nut were consumed. And the findings indicated that 48.3% (145) consume betel nut 1 to 5 times per day. And approximately 22.3% (67) chew 1 time or none within a day. Others stated that betel nut is chewed at least 5 to 10 times within a day that adds up to 18% (54). Whilst only a few of the respondents, 8% (24) stated that betel nut is chewed approximately 10 to 15 times within a 24-hour period.

Very few of the responders that makes up 3.3% (10) indicate chewing betel nut over 15 times within a day. So obviously people who consumes betel nut more than 10 times per day can easily be identified as being addicted. And those that chew at least 5 times or less within a day can best be described as soon to be addicted.

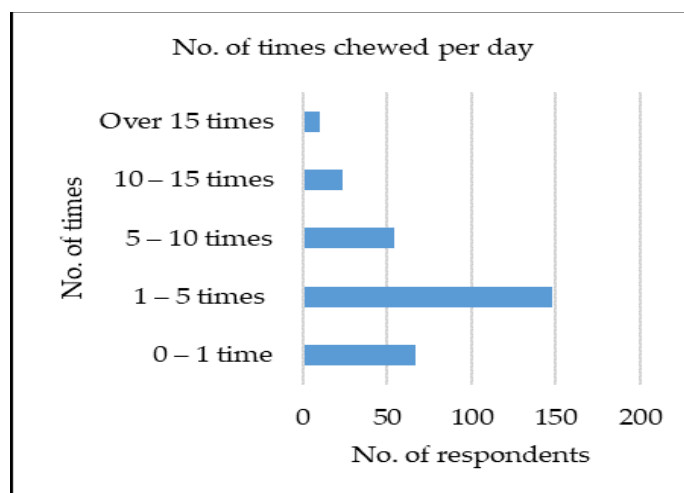


Figure 8 The graph shows the number of times responders consume betel nut in a day

The survey also tried to determine the number of betel nut consumed at a single time. The findings revealed that majority or 73.7% (221) of the respondents chew only 1 betel nut at a single time. Others responded that they chew about 2 betel nuts at a single time that constitutes to 24% (72) of the participants. However, only few respondents revealed that at least 3 betel nuts are consumed at a single time that constitutes to 2.3% (7). The study also determined that no one consumed more than 4 betel nut at a single time. Even though the number of betel nut consumed at a single time appeared to be less, the rate of betel nut consumed in a day revealed a much bigger proportion. It can now be assumed that the rate of betel but consumption is higher considering the number of times chewed. Therefore, the number of betel nut consumed does not significantly affect the rate at which consumers chew per day.

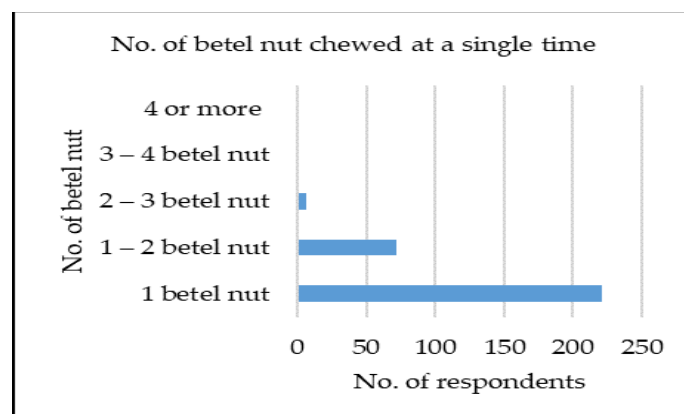


Figure 9 Showing the number of betel nut consumed at a single time

The survey designed was also aimed to investigate the duration of betel nut consumed before disposing its quid salivary wastes. And the findings revealed that 78.7% (236) of the people spit betel quid salivary off within a time span of 5 minutes. About 18% (54) spit betel quid after 5 to 10 minutes. Very few of the respondents spit out betel quid over 15 minutes that constituted to 3.3% (10). No one has indicated to have spit out betel quid over 30 minutes. Considering the rate of betel quid salivary spittle, it can be assumed that the less timing involved in chewing and disbursing salivary quid spittle is directly proportional to higher rate of consumption per day. It now simply implies that more wastes are being disbursed into the environment.

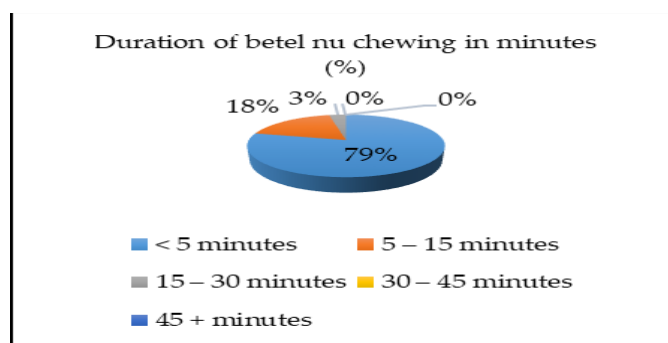


Figure 10 Displays the approximate range of timing that betel quid lasts inside a chewers mouth prior to disposal

The survey ensures to investigate the amount of money spent in a day for the purchase of betel nut. The findings revealed that 62.3% (187) of the respondents spent less than K5.00 per day. And 28.3% (85) stated that at least K5.00 to K10.00 was spent on the purchase of betel nut per day. About 7.3% (22) responded that they spend between K10.00 to K20.00 per day on the purchase of betel nut. A very few respondents of about 2% (6), stated that the purchase of betel nut per day costs over K20.00. The findings indicate that more than half of the respondents spend less than K5.00 per day which significantly indicate that there is surplus in betel nut quantity being sold on the streets. When there is surplus in quantity, more people spend less to buy more and in the process, there is increased consumption rate. As a result of increased consumption, more wastes are disposed into the surrounding environment. For those people that spend more than K5.00 per day in the purchase of betel nut were assumed to be retail street vendors as well as working class population. Street vendors spend more so that they can be able to resell whilst working class people can have surplus to consume during the duration of working hours.

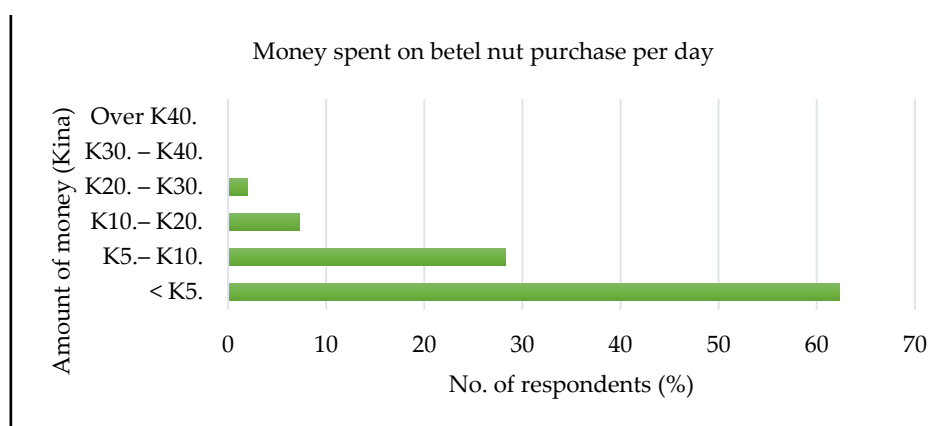


Figure 11 Showing the approximate amount of money (PNG Kina) spent for the purchase of betel nut in a day

3.3. Environmental pollution details

Wastes derived from betel nut comes in two forms as husk and salivary quid spittle. The survey involved separate questions for each wastes generated and disposed into the environment. The respondents were asked to comment on their waste management approach to determine their level of concern for the environment. And 6.7% (20) of the respondents stated that most times husks (waste) are being deposited directly into trash bins or cans. And 15.7% (47) stated that most of their husks are somewhat disposed away from public places. Almost 67% (201) revealed that the husks were usually disposed anywhere without due care. At least 6.3%(19) stated that the husks are usually kept and disposed at home in waste bins. About 4.3% (13) revealed that they do practice all of the above methods of disposing wastes.

In terms of quid spittle waste disposal, 9.7% (29) stated that they do disposed their wastes in trash bins/cans. A

staggering 39% (117) stated that most of their salivary spittle were usually disposed away from public places. Almost 51.3% (154) of the people do not necessarily care and thus disposed the quid salivary spittle anywhere without due care for the environment.

The findings between the husks and quid waste spittle revealed a similar trend with more than 50% of the people disposing wastes without due care. The study also revealed that at least less than 50% of the population do care for the surrounding environment and thus dispose their wastes away from public places. Very few of the respondents tend to apply some basic human self-care for the surrounding environment by practicing proper waste management through disposing of wastes into the prepared trash bins.

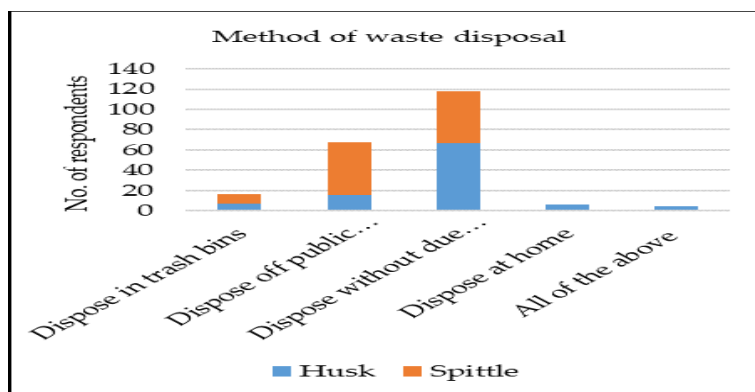


Figure 12 Depicts the various mode of betel nut husk and quid salivary spittle waste disposal

Another very important question was asked to ascertain their concern for the surrounding environment towards managing their wastes. The findings revealed that a staggering 73% (219) of the respondents do not encourage other people to control their wastes. Followed by only 20% (60) who mentioned that at least some words of encouragements were given to other betel nut chewers to control their wastes and dispose them away from public places. The findings also revealed that about 5% (14) tend to encourage other chewers to dispose their wastes into trash bins/cans. Only 2% (7) stated that they do encourage the general public to keep their wastes safe and dispose them in the right place. The findings revealed that there are no people to people communication in encouraging each other to manage betel nut wastes. This is a direct indication of people to people failure to take responsibility in encourage consumers on the importance of waste management.



Figure 13 The graph showing the respondents initiative to encourage other people in managing the betel nut waste.

3.4 Extent to which respondents agree

General questions were asked to retrieve respondent's opinion as to whether they agree or disagree on certain aspects surrounding betel nut usage in Port Moresby. The findings revealed that 54.3% (163) of the respondents strongly agree that betel nut waste disposal contributes to environmental pollution and degradation. Whilst 29% (87) simply agree on the statement. About 14.7% (44) neither agree nor disagree. Less than 2% (6) of the people disagree that betel

nut waste does not necessarily constitute to environmental pollution. Many of the respondents tend to have a fair idea about betel nut wastes contributing towards environmental pollution and degradation. Although they do have fair idea of betel nut wastes contribution to the environmental degradation, their behavior does not necessarily change to improve the scenario. It is a direct indication of being so ignorant in terms of controlling their wastes.

A question on the carelessness of the betel nut consumers handling and managing wastes were asked and the findings revealed that a staggering 56% (168) strongly agree to the statement. About 35% (105) of the respondents simply agree to the statement whilst only a very small percent of the population, 9% (27), neither agree nor disagree. However, the findings revealed that no one strongly disagree to the statement thus indicating that carelessness or rather ignorance in managing environmental wastes exists among the sampled population. The people were asked if more education and public awareness was necessary to be made to the general public on the importance of improper betel nut waste management and its serious negative implications. The response received indicate that 54.3% (141) strongly agree that more efforts and education is necessary to be made through all forms of medium to enlighten the people of the series nature of environmental impacts brought about by unwise waste disposal. About 29% (95) seem to have agreed that education and awareness is important for managing environmental health and hygiene. Those that neither agree nor disagree makes up 14.7% (51) whilst only 2% (13) totally disagree on the notion. Some people even made mention that betel nut waste does not necessarily affect the outlook of the city. They further stressed that a lot of wastes come from other sources but they believe that more education and awareness is needed as an important tool necessary for livelihoods wellbeing and health.

A notion of completely banning betel nut trade within the city of Port Moresby was asked to ascertain the people's opinion. And the findings revealed that a small portion of the people comprised of 10.7% (32) strongly oppose the notion. Similarly, about 10.3% (31) disagree on the idea of imposing complete ban on betel nut trade and use in public places. Whilst 39.7% (119) neither agree nor disagree that thus indicate that any scenario or changes imposed in the future would not affect their present stance. Those that disagree constituted to 24.7% (74) whilst 14.7% (44) strongly opposed the idea of imposing complete ban on betel nut trade. Those that strongly disagree mentioned that there will be serious social and economic issues within the city if there is a complete ban.

A follow-up question was asked on whether betel nut trade can be controlled rather than imposing a complete ban. The findings revealed that 39.3% (118) strongly agree whilst 40.3% (121) simply agree. Now, this simply implies that responsible authorities such as the National Capital District Commission (NCDC) should look for ways to control betel nut trade that does not harm the environment. Those that neither agree nor disagree to the idea of controlling the use of betel nut rather than imposing complete ban consists of 12.7% (38). And about 7.7% (23) disagree on the control of betel nut sale within the city and wants a complete ban. They believe that controlling the use of betel nut within the city will not change the way people use and manage wastes and therefore a complete ban is necessary.

Another vital follow-up question was asked if betel nut ban may lead to social and economic problems for those unemployed people. And the findings revealed that over 41% (123) strongly agree that the ban would give rise to more social and economic problems. They further stated that many of the city's population involved in betel nut trade and usage are those that are unemployed. With limited job opportunities, betel nut trade and usage has been their lifeline for most of the people and to impose a complete ban may lead to poverty and an increase in criminal activities. About 19.3% (58) agree to the notion whilst 17% (51) neither agree nor disagree. At least 19% (57) simply disagree that no issues would arise whilst only 3.7% (11) strongly opposed the idea. Those that disagree indicate that the ban would not affect the people as they would adapt to the changes and live a better and healthier lifestyle.

The interviewees were asked to state whether quid spittle contributes to dephasing of public property. And 26% (78) strongly agree. Over 43% (129) simply agree whilst 15% (45) neither agree nor disagree. Those that disagree consists of less than 7.3% (22) whilst 8.7% (26) strongly disagree.

A question was asked to determine if sea shell harvests from coastal communities can be stopped in order to discourage betel nut consumption. The findings revealed that less than 4% (12) strongly agreed that some form of laws and regulations will have to be implemented to discourage unnecessary sea shell harvest. About 18% (54) responded that unnecessary sea shell harvests will somehow have to be stopped. A massive 43% (129) of the respondents neither agree nor disagree thus indicate a conflict in opinion. Whilst 24.7% (74) and 10.3% (31) of the respondents disagree and strongly disagree respectively. They further explained that sea shell harvest can be impossible to be stopped as local coastal people harvests it for food and the wastes are turned into lime which is a useful commercial product.

Table 1 Showing the number of respondents based on their level of liking pertaining to the statements or questions

1 Betel nut waste disposal contributes to environmental pollution		
	Number of respondents	Percentage (%)
Strongly agree	163	54.3
Agree	87	29
Neither agree nor disagree	44	14.7
Disagree	6	2
Strongly disagree	0	0
2 Betel nut chewers careless in managing wastes		
Strongly agree	168	56
Agree	105	35
Neither agree nor disagree	27	9
Disagree	0	0
Strongly disagree	0	0
3 More education and awareness needed to encourage chewers to manage waste		
Strongly agree	141	47
Agree	95	31.7
Neither agree nor disagree	51	17
Disagree	13	4.3
Strongly disagree	0	0
4 Should betel nut sale or trade be banned?		
Strongly agree	32	10.7
Agree	31	10.3
Neither agree nor disagree	119	39.7
Disagree	74	24.7
Strongly disagree	31	10.3
5 Quid spittle contributes to dephasing of public property		
Strongly agree	78	26
Agree	129	43
Neither agree nor disagree	45	15
Disagree	22	7.3
Strongly disagree	26	8.7
6 Should betel nut trade be controlled?		
Strongly agree	118	39.3
Agree	121	40.3
Neither agree nor disagree	38	12.7
Disagree	23	7.7
Strongly disagree	0	0
7 Banning betel but trade may leads to more social problems		
Strongly agree	123	41
Agree	58	19.3
Neither agree nor disagree	51	17
Disagree	57	19
Strongly disagree	11	3.7
8 Should Sea shells harvest be stopped to discourage betel nut consumption		
Strongly agree	12	4
Agree	54	18
Neither agree nor disagree	129	43
Disagree	74	24.7
Strongly disagree	31	10.3

4. Conclusion

The study revealed differences and variations in opinions on the management of betel nut wastes in the city. The survey identified a number of issues that hinders efforts needed to ban the use and sale of betel nut. The main issue identified showed that people depend on the trade and use of betel nut which has been part and parcel of an important

informal economy that supports a huge proportion of the unemployed population. Today with the increase in the economic activities coupled with extreme high demand from betel nut consumers, it will be a very big challenge for the city authorities to control the trade and usage. Betel nut businesses have helped some of the local unemployed city residents out of poverty and plays an important role in reducing economic burdens.

But the manner in which the wastes are being managed from the use has been seen as irresponsible and ignorant from the consumers. More wastes are being added to the environment than are being cleaned on a daily basis. The survey also revealed that the cost of betel nut does not affect the demand and supply. As more money are being spent on buying betel nuts, more wastes are being added into the environment. The findings revealed that carelessness among consumers was identified as a behavior that exists among the users. Efforts needed to change human behavior will come at a greater cost considering the ripple effect that may arise. Laws and regulations will have to be imposed to change human behavior and control the spread of wastes. Controlling the sale of betel nut should be a better approach and assigning specific locations of trading would help alleviate environmental waste management problems.

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