CHAPTER 5

RESULTS AND DISCUSSION

5.1 Preliminary

As a common practice, all narcotics cases including illicit heroin that are seized from the four major geographical regions, namely Kuala Lumpur (KL), Selangor (SL), Negeri Sembilan (NS) and Pahang (PH) are usually submitted to the Department of Chemistry Malaysia (Headquarters) for analysis. During sample collection, there was no specific preference toward any of these regions. Due to the availability and accessibility with the consent from the responsible chemists, only a portion of the heroin case submissions were considered in this study. The process of sample collection was accomplished at the headquarters laboratory from January to August, 2010. Hence, the present situation could not provide a truly representative sampling strategy (e.g. taking an equal number of samples from all the states within Malaysia) because of the following factors:

- **Logistics:** The delivery of heroin samples from other laboratories involves legal complications and is costly. It will also incur risks of sample alteration in the transportation process.

- **Police operation:** Relatively active raids will result in a higher number of heroin seizures. Hence, more samples are submitted from locations with active police operation and thus there would be an imbalance between two regions in terms of the number of samples. For example, KL and SL usually have a considerably higher number of seizures compared to other regions. This issue is outside the researcher's control.

The sample collection relied on the heroin cases/samples submitted to the department. In relation to this, the element of intent/bias was absent in the sampling process and hence the collected samples can be considered to be random. Therefore, the analytical findings derived from these samples are somewhat representative of the four regions and to some extent could also be generalized to the Malaysian heroin samples.

Over a period of eight months, 311 illicit heroin cases (packed in plastic bags or plastic packets) submitted from the above-mentioned regions were taken into account. Each case provided a sufficient amount of sample for profiling. The geographical representation of the heroin cases/samples is illustrated in Figure 5.1.

Figure 5.1: A map of Peninsular Malaysia showing four major geographical regions from which the illicit heroin samples were sampled

5.2 Task 1: Visual Examination and Physical Characteristics

When subgrouping was accomplished, each case was visually examined and the physical characteristics were recorded. Ten aspects were emphasized in this task. Depending on the quantity of the sample units, each case took approximately 1–2 hours to complete this preliminary procedure. The collected data (quantitative data) were then employed to facilitate sample classification at the street level.

5.2.1 Police Information

All police information and case backgrounds were collected and updated in the database. In order to maintain objectivity during analysis, case details were not recorded. The details often involved a narration of how and where (the specific location such as the pocket, under the chair, etc) the case samples were seized from the crime scene.

The distribution of the 311 illicit heroin cases submitted by the district police headquarters in the four geographical regions is presented in Figure 5.2. Overall, KL and SL respectively recorded 122 and 145 cases. They constituted 85.9% cases of the whole database. NS and PH contributed 35 cases and 9 cases respectively. In addition, 67.8% cases were categorized under possession. The remaining 24.1%, 1.9% and 6.1% fell under the categories of 39A1, 39A2 and 39B.

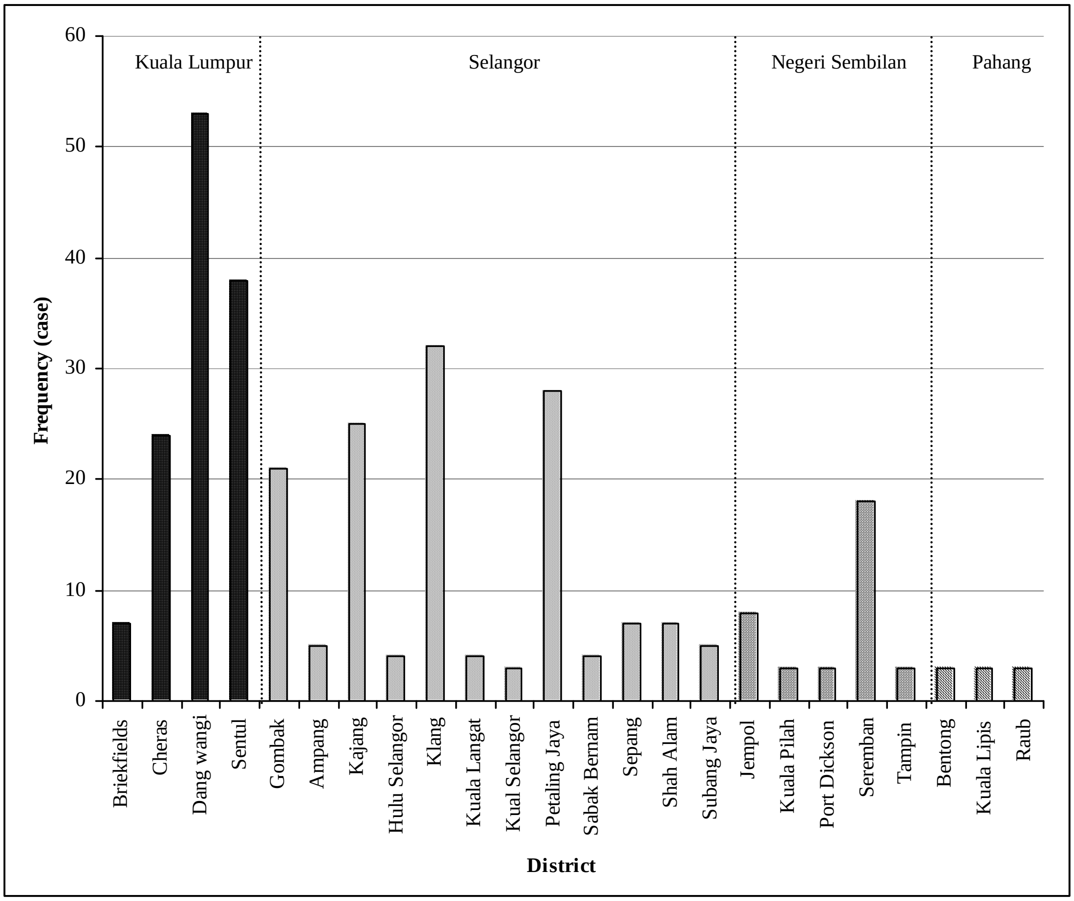

Figure 5.2: Distribution of 311 cases from four geographical regions

5.2.2 Photography

To date, there has not been any published work detailing the procedure of photography for packaged heroin. The photographic setup adopted in this study was inexpensive and user-friendly. Each sample took less than 3 min to complete the photographic session. Through photography, all crucial details such as the geometrical shape of the plastic package, the coarseness of the heroin substance and many other qualitative data can be clearly recorded in a color photograph. Hence, comparison of qualitative information can be made easier. For example, the photographs make it easy to comprehend different wrapping styles. More importantly, the representative photographs can also aid future tracking if they are preserved in the profiling database.

Without the use of expensive instruments, the simple photographic setup employed in this study to some extent was prone to errors. Two prevailing types of errors are notable; namely 1) the error inherently associated with the substance and 2) the error arising from the setup and environment. The first type of error is common in powdery samples which always exhibit inconsistencies of color and particle size. Smaller particles in various sizes are formed by rough handling or accidental crushing. The irregular particle surfaces tend to give rise to visual confusion as the lights are reflected in random directions from the particles and thus displaying varying tones in its color. In addition, the error is highly dependent on the positions of the particles and light reflections. The same sample can vary slightly in the tone of color if the general position of the sample substance is altered. Besides, reflections from the plastic surface and colored markings were another potential source of error which could not be easily eliminated during photography. The second type of error is the variation associated with the lighting as well as the angle at which the camera was held.

In view of these two errors, the photographs obtained were therefore neither repeatable nor reproducible. However, with a CMYK calibrator placed next to the sample, the second type of error can be generally addressed. The photographs shown in Figure 5.3 clearly depict the possible visual distortion imparted by the irregular surfaces and the lighting for a sample photographed at three different times in a series. Despite the poor precision between the photographs, the strips of the CMYK calibrator in the photographs provide a reference to show how much the color deviates in each series. It is observed that all the three series show varying degrees of brightness or darkness. However, this factor does not significantly affect the color of the heroin substance. To the minimum extent, the substance colors in these three individual cases are readily decipherable and distinguishable. In addition, direct comparison can be made between the photographs showing a close agreement in the lighting (e.g. 265-c, 293-c and 294-c) as if they were placed side by side since they received the same degree of hue distortion.

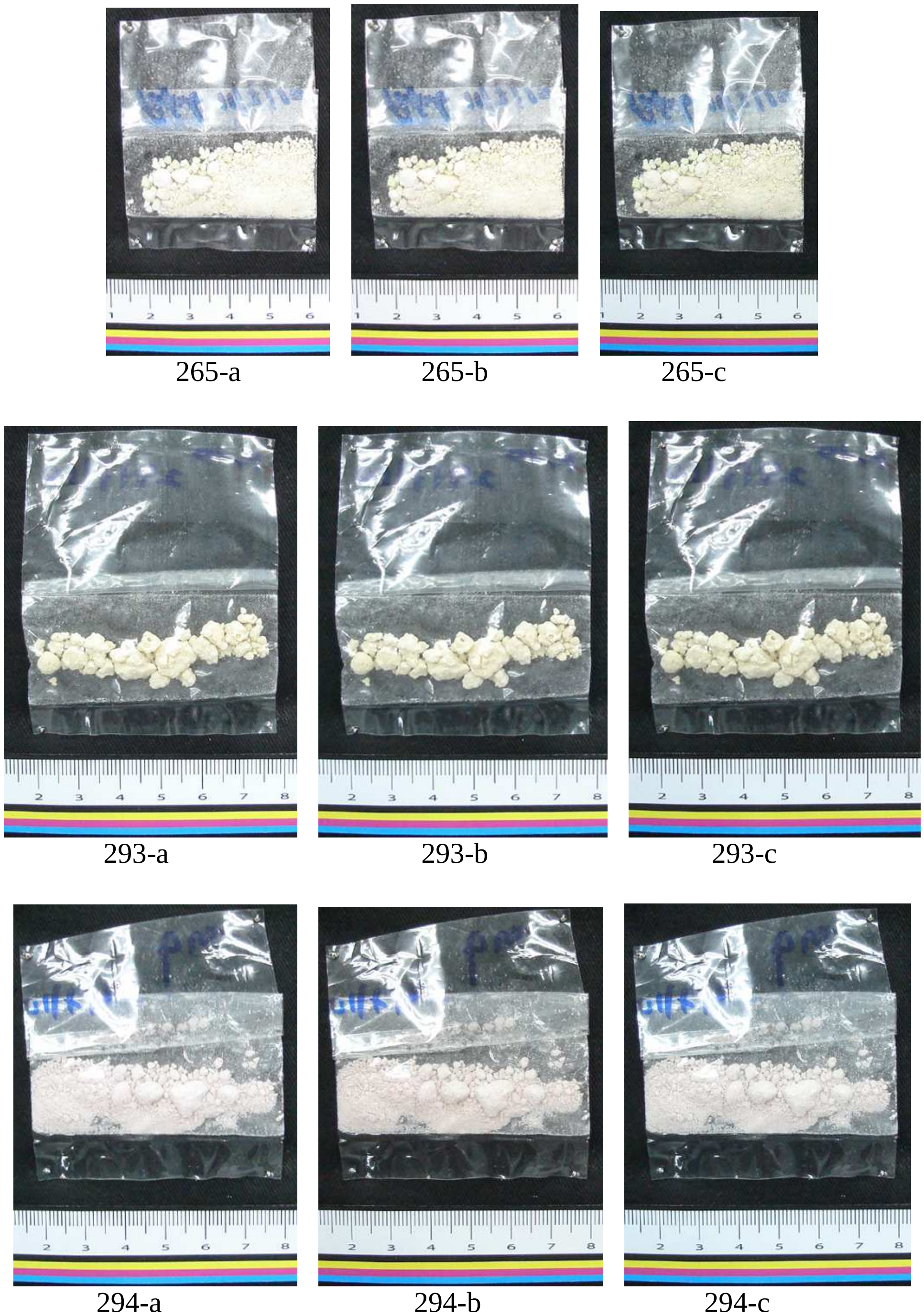

Figure 5.3: A comparison of three different original photographs of three samples taken at different times without photo editing

With this economic means of photography, the descriptive details (e.g. general color, appearance and dimensions, etc) are very well-preserved in each photograph. All photographs obtained with this new photographic technique were found to be sufficiently clear and distinctive as references for the database.

5.2.3 Color of the Heroin Substance

Color analysis is not new in drug analysis. The analysis of the color of soil sediments can be done qualitatively by comparing with a standard reference chart called the Munsell Soil Color Charts (Schaetzi & Anderson, 2005). It can also be analyzed quantitatively by a spectrophotometer (Guedes, Ribeiro, Valentim & Noronha, 2009). These techniques could be undertaken to give elaborate descriptions to distinguish between the heroin samples. However, due to the high cost and tedious procedure involved in the techniques, a rather simpler and straightforward color identification system was employed in this study. This decision was made after considering the fact that many chemists can be easily confused with a color codification that is too detailed. In particular, confusion arises for colors that only vary slightly in tone or value. In addition, the irregular particle surfaces in the mass of substance often interferes with the color determination as inconsistent light reflection and absorption take place in different parts. As a result, it was resolved to use a simple coding system such as that specified in Table 4.3 to describe the color of the substance. Table 5.1 displays some varieties of color of the substance found in the 311 cases.

Table 5.1: Examples of substance color varieties encountered in 311 heroin cases

Photograph	Substance color
	Off white
	Pink
	Brown
	Yellow

Table 5.1: Continued

Photograph	Substance color
	Green
	Orange

Substance colors that are in very close agreement are useful to associate the samples at the cutting level since colorants along with other adulterants are added when the high purity heroin is diluted. The frequency of commonly encountered substance colors in the 311 heroin cases is presented in Figure 5.4. The dataset was dominated by the monochrome off-white (9.6%), monochrome brown (11.3%) and dual color off white-brown (41.2%). The off-white and brown monochrome colors are assumed to be the natural colors inherited from processing. As demonstrated by Zerel *et al.* (2005), the brownish substance is often refined to off-white and off white-brown, so cases belonging to these colors are hypothetically assumed to have been less prone to cutting. However, this hypothesis was shown to be false for the illicit heroin seized within Malaysia after chemical analysis was performed.

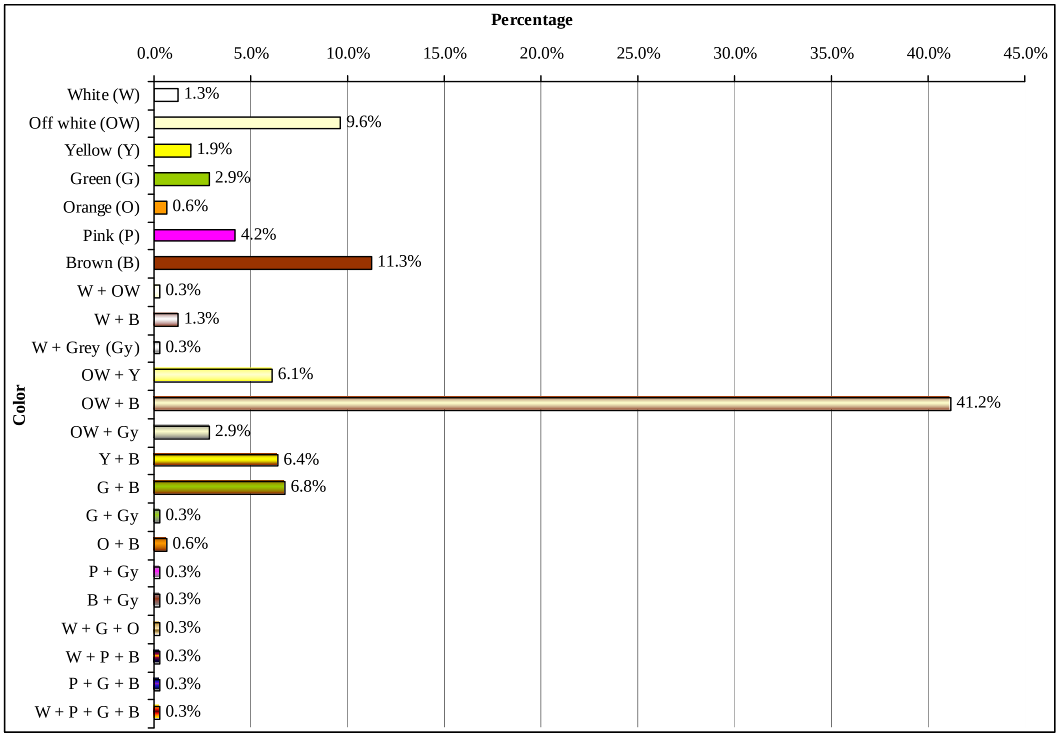

Figure 5.4: Frequency of substance colors in 311 cases taken for profiling

As off-white and brown are characteristic of the initial heroin product, it was also expected to be frequently associated with secondary colors, yielding off white-yellow and brown-green appearances in the local seizures. The secondary colors such as pink, green, yellow and orange however are assumed to have resulted from adulterants and food dyes added during the cutting process. Sometimes, ‘grey’ is more appropriately interpreted as ‘dust’ rather than a specific colorant acquired during processing. Based on prior experience, the orange category is considered a new variety as it had not been observed in the past two years. The yellow coloring was most commonly used in three incidents: yellow (1.9%), off white-yellow (6.1%) and yellow-brown (6.4%). Unlike ecstasy pills, the heroin substance does not have specific markings such as logo and trademark, so color is probably the trademark used by the distributor to differentiate between batches and manufacturers. Heroin substances in three or more colors are rare and have not been expected at the initial stage. However, four multicolors were encountered and they are assumed to have originated from the same cutting process due to their close matching with the color combinations.

5.2.4 Texture of the Heroin Substance

In comparison with tablets or shaped drugs, the heroin substance is mostly present in irregular form such as powders, particles and granules. This has posed a problem in the definition of its texture. In this study, almost all samples contained both fine powders and coarse granules. However, it is inaccurate to characterize the intended condition of these samples as ‘coarse and fine’ structures, since handling and shipment can also give rise to the dislodgement of the fine powders and particles from the main coarse structures. In this regard, small amounts of fine powders in the sample were disregarded when coding the texture as the ‘coarse’ structure. If there was a significant amount of the fine powders (approximately 50% of the sample) together with an equal amount of the coarse structures present in the majority of the sample units of a single case, then it was justified to group them in the ‘coarse and fine’ category. Hypothetically, the presence of very large quantities of fine powders (in the ‘fine’ category) is often the result of grinding and crushing during packing. In contrast, rough handling would usually not produce more than 50% fine powders in the majority of the sample units. Guided by the foregoing rationales, 86.2%, 11.3% and 2.6% of the 311 cases were respectively categorized into ‘coarse’, ‘coarse and fine’, and ‘fine’ categories (Figure 5.5).

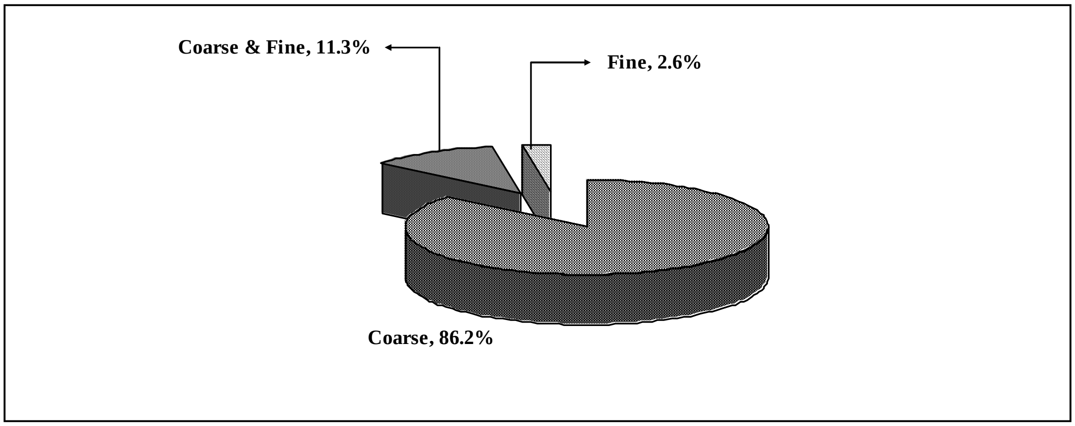

Figure 5.5: Distribution of substance texture in 311 cases taken for profiling

It must be aware that the coded texture was seldom observed in all the sample units in an individual case. This observation could be explained by the influence of other environmental variables during distribution. For example, some sample units may have been actively involved in street sales with rough handling compared to the corresponding units which could have just been stored as stock. Thus, the presence of excess fine powders in the former samples compared to the latter can be attributed to the coarse granules being repeatedly handled and disturbed. Besides, the highly irregular and inconsistent structures could be the result of breakage while scooping out the sample for packing. Owing to this reason, the sample units in the case sometimes showed varying sizes of granules. Due to many unpredicted factors, the coded texture for the case was therefore decided based on the general occurrence of the texture rather than the accurate texture in the majority of the sample units.

The ‘coarse’ category plays an important role in distribution. The coarseness of the illicit heroin under this study varied from approximately 3 cm to a fraction of 1 mm. Coarse substances are space consuming and require tedious handling procedures as compared to the fine powder. However, its 86.2% prevalence signifies the importance of this structure in the distribution process. If the illicit heroin is kept as powders, it will increase the surface exposure of heroin/diamorphine to atmospheric moisture and thus speeding up undesirable decomposition of diamorphine to 6-monoacetylmorphine. So, the mass of the seized heroin was not crushed into powders. Instead, large granules were maintained as such in the distribution so as to reduce the surface area. Limited surfaces for water interaction would have therefore reduced the effects of deacetylation. The mixture of the coarse and fine structures was probably the result of rough handling. Samples in this category could have been circulated for street sale for a prolonged period since the particle dislodgment is time-dependent. The 'fine' category on the other hand also fits a specific purpose. For example, the fine powder can be easily rolled into a cylindrical shape and packed in a tube-shaped package so that the trafficker can swallow it for the purpose of cross-border smuggling (Figure 5.6).

(a) (b)

Figure 5.6: A heroin sample unit in a cylindrical shape (Fine powdered illicit heroin with clumped masses in (a) which was recovered from (b) before it was opened up; illicit heroin rolled into a cylindrical shape shown in (b) with additional packing)

5.2.5 Wrapping Style of the Plastic Package

After taking the color of the substance into consideration, the wrapping style could be used as a screening criterion to determine if the sample units were from the same batch (referring to the batch at the packing level). In general, if two samples appear as yellow substances but with two different wrapping styles, they should be treated as two individual cases. In line with the concept of *modus operandi*, the chosen wrapping style is assumed to be the common mode of operation adopted by the packer/syndicate. Therefore substances coming from the same batch could have been packed using a similar wrapping style. The wrapping styles encountered in the 311 heroin cases comprised seven major types and the frequency is presented in Figure 5.7. However, Types 1a, 1b and 1c were not encountered in the cases. Among all, Type 3a (2 seals, 2 margins and 5 portions) was the most commonly employed wrapping style in Malaysia. Its wide adoption is largely attributed to the folding that is able to help prevent leakage of the substance by having an empty gap in between (Figure 5.8). In addition, folding the packet may also help to shorten the extra length of the plastic packet. For shorter plastic packets, Type 2a (without a fold) instead, was occasionally employed. The choice of other less common styles may also signify that there could have been other dealers whose common mode of packing was not associated with Type 3a. These minor styles could be the signature wrapping styles adopted by these dealers.

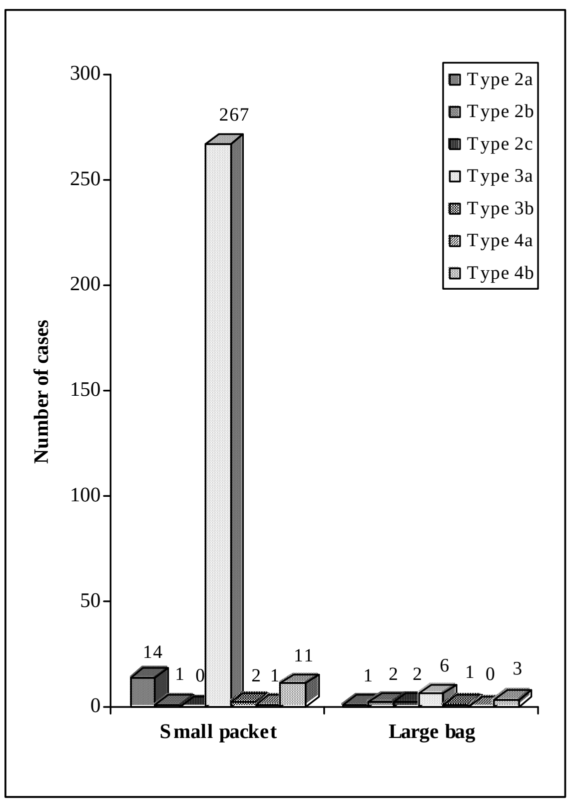

Figure 5.7: Frequency of wrapping styles in 311 cases taken for profiling

Figure 5.8: An example of wrapping Type 3a (This is an edited photo)

5.2.6 Sealing of the Plastic Package

The sealing characteristics may indicate the mode of packing. All packages were sealed and Table 5.2 indicates that 94.9% of the cases had originated from one particular sealing procedure. A single seal (referring to that deliberately made by the packer) is common because it is the most rapid way to seal off the opening of the receptacle for the purpose of securing the substance. Packages with two and three seals were rare, accounting for 14 and 2 cases respectively. Such additional sealing was usually made on other edges of the plastic packet/bag which were previously cut open. Besides, 83.0% of the cases had seals bearing rectangular patterns whereas 16.7% had undefined patterns. The rectangular pattern is the impression transferred from the sealing base to the plastic film when the hot sealer's blade is pressed against it. Usually, a new sealing machine will show clear patterns on the plastic film. For undefined patterns, it could be due to two reasons. First, the machine is old and due to prolonged usage, the impression is no longer prominently displayed on the plastic film. Second, the sealer's blade is excessively hot until it melts or distorts the impression.

According to Table 5.2, it is also recorded that 203 cases showed clear and complete seals, compared to 92 cases with vague and complete seals. The latter occurrence was probably due to poor pressing and insufficient heating during sealing.

Table 5.2: Frequency of seal patterns and seal clarity according to the number of seals

No. of seals	Seal clarity	Seal type								Total
		Not Applicable		Undefined		Rectangle		Clip		
		S	L	S	L	S	L	S	L	
0	**-**	0	0	-	-	-	-	-	-	**0**
1	**C & C**	-	-	13	0	184	5	1	0	**203**
	C & inC	-	-	0	0	0	0	-	-	**0**
	V & C	-	-	36	1	54	1	-	-	**92**
	V & inC	-	-	0	0	0	0	-	-	**0**
2	**C & C**	-	-	0	0	7	6	-	-	**13**
	C & inC	-	-	0	0	0	0	-	-	**0**
	V & C	-	-	0	1	0	0	-	-	**1**
	V & inC	-	-	0	0	0	0	-	-	**0**
3	**C & C**	-	-	0	0	0	1	-	-	**1**
	C & inC	-	-	0	0	0	0	-	-	**0**
	V & C	-	-	1	0	0	0	-	-	**1**
	V & inC	-	-	0	0	0	0	-	-	**0**
Total		**0**	**0**	**50**	**2**	**245**	**13**	**1**	**0**	**311**

S = Small packet; L = Large packet
C & C = Clear and complete; C & inC = Clear but incomplete
V & C = Vague but complete; V & inC = Vague and incomplete

5.2.7 Weight of the Heroin Substance

Based on the visual inspection, the illicit heroin packed in each packet appeared to show a consistent substance weight corresponding to the packets in the same case. In this case, the packer could have used a standard scoop to dispense a standard weight for each packet when a finite volume of the street doses was packed. A slight variation in the weight could be ascribed to the irregular shapes of the product which render an inexact weight while scooping. In relation to this, if the samples seized from different locations show a very similar substance weight, they could have come from the same packing line when other physical features are also congruent. A significant variation however implies the use of multiple scoops of different sizes in the packing process. It could also be due to the poor packing skills of the packer.

From the 311 heroin cases, the sample units in each individual case varied in the substance weight per package. The intra-sample variation is best described by the relative standard deviation (RSD) calculated from the sampled units in each case. Figure 5.9 illustrates this variation observed in four sample cases.

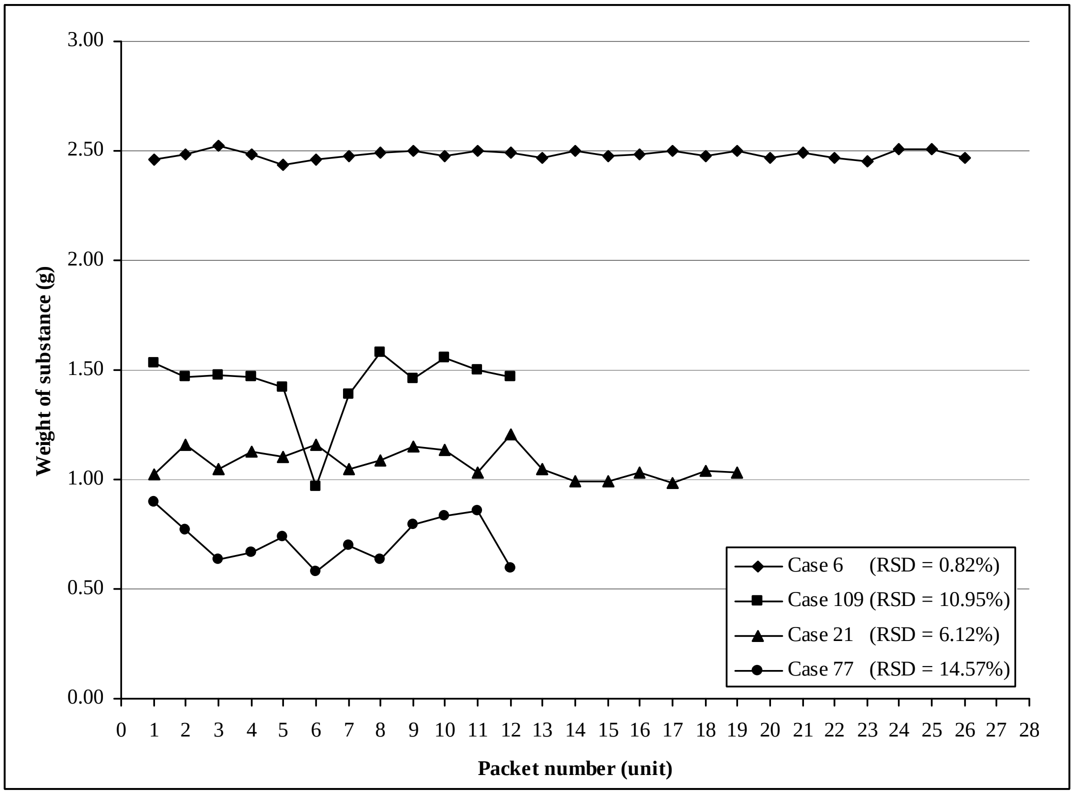

Figure 5.9: Variation in the weight of substance shown by four cases

Case 6 showed a relatively constant weight at approximately 2.5 g. Conversely, Cases 77 and 109 respectively exhibited a relatively high variation in the substance weight. The high RSD value observed in Case 109 was a result of the presence of an extremely high substance weight in the case. On this basis, the RSD values of other cases were also calculated. Generally, the substance weight showed RSDs within 0.06 – 42.86% (excluding cases containing a single package). Low RSDs may be associated with a relatively good quality control in the weighing process during packaging. The packer could have weighed accurately the substance before packing and constantly used the same measuring scoop. As a common practice, the RSD of 3% is regarded as 'good quality' (Zingg, 2005). By applying this criterion, approximately 41% of the 294 cases containing more than one plastic package were characterized as 'a good quality batch' in terms of the substance weight.

When the mean value was calculated from the sample units within each individual case, a wide range of substance weights chosen by the packers as the on-the-road dose in Malaysia was obtained. Taking bars having > 20 cases to define the most frequently encountered range, it was found that the commonly encountered weight of substance in each small package falls between 1.25 g and 1.45 g (Figure 5.10), which is a 'handy' amount to distribute at the street level. In the case of large packages, the data are insufficient to arrive at any conclusion.

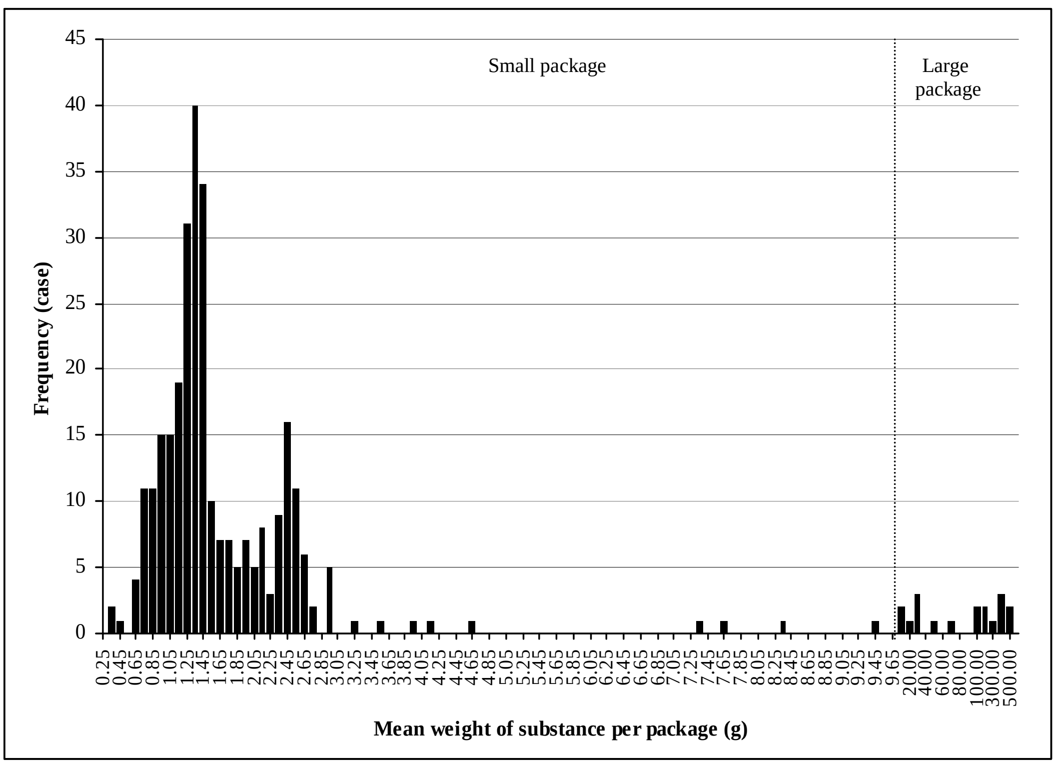

Figure 5.10: Frequency of the weight of substance per package encountered in 311 cases (Mean value on the histogram x ± 0.05g for small package, $x_{value\ less\ than\ 100}$ ± 5g and $x_{value\ more\ than\ 100}$ ± 50g for large package; bars containing > 20 cases are used to define the most frequently encountered range)

5.2.8 Weight of the Plastic Receptacle

When considering the comparability of the weight readings obtained from different balances, it is important to examine the reproducibility of the readings obtained with these balances by using a fixed sized object such as a plastic film. Table 5.3 (left column: before washing) presents the readings for a batch of 12 empty plastic packets measured on Balances A (Sartorius BT224S) and B (Denver Instrument AA-200). From the measurements, the difference in the precision between the two sets of readings obtained with a single balance at different times (e.g. Balance A versus Balance A) and between different types of balance (e.g. Balance A versus Balance B) was insignificant. Overall, the measurements are highly precise with an RSD = 1.4%.

As the case plastic packets were only cleaned with a tissue paper, some particles were inevitably attached to the plastic films. If cleaning is done with water, the plastic films will certainly become much cleaner. The investigation was extended to examining the impact of residual substances on the readings. In Table 5.3, the left column (before washing) represents the readings obtained with plastic packets that were cleaned with a tissue paper whereas the right column represents the readings obtained for plastic packets after washing with water. The results show that the readings before and after washing are in close agreement. Thus, washing does not significantly influence the readings. Hence, as long as the daily performance check is passed, weighing with these balances should be able to give reproducible and comparable findings.

The average weight per plastic packet was calculated from the representative sample units in each case. According to Figure 5.11, the heroin distributor was inclined to use plastic receptacles with a weight in the range between 0.46 g and 0.54 g. Approximately 45% of the 294 cases (containing more than one plastic package) showed a small variation (RSD $< 3\%$) in the weight of the plastic packet under the same case. This infers that the sample units were respectively packed with a similar batch of plastic packets since they displayed a small plastic weight difference in the case.

Table 5.3: Reproducibility of a batch of 12 empty plastic packets

No.	**Weight before washing (g)**			**Weight after washing (g)**		
	Balance A (Sartorius)		**Balance B (Denver)**	**Balance A (Sartorius)**		**Balance B (Denver)**
1	0.5139	0.5136	0.5143	0.5134	0.5130	0.5133
2	0.5201	0.5199	0.5204	0.5191	0.5192	0.5203
3	0.5092	0.5093	0.5096	0.5086	0.5086	0.5089
4	0.4956	0.4957	0.4958	0.4952	0.4952	0.4950
5	0.5066	0.5062	0.5065	0.5057	0.5058	0.5059
6	0.5133	0.5135	0.5140	0.5130	0.5132	0.5133
7	0.5090	0.5091	0.5095	0.5084	0.5084	0.5089
8	0.5111	0.5109	0.5112	0.5102	0.5100	0.5104
9	0.5171	0.5170	0.5176	0.5164	0.5164	0.5163
10	0.5233	0.5232	0.5238	0.5228	0.5229	0.5227
11	0.5154	0.5152	0.5155	0.5148	0.5148	0.5151
12	0.5073	0.5068	0.5079	0.5071	0.5069	0.5073
Mean	**0.5118**	**0.5117**	**0.5122**	**0.5112**	**0.5112**	**0.5115**
SD	**0.0072**	**0.0072**	**0.0073**	**0.0072**	**0.0072**	**0.0073**
RSD (%)	**1.41**	**1.41**	**1.42**	**1.40**	**1.41**	**1.42**

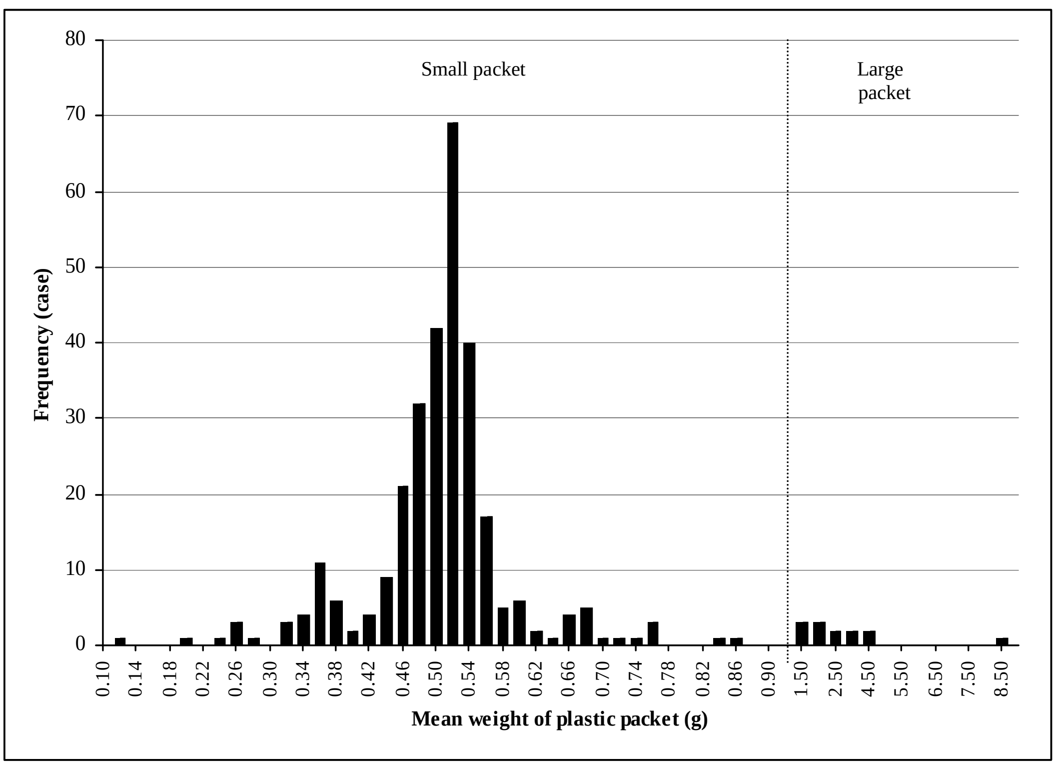

Figure 5.11: Frequency of the weight of plastic packet encountered in 311 cases (Mean value on the histogram, x ± 0.01g for small packet, x ± 0.25g for large packet; bars containing > 20 cases are used to define the most frequently encountered range)

5.2.9 Width of the Plastic Receptacle

The width of the plastic receptacle may be part of the branding. According to Figure 5.12, there exist two distinct groups in the small packet category. 8% and 82% of the cases respectively used packets measuring about 4.80 – 5.10 cm and 6.20 – 6.40 cm in width to pack the heroin substance with the latter range being the most commonly encountered width.

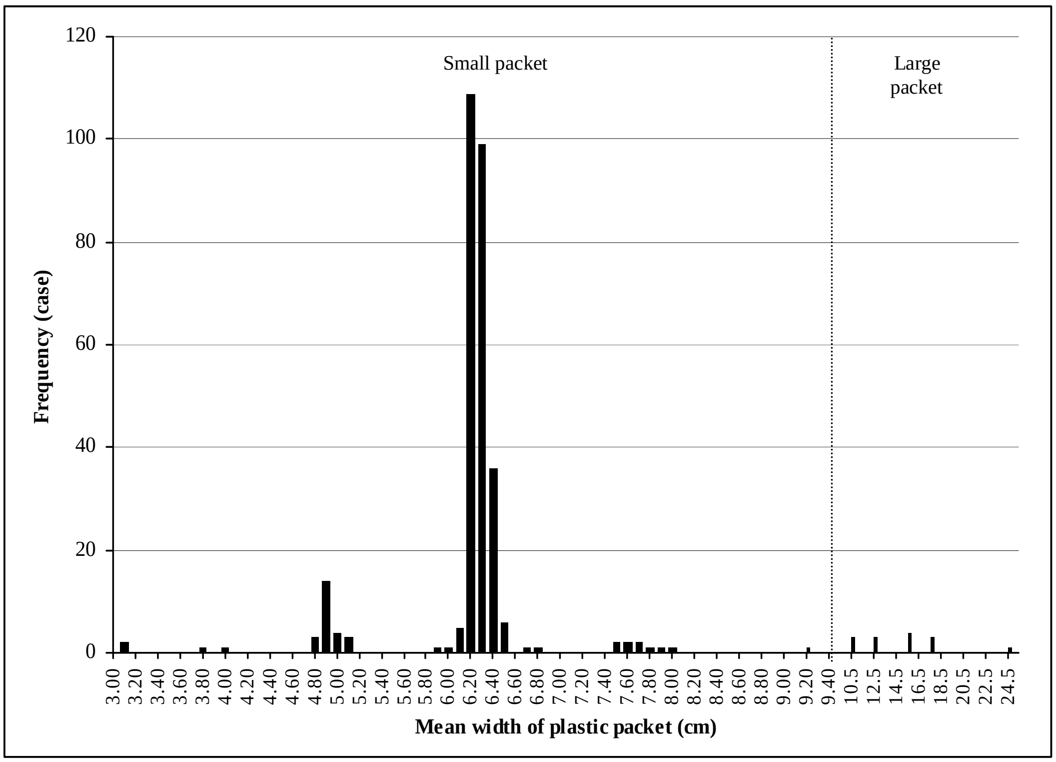

Figure 5.12: Frequency of width of plastic packet encountered in 311 cases (Mean value on the histogram, x ± 0.05cm for small packet, x ± 0.5cm large packet; bars containing > 20 cases are used to define the most frequently encountered range)

Usually, the plastic packet with a smaller width range was used to contain < 1.5 g substance per packet whereas the latter was packed with 0.3 – 3.0 g substance per packet. The substance weight range for the plastic packets with wider widths suggests that smaller packets were not necessarily chosen for smaller amounts of substance. In fact, packing the substance in plastic packets having a width < 5 cm will cause difficulties in handling due to sample bulging. However, there were cases showing consistent use of these bulged packets despite the handling difficulties. Hence, it is assumed that the plastic width could be one of the marketing strategies to represent trademark, production line, etc to facilitate the ease of recognition of the products by the dealers. Larger packets on the other hand allow sufficient space for folding and sealing. As a result, there was a high prevalence of plastic packets with wider widths in the small packet category. In the large packet category, the preferred width is not immediately clear but the dimensions were chosen to suit the convenience for packing and shipment.

Two sources of errors were encountered when measuring the width of the plastic packet: 1) the relatively large error of the ruler and 2) errors associated with the shrinkage and expansion of the plastic film caused by environmental factors. These factors gave rise to errors (approximately ± 0.5 mm), amounting to RSDs within 0.54 – 1.61% and 0.20 – 0.48% in the small packet and large packet categories respectively. Based on these ranges, when the lowest RSDs were referenced as the permissible errors in the plastic width measurement for both categories, it was found that approximately 78% of the small packet cases and 20% of the large packet cases showed variation less than these permissible errors.

5.2.10 Thickness of the Plastic Receptacle

Of all physical characteristics, the film thickness is the least reliable parameter. The precision of the readings was examined by using two micrometers, X and Y (both of Chicago brand) using two different batches of samples. 12 plastic packets marked ‘Std’ were commercially obtained from the same source. Another 12 plastic packets marked ‘Spl’ were obtained from a case. The thickness of the plastic films were measured with micrometers X and Y, whereby X1 and X2 represent two different sets of measurements obtained with the same micrometer X. The intra-micrometer (e.g. Std-X1 versus Std-X2 or Spl-X1 versus Spl-X2) and inter-micrometer (e.g. Std-X1 versus Std-Y1 or Std-X2 versus Std-Y1 and the same applies to Spl) precision as indicated in Figure 5.13 are generally consistently low. Both the Std and Spl categories respectively showed a wide range of thickness irrespective of the types of micrometers used. The ranges were however consistent in the box-and-whisker plots in each category. This signifies that the low precision of the readings was not associated with the micrometer. Instead, the films naturally have high variation in the thickness. In comparison with the new plastic films, an even wider range was observed in the case plastic films. This infers that the used plastic films such as those case packets will exhibit a higher intra-sample variation. If the plastic films had originated from a single source, the variation would most likely be the combined result of 1) natural manufacturing variation, 2) environmental influence and 3) attachment of microparticles that leads to uneven force upon measuring.

According to Figure 5.14, the most commonly encountered film thickness falls between 42 µm and 52 µm. As expected, the RSD of the plastic film thickness per case was very high. The first quartile of the calculated RSD is 8.34% while the third quartile 12.64%.

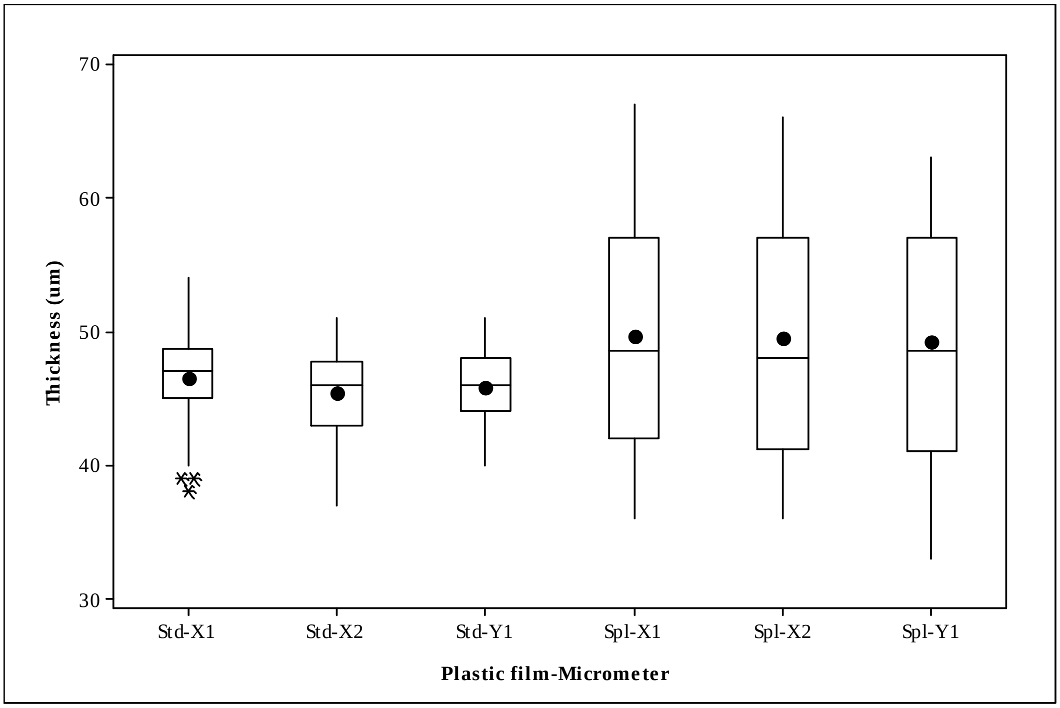

Figure 5.13: Boxplots of thickness of commercial plastic packets and case plastic packets measured with two micrometers (Each boxplot represents 48 readings)

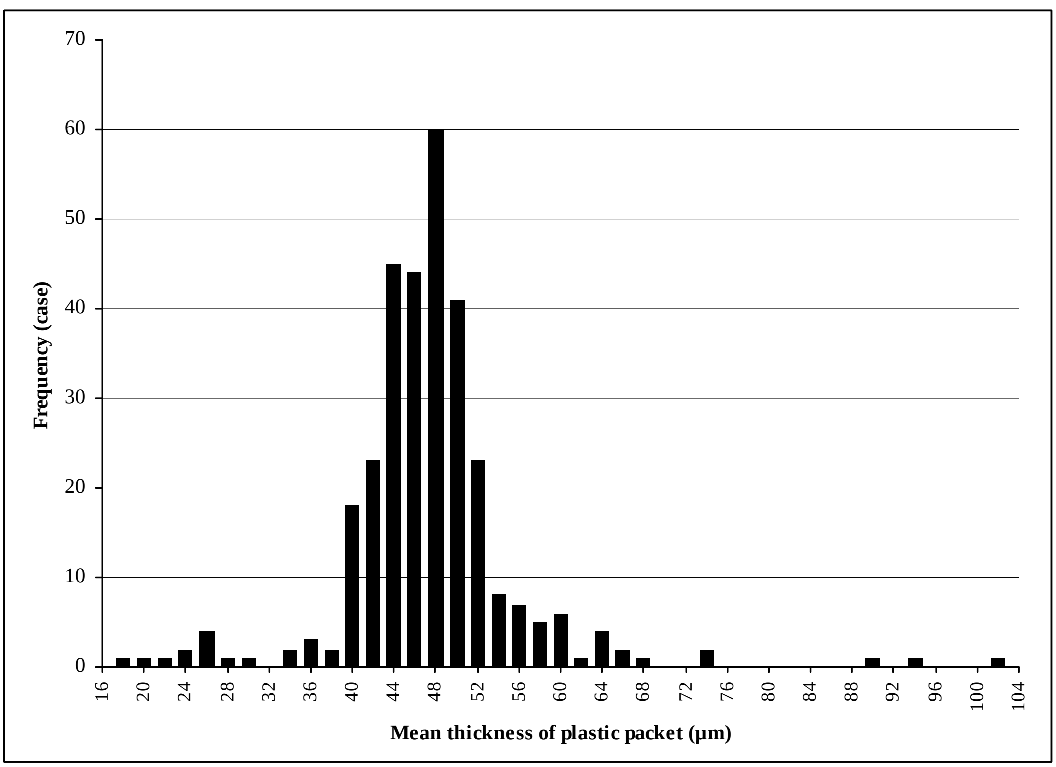

Figure 5.14: Frequency of thickness of plastic packet encountered in 311 cases (Mean value on the histogram, x ± 1µm; bars containing > 20 cases are used to define the most frequently encountered range)

5.2.11 Classification of Heroin Cases by Physical Characteristics

To assess the relationships between the collected cases at the distribution/street level, 296 small packet cases were selected (the remaining 3 cases of 299 small cases utilized large packets). Four measurements (weight of substance per package, weight of plastic packet, width of plastic packet and thickness of plastic packet) obtained from each case were decomposed into two axes by principal component analysis (PCA) in correlation mode. Figure 5.15 displays the case-to-case relationships on a 2-dimensional score plot with the % variability expressed as $\%V_1$ and $\%V_2$ respectively for PC1 and PC2. It indicates that the majority of the cases show a close agreement for the four physical characteristics (referring to the dense area marked ‘P’ in the centre). In some cases (the dense area marked ‘Q’ and the scattered data), the dealer may have chosen other measurements for packing the drug.

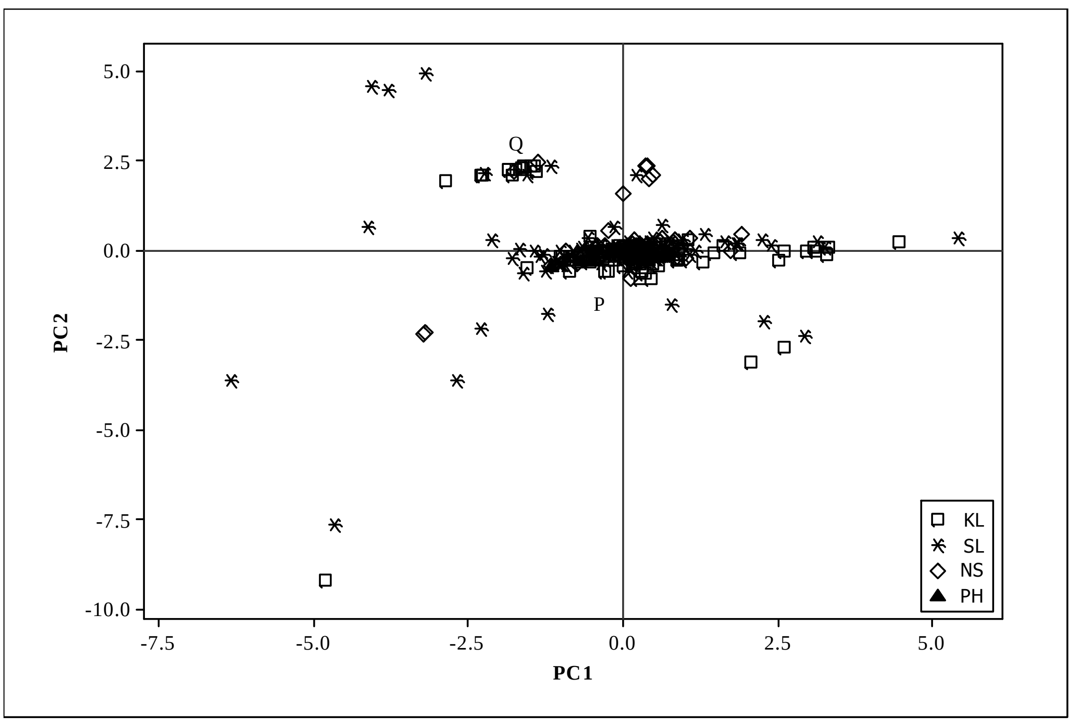

Figure 5.15: A score plot representing four physical measurements obtained from 296 small packet cases analyzed by PCA in correlation mode, $\%V_1 = 44.3\%$ and $\%V_2 = 34.9\%$

Based on the score plot, it is suggested that at the retail level directly related to the seized heroin, there could be a single chief drug dealer (dense area P) controlling the majority of the heroin samples within the country. The dense area P is the significant cluster that suggests frequent employment of a particular type of plastic packet with similar dimensions for packing a relatively similar amount of substance in each packet.

5.2.12 Summary

A total of ten aspects of visual examination and physical measurements were performed on each case. From the results, it showed that each case had a unique set of visual and physical characteristics. Commonly encountered characteristics would signify the common choices of the heroin packers. To some extent, the use of physical measurements is also helpful to evaluate the relationships between cases at the distribution/street level.