CHAPTER FOUR

4. Results and Discussion

4.1. Introduction

UM is an educational institution with more than 27,000 students and 1,700 academic staff with 17 faculties, Institute and research centers. As an academic institute, its consumption on white paper is significant. Generally, paper (coloring paper, white paper) conducted by Administration and Finance Division, Registration Department, which will be distributed among some faculties, administration office and residential colleges. Despite the normal way of purchasing and distribution of paper in UM is by that Department however, some Faculties and institute purchase their paper from paper suppliers while all the Residential Colleges get the paper from UM. All the faculties, research center, institute and administration offices are supervised and monitored by Department of Development and Asset Maintenance which is generally known as JPPHB in UM. Looking at the generation of waste paper, this study taken to analyze waste paper generation by Faculties research center, institute and administration offices however, for results and discussion, this study is focused more on white paper generated in UM as waste. Data collection was conducted two times in 2008 and once in 2009 as for residential colleges it was done once a month due to some limitation (in most Residential colleges, the management can only cooperated with this research for a month). This research was possible by

getting the co-operation of the cleaners to collect, sort and keep all the waste paper that was collected from Faculties, Residential Colleges and Offices in the University of Malaya. The paper collected was classified into different groups as follows: White paper, Newspaper, Cardboard, Book and Mixed paper.

4.2. Waste paper generation in Residential Colleges

There are twelve Residential Colleges in the UM. Ninth Residential College and International House were not included at this research as this research just focusing on waste paper generation in UM. Data collection for these colleges was carried out by interviewing with the Residential College's principal, administrations and the cleaners. Most of the colleges do not have specific bins for waste collection due to the cost of bins. However, they separated the waste which consisted of waste paper and other recyclables materials and get income from this activity. Nevertheless, from observation during data collection conducted at residential colleges, it was find out that lack of awareness among staff, student and cleaners about separation of recyclable materials, rate of the recycling activity are factors why recycling was not fully successfully conducted. Table 4.1 shows paper waste generation in Residential Colleges in UM for a period of one month. At UM level, the distribution of paper (any type such as coloring paper, A3, A4 and so on) is starts the beginning of each year by sending a request form and filled it by principal of Residential Colleges to inform Administration and Finance Division, Registration Department about their request/needs on paper for a period of one year. In some Residential Colleges, students get paper from the offices when they have any activity and

it is compulsory for students to pay from their account. From Table 4.1 it shows that 10,730 numbers of students and staff generated 2500.6kg of waste paper in the period of one month. According to the principal of the Colleges, they get money from selling waste paper and other recyclable items. The price for selling of one kg of waste paper to the recycler in residential colleges is RM 0.15. So, for total amount of 2500.6kg of waste paper, total income for all residential colleges reached about RM 375.09/ month.

On the other hand, UM spent RM11 for one ream of A4 paper (white paper). It can be assumed that for the total no of reams of paper UM supplied to Residential Colleges is RM 2,849. Results in Table 4.1 indicated that there are a huge difference between the amount UM spent to purchase reams of paper and the income that colleges can get from white paper recycling. Results that presented in Table 4.1 is focused on white paper generation as this type of waste paper in UM was quite significant among other waste paper and generally data collection from faculties, institutes, research centers, administration offices and residential colleges showed that all these places used white paper while usage of coloring paper, cardboard, newspaper and books are of similar pattern between all places. During data collection from residential colleges it was observed that, some colleges tried to reduce the usage of paper one such example is seventh college while generated 73kg of white paper during the period of one month. This college use email instead of send paper for their records or office work also reduced the usage of printing and copying paper by using fax. As it is presented in Table 4.1, seventh college generated the lowest amount of white paper among the other colleges. However, twelfth college generated the highest amount of white paper during the period of one month. In twelfth college there was not any recycling activity.

Table 4.21: White paper generation in Residential Colleges (kg/month)

Residential Colleges	White paper (kg/month)	Student no. (one semester)	Staff	Total persons	Average paper used (kg/person/ per month)	Reams of paper supplied by UM
First college	480	800	32	832	0.58	20
Second college	130	700	40	740	0.18	20
Third college	130	750	40	790	0.16	20
Fourth college	141	664	41	705	0.20	10
Fifth college	120	800	40	840	0.14	20
Sixth college	200	700	35	735	0.27	10
Seventh college	73	740	35	775	0.09	20
Eight college	200	822	32	854	0.23	4
Tenth college	215	700	9	709	0.30	25
Eleventh college	128.2	740	10	750	0.17	10
Twelfth college	683.4	2,990	10	3,000	0.23	100
Total	2,500.6	10,406	324.00	10,730	0.23	259

Figure 4.1 shows the results on total number. of students and staff and total amount of white paper generation in residential Colleges during the period of one month. More details about the Figure and the Residential Colleges will be discussed on each residential Colleges separately.

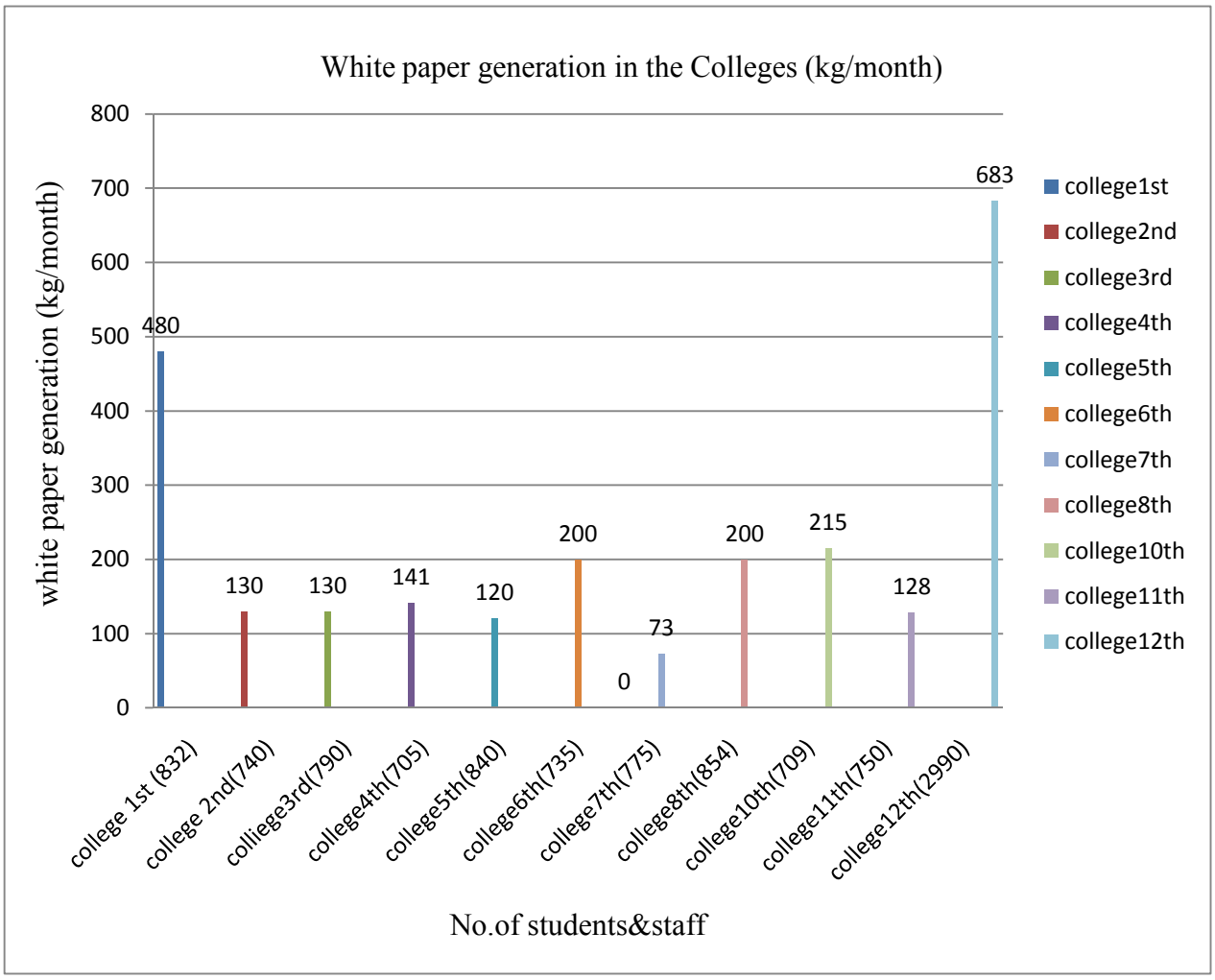

Figure 4.2: White paper generation in Residential Colleges during the period of one month

As presented in Figure 4.1, Twelfth College is the highest generation of white paper while First College is second. As mentioned before, First College had a great activity on recycling however; the total usage of white paper is quite huge compare to the other that did not follow any recycling activity. Data collection and interviewing with principal and students of residential colleges shows that applying the recycling activity dose not play main role alone while the other factors such as having the proper

management, type of progrmme students have and facilities also plays the important role for recycling activity. As it shows in Table 4.1 and Figure 4.1, such colleges like First colleges generated a lot of waste paper. After interviewing with the principal and students from these colleges results showed, most students in this college is from Faculty of Engineering and Faculty of Built Environment .Even, each level of academic degree has different results on generation of waste which in this case is waste paper. As this research shown, students in First Degree and Foundation level generated more paper waste compare with master and Phd level. Although, generation of waste paper may be increase due to the programme study. As an example, students in Faculty of Law generated more newspaper and white paper compare to the Sport center. Approximately, 80% of students in Twelfth College are from Center of Foundation in Studies Science. As the name of this center shows, generally, all students in this center are in Foundation level, so, this is why some colleges those have students from first degree generated the highest amount of paper. The reason is these students consumed huge amount of paper due to their programme and projects. As discussed earlier, the rate of selling one kg of waste paper is vary in UM from recycler people and it is depend to the type of paper. However, insufficient storage of paper in UM, caused that in some cases, the cleaners was not being able to get the higher benefit from the recycling activity. For example in Second College, cleaners kept the recyclable materials in open area, and due to the changes weather in Malaysia, humidity and rain may reduced the price that recycler offers to the cleaners.

4.2.1. The First Residential College

The First Residential College is the oldest residential college in the University of Malaya. It was built in 1959 and comprises of 3 blocks, namely block A, B and C. The number of students in this College has grown rapidly and today it regularly houses over 800 students. The total waste paper generation was 480 kg in one month. The number of students and staff in this College at the time of this research was 832. This Residential College purchased its paper from UM and the total ream of paper for one month is 20. This College was very strict about recycling and had its own policy for recycling. The cleaners sorted all the recyclable items such as paper, glass, cans and plastic and kept these items. At the end of each month these items were sold and the income was used by the college. Most of the students in this college are from Faculty of Engineering and Faculty of Built Environment. Also, the no of first degree students are higher compare to the master and phd level.

4.2.2. The Second Residential College (Tuanku Bahiyah Residential College)

When the University of Malaya campus was moved from Singapore to Kuala Lumpur in 1958, a new hostel was constructed and that hostel was called the Second Residential College, or Second RC. This College had a total number of 700 students and a staff of 40 in April 2009. The amount of reams of paper that supplied by UM in this College was an average of 20 reams a month. If the students staying in the College had any activities, the office usually gave them the paper needed and it was compulsory for

students to pay from their account. The total waste paper generation in this College was 130 kg in April 2009.

4.2.3. The Third Residential College (Tuanku Kurshiah Residential College)

The Third Residential College is one of the oldest hostels in the University of Malaya and accommodates both undergraduate and postgraduate students. In April 2009, this college had 750 students and 40 staff. University of Malaya provided 20 reams of paper for each month to this Residential College. The total amount of waste paper generated in this college in April 2009 (one month) was 130 kg.

4.2.4. The Fourth Residential College (Bestari Residential College)

The Fourth Residential College or Bestari Residential College was established in August 1963.This College can accommodate and provide meals for more than 700 undergraduate and postgraduate students. The number of students in April 2009 was 664 and the number of staff in this college was 41 persons. This college supplied 10 reams of paper for one month from UM. The students were provided with paper for their activities. The total amount of waste paper generated by this College in April 2009 was 141 kg.

4.2.5. The Fifth Residential College (Daya Sari Residential College)

The Fifth Residential College was officially opened in June 1966. In Semester 2 (April 2009) there were 800 students and 40 staff. This College also purchased the paper

from UM and this amount was 20 reams of paper for one month. Fifth residential college generated 120 kg of waste paper in one month April 2009.

4.2.6. The Sixth Residential College (Ibnu Sina Residential College)

Currently it is home to over 700 undergraduates studying at the UM and the number of staff working in this college is 35. This College uses 10 reams of paper monthly. Students took paper from the office when they had activities. The total amount of waste paper generated in this College in April 2009 was 200kg.

4.2.7. The Seventh Residential College (Za'ba Residential College)

The Seventh Residential College, also known as Za'ba Residential College, was officially opened in 1975. Currently, it houses and provides meals to over 800 undergraduate students. During the data collection (April 2009) the number of students who stayed in this College was 740 and the number of staff was 35. The total number of reams of paper that this College ordered from UM was 20 per month. However, all this paper was used by only the office, none was supplied to students. The amount of waste paper generated by this college in one month was 73 kg. most of the student in this college studied in Faculty of Computer Sciences and Information Technology.

4.2.8. The Eight Residential College (Kinabalu Residential College)

This College was opened in 1987. Approximately 700 - 900 undergraduates can reside in the Kinabalu Residential College. In Semester 2(April 2009) the total number of

students was 822 and the number of staff was 32. Total reams of paper that provided by UM for this Residential College per month was 4 reams and all this paper was used by the office only. This College tries to reduce the usage of paper by using other means such as scanning, email, etc. In Eight College the total waste paper generation in April 2009 was 200 kg. After interviewing with the principal of this colleges it was observed that this college and Tenth College is a house for students from Academy of Islamic Studies and Academy of Malay Studies.

4.2.9. The Tenth Residential College (Tun Ahmad Zaidi Residential College)

The College has been providing students with accommodation since 1st June 1997, and unlike many of counterparts it gives students the option of not having meals at the College, thereby proving to be a more economical option for the students concerned. Around 700 students currently live here, with three blocks allocated for female students. The total number of students for Semester 2 (April 2009) was 700 and the number of staff was 9. According to the principal of this Residential College, the full capacity of this College is 1023. The total number of ream of paper that Tenth College take by UM per month was 25.This College gives paper to students for their activities. Total waste paper generated for one month (April 2009) was 215kg.

4.2.10. The Eleventh Residential College (Ungku Aziz Residential College)

When constructed in 1997, the Eleventh Residential College was built to accommodate students who enrolled in the Centre for Foundation Studies in Science pre-

university programme, as well as, the students in the Japanese University Preparatory Programme (RPKJ) offered by the Ministry of Education. In Semester 2 (April 2009) the total number of students was 740 and the total number of staff was 10 and the number of reams of paper provided by UM was 10. The amount of waste paper generated by this College in April 2009 was 128.2 kg/month. Lots of students from Sport center are staying in this residential college.

4.2.11. The Twelfth Residential College (Raja Dr Nazrin Shah Residential College)

The newest and biggest Residential college built in the University of Malaya, the Twelfth Residential College was completed in 2002, and is a collection of five interconnected buildings, Block A to Block D and the cafeteria. The college was named after his Majesty, His Royal Highness Raja Dr. Nazrin Shah Ibni Sultan Azlan Muhibbuddin Shah, who honored the University by opening the Residential College on 26th of February 2005. The college has the capacity to house an amazing number of 2990 people comfortably at any one time, and provides the University's many undergraduates and postgraduates with some of the newest facilities in the UM. The total number of students in April 2009 was 2990 and the total number of staff was 10. The number of reams of paper which given by UM to this college was 100 per month, which was used by the office and the students. The total amount of waste paper generated in this college in April 2009 was 683.4 kg/month. This residential College provided house for mostly students from Center of Foundation studies in Science.

Table 4.1 shows that total number of student and staff in Residential Colleges in 2009 was 10,730 persons. As mentioned before, there are twelve numbers of Residential Colleges in University of Malaya. From these numbers, Ninth College and International House were not included in this study as these places are outside the scope of the study. For all these places UM supplied reams of paper for their usage and this amount was depending on the number of reams of paper that each Residential Colleges requested. Therefore, some Residential Colleges sell these papers to student when the students had any activity and students should pay for paper from their account. The principle of some Residential Colleges and the cleaners separated the waste paper and the other items which can be recycled and kept the items in a place which is not a proper place for recycling this was due to high cost of recycling bins. In most of the colleges it was done by the cleaners and they did it as they could receive income from this activity furthermore, for some Residential Colleges like First College, this income was spent for college. After separation the recycling items at the end of each month the cleaners or principle of colleges, contact the person who was interested to buy the recycling items. The important point was that these people didn't give the same price as they weren't from the same company. Among the Residential Colleges First College generated 480 kg of waste paper by 832 persons which means the average of waste paper generation per person per month was 0.58 kg.

According to Mr Termezi Ahmad Ab Aziz (Management of Administration and Finance Division, Registration Department, UM spent RM11for each reams of A4 paper, so, total reams of paper that supplied by UM for colleges cost RM 2849 (RM

11*259). Results indicated that total amount of waste paper that all these residential colleges generated for one month was 2,500.6 kg. According to the principal and/or cleaners the recycler people bought one kilogram of waste paper from RM 0.15 to RM.0 20. However, the rate of RM 0. 15 was the most abundant income. From all of these, this study assumed that if the colleges had the income from the waste paper the total money that they got from this activity was RM 375.9 per month. The scenario of waste paper in UM in Residential Colleges shows that these places didn't get any enough benefit from selling of waste paper as a recycle item compare to the amount of money that UM spent for purchasing paper. Plus the price of consumption could be more if the take into account students that purchased their paper themselves. Moreover, they generated a huge amount of waste paper due to lack of information on recycling, lack of training for cleaners, students and staff, technology , facilities and policy.

4.3. Waste paper generation in Faculties

Currently, there are 17 faculties, research center and institute in the UM. In these places UM did not provide the reams of paper for them and some places purchased their paper from outside of UM while some purchased it from UM, so, the reams of paper had not taken into account as the source of paper is not from the same place. All the waste paper that weighted was in five categories as follow: white paper, cardboard, books, newspaper and color paper. In this part, the average rate of waste paper generation in faculties was not taken into account. The reason is the amount of waste paper generation in faculties compare with the waste paper generation in Administration offices and Residential Colleges are not belong to the students alone as they maybe are from the

other places however, waste paper generation in residential colleges and administration offices is generated just from the staff or student which really work or stay in these places. So, the results present the means of three time data collection in faculties and administration offices. This activity was done after asking from the supervisor of the cleaners from each faculty to keep the waste paper from these places. Again in the faculties also, cleaners sorted the waste and classified it into 4 groups as paper, glass, plastic and cans. These persons keep all the recyclable items and sell to the recycler persons. It was not centralized in UM so, each place for example Faculty of Science deal with the peoples which was different with the recycler from the Faculty of Dentistry. So in some cases the price that these persons offer to cleaners also was different, it was the range between RM 0.15 to RM 0.20 for white paper. The rate of price for newspaper and color paper was lower than white paper. All the cleaners had the income from this activity and because of this matter they were very restrict on sorting the items. In this study, the research Center and Faculties were divided into two groups based on the practical courses. In group one the faculties had the less practical courses or no practical courses and more focus on theory courses and programme. These faculties are as follow: Faculty of Business and Administration, Faculty of Art and Social Sciences, Faculty of Language and Linguistic, Faculty of Education, Academy of Islamic Studies, Academy of Malay Studies, Asian. Europe. Institute, Center of Foundation Studies in Sciences (Jepun, Asasi Sciences), Faculty of Economic and Administration, Faculty of Law and Faculty of Built Environment. The Faculties that had the practical Courses were as follow: Faculty of Medicine, Faculty of Dentistry, Faculty of Engineering, Faculty of Science, Faculty of Computer Sciences and Information Technology, Sport Center.

4.3.1. Waste paper generation based on Practical Courses in Faculties

Table 4.2 shows the waste paper generation in faculties that had the practical Courses rather than theory courses and programme. As mentioned before, in these places most of the programmes are based on practical and Lab working rather than the theory programme. For this reason the paper that used by students were lower than the Faculties that had the Theory programme. From the results indicated that Faculty of Engineering generated the highest amount of white paper among the other faculties with 33.9 kg per week and it follows by faculty of Medicine by 8.1 kg, Faculty of Science (6.2 kg), Faculty of Computer Sciences and Information Technology (5.6 kg), Faculty of Dentistry (4.6 kg) and Sport Center (3.6 kg).For Cardboard, Faculty of Engineering generated the amount of 6.2 kg and Faculty of Medicine came in to second place with 5.45 kg. Faculty of Computer Science and Information Technology generated 8.5 kg of books as waste paper. In this Faculty according to the Students, they used books and magazine. Faculty of Engineering generated 9 kg of newspaper per week while Sport Center was in second by generate 1.4 kg. It is clearly that in Sport Center, most of the programmes are based on practice. This is why in this center the waste paper is less. Most of the people (mostly student) that came to Sport Center for activity, carry the newspaper from outside the center and usually after activity they spent their time to read the newspaper so, people put the newspaper down after reading and it becomes as waste paper in this center. This

was one of the reason why this center had the newspaper as a waste paper. For color paper part, also Faculty of engineering had the highest amount of waste paper by 6 kg/week. According to the results, Faculty of Science had the highest amount of population including student and staff among other faculties by 4230 and follows by Faculty of Engineering with 3206, Faculty of Medicine with 1839, Faculty of Computer Sciences and Information Technology 1233, Sport Center with 478 persons and Faculty of Dentistry with 433 persons. As shows in Table 4.2 Faculty of Engineering generated 55.1 kg of total waste paper while Faculty of Medicine is in second with generation 19.35 kg, Faculty of Computer Sciences and Information Technology with 14.1 kg, Faculty of Science 6.2 kg, Sport Center 5 kg and the last one is Faculty of Dentistry with 4.6 kg.

Table 4.3.11: Waste paper generation in Faculties based on practical Courses

Faculty	**White paper**	**Cardboard**	**Books**	**newspaper**	**Color paper**	**No.of student**	**No.of staff**	**Total no.of persons**	**Total amount of waste paper (kg)**
Faculty of Medicine	8.1	5.45	0	0	5.8	921	918	1839	19.35
Faculty of Dentistry	4.6	0	0	0	0	141	292	433	4.6
Faculty of Engineering	33.9	6.2	0	0	6	2842	364	3206	55.1
Faculty of Science	6.2	0	0	9	0	3540	690	4230	6.2
Faculty of Computer Sciences and Information Technology	5.6	0	8.5	0	0	1098	135	1233	14.1
Sport Center	3.6	0	0	1.4	0	397	81	478	5
Total	62	11.65	8.5	10.4	11.8	8,939	2,480	11,419	104.35

As a conclusion, Faculty of engineering with the total 3206 no of people (student and staff) generated 55.1 kg of waste paper per week. These amount of waste paper included white paper, cardboard, books, newspaper and color paper. Faculty of Science with 4230 people generated the total amount of waste paper 6.2 kg per week. Because the results for Faculty of Science didn't look like reasonable so, for this place waste paper measurements done for three times to make sure that the results is correct. In all these times the results was very close to the result that shows in Table 4.2.

4.3.2. Waste Paper generation in faculties (no practical)

Faculties in this group were classified based on non practical courses and progarmme. This means that in this category students used more paper for their projects rather than Lab working. In this category, the name of the faculties were as follow: Faculty of Business and Accountancy, Faculty of Built Environment, Faculty of Art and Social Sciences, Faculty of Language and Linguistic, Faculty of Education, Academy of Islamic Studies, Academy of Malay Studies, Asian Europe Institute, Center of Foundation Studies in Sciences (Jepun and Asasi Sciences), Faculty of Economic and Administration and Faculty of Law. Table 4.3, results indicated that Faculty of Built Environment generated the highest amount of white paper by 48.7 kg among the other places. Faculty of Business and Accountancy came in the second place by 32.9 kg, and it followed by Center of Foundation Studies in Sciences (20.8 kg), Faculty of Language and Linguistic (11kg), Faculty of Economic and Administration (9.5kg), Academy of Islamic Studies (9.1 kg), Academy of Malay Studies (6.8kg), Faculty of Education (5.9kg), Faculty of Law (5.3kg) and Asian Europe Institute by total amount of 5 kg. During this

research, it obvious that in Faculty of Built Environment, students from Architecture Department, used a huge amount of paper for their projects and assignment. After they finished their course they discarded all the paper that they used for their project in faculty. However, in most cases, the lecturer and supervisors asked them to put it as a showcase study inside the faculty. This is one reason that the amount of white paper as a waste was quite lot compare with the other faculties. As it can be cleared that the usage of the cardboard also by this faculty was in the first place by 28.75 kg. According to the Table 4.3 Faculty of Law had the highest amount of newspaper as waste paper. In this faculty students need to get the update information about the news that happened in the society. They read newspaper to get more information about the law and guildlines or new act on Law. This is why in this faculty the usage of newspaper is a lot.

Table 4.3.21: Waste Paper generation in Faculties (non- practical) for one week

Faculty	White paper	cardboard	books	Color paper	Newspaper	No.of student	No.of staff	Total no.of person	Total amount of waste paper (kg)
Faculty of Business and Accountancy	32.9	0	5	0	0	2068	148	2216	37.9
Faculty of Art and Social Sciences	6.6	18.2	0	0	0	2084	243	2327	24.8
Faculty of Language and Linguistic	11	0	0	3.9	0	835	169	1004	14.9
Faculty of Education	5.9	23	9.4	0	0	2662	143	2805	38.3
Academy of Islamic Studies	9.1	6.1	0	5.5	0	2377	212	2589	20.7
Academy of Malay Studies	6.8	0	0	4.5	0	863	73	936	11.3
Asian Europe Institute	5	0	0	2.6	2	47	30	77	9.6
Center of Foundation Studies in Sciences	20.8	6	0	3.2	0	801	157	958	30
Faculty of Economic and Administration	9.5	0	0	12	10	1044	106	1150	31.5
Faculty of Law	5.3	0	0	0	18	826	60	886	23.5

Faculty of Built Environment	48.7	28.75	0	0	0	814	101	915	77.45
Total	161.6	82.05	14.4	31.7	30	14,421	1,442	15,863	319.95

Results shows that total income that cleaners received from the white paper (selling as a recycle item) was RM 24.24.

161.6 (total amount of white paper generation by these places)* RM 0.15= RM 24.24

In all the above Faculties, 15,863 persons including the staff and the students generated 319.95 kg of total amount of waste paper during one week.

4.4. Waste Paper generation in other places in UM

In this study, waste paper was measured in the following places: Art Asia Museum, Examination Building, Institute of Post Graduate Studies (IPS), Culture Center or Perdanasiswa, Department of Development and Asset Maintenance (JPPHB) and Chancellery Building. As mentioned before this study was possible by asking the cleaners of each places to collected the waste paper that generated in these places and sorted with them into following group: white paper, cardboard, books, newspaper and color paper. This activity was done for three times which means for three weeks (2 weeks in 2008 and one week in 2009) all results that shows in Table 4.4 are the means of these three week.

Table 4.41: waste paper generation in other places in UM

Administration office	White paper	Cardboard	Color paper	Newspaper	No.of staff	Total waste paper /week(kg)
Art Asia Museum	7.9	3	0	4	9	14.9
Examination Building	10.3	4	6.8	0	49	21.1
Institute of Post Graduate Studies(IPS)	30.4	0	0	0	46	30.4
Culture Center or Perdanasiswa	20.91	6	10	22.5	3201	59.41
Department of Development and Asset Maintenance (JPPHB)	9.3	0	0	0	279	9.3
Chancellery Building	41.6	0	0	18.06	340	59.66
Total	120.41	13	16.8	44.56	3,924	194.77

Results show that for Art Asia Museum with 9 people (total number of staff) this place generated 7.9 kg of white paper and 3 kg of cardboard. The mean of newspaper that generated by this place was 4 kg. According to the staff of Art Asia Museum, they used white paper to increase the knowledge of the visitors about this place. The visitors are from school, universities, institution and other colleges. The visitors can be from UM and outside the UM. On the other hand, most of the visitors through away all these paper that received from Art Asia Museum after visiting and these waste generated a huge amount

of white paper. However, the people leave the newspapers that carry out with themselves and it becomes as a part of waste paper for this place.

For Examination Building, they used both white paper and coloring paper for sending the letter for student and Faculty offices and even for Administration Offices. At that time the exam slip that students collected before final exam from this part was in color. In some cases some mistake about the personal information or /and programme of the students who wants to attend in the final exam leads this place to generated color paper as a waste paper. This shows that in this building the amount of color paper as a waste paper is 6.8kg while the white paper generated by this place is 10.3 kg .The mean of cardboard that generated by this place is 4 kg. Total waste paper generation for one week was 21.1 kg by 49 staff.

Institute of Post Graduate Studies which called IPS in UM had 46 Staff. This place had the different Laboratory and Administration Offices. There is 4 block in this building. Total white paper that IPS generated for one week was 30.4 kg. Most of the students from Laboratories used the paper from their research grant so they were so restrict about the paper that they used. However, the usage of paper in this place was low by students as the students had lab working.

Culture Center or Perdanasiswa, is the famous place in UM for International Students as several offices for international Students are in this place. Culture Center also the same as IPS had multi blocks. There were two book shops in this place. A lot of activity and festival was hold in this place and this place introduced as a place that students can practice for their activity or festivals here. As mentioned before, because of festivals a huge amount of coloring paper and white paper used as a decoration and

advertisement. There were 3201 no of staff working in this place. Total waste paper including white paper, cardboard, color paper and newspaper that generated by this place was 59.41kg for one week. Book shops in this complex keep most of their cardboard to reuse it again for example when they get order from any places regarding with the items that they sell. Book shopkeepers packed that item with the cardboard and give it to the customers who order the things from this place.

Department of Development and Asset Maintenance or JPPHB is a place that coordinated all efforts to preserve the importance and comfort of the campus society and users of the university's facilities. This place provided all the maintenance and developments services. JPPHB had 279 staff. Total waste paper that generated for one week in this place was 9.3 kg which was just the white paper.

Results shows that total number of 3924 staff in Art Asia Museum, Examination Building, Institute of Post Graduate Studies (IPS), Culture Center or perdanasiswa, Department of Development and Asset Maintenance (JPPHB) and Chancellery Building generated 194.77 kg of waste paper which is included white paper, cardboard, color paper and newspaper. As this amount is the mean of three measurements, it assumed that during one month the staff from all these places can generated total amount of 799.08 kg of waste paper. If the income from the selling waste paper to the recycler people was calculated as RM 0.15 then the total income from these places for waste paper will be assumed RM 119.86. However, in this study focus on white paper as a waste paper. So, it assumed that roughly each week 120.41 kg of white paper was generated in these places which means in one month this amount reach to 481.64 kg. While, cleaners had

total amount of RM 72.24 in each month from just the white paper (the mean of price for selling one kg of white paper was assumed as RM0.15).

Chancellery Building is the last place in this group. There are different administration offices in this building. Total number of staff that was working in this building was 340. In this building during the one week total amount of white paper that generated was 41.6 kg and 18.06kg of newspaper. Most of the staff from Chancellery Building mentioned used the public transport like LRT, Monorail, and Bus and so on…. In the early morning in some station people can get the newspaper as a free. So, the staff in this building carry out the newspaper from outside the UM and simply through it away in UM after they read it. From the results and the survey it can be assumed that the source of newspaper mostly in UM is not really from UM it is from outside the UM. More details about this building will be presented in the next part (4.5).

4.5. Waste paper generation in Chancellery Building

There were several offices in the Chancellery Office as following: Vice Chancellor's office, International Corporate Relations Office, International Student Center, Legal Unit, Security Center, UM Center for Continuing Education, Corporate Planning Unit, UM Press, Palapes and Quality Management and Enhancement Center.

Table 4.51: Summary of no of reams that supplied by UM for Chancellery Building offices and no of staff

No	Name of the offices	No.of reams that supplied by UM	No.of Staff
1	Vice Chancellor ‘s office	350	10
2	International Corporate Relations Office	250	28
3	International Student Center	200	18
4	Legal Unit	120	6
5	Security Center	200	167
6	UM Center for Continuing Education	800	72
7	Corporate Planning Unit	300	3
8	UM Press	350	25
9	Palapes	120	4
10	Quality Management and Enhancement Center	150	7
11	Total	2840	340

Table 4.5 shows the summary of no of reams that supplied by UM for Chancellery Building offices and no of staff. All the places mentioned in Table 4.5, order the reams of paper that they need during one year from UM. This means that at the beginning of each year, all places that interested to get the paper from UM fill the official form and send it to the person who is in charge at Administration and Finance Division

Department. So, their request will be taken into account for the ordering paper. There was a meeting of the Management of Administration &Finance Division Registration Department which was conducted on 5th of May 2009. According to the information provided at the meeting, University of Malaya ordered 50,000 reams of paper in 2008 and this was increased to 70,000 reams of paper in 2009.According to Mr Termizi Ahmad AB Aziz (Management of Administration and Finance Division Department) each reams of A4 paper cost RM11 for UM. So, it can be calculated that for the total reams of paper (2840) that UM supplied for the offices in Chancellery Building cost RM 31,240. This money spent for the white paper while, UM also buy the coloring paper and A3 paper and the other types of paper which the price are different. Therefore, total waste paper as white paper that was generated in one week in Chancellery Building was 41.6 kg. It assumed that for one month total waste paper generated in this place was 166.4 kg. Cleaners had income of RM0.15 per one kg of white paper approximately, so for total income from the white paper in Chancellery Building, is RM 24.96. So, it can be discussed that from the total amount of money was RM 31,240. Data shows that during one year UM spent RM 31, 240 for purchased A4 paper for Chancellery Building and the income from recycling white paper for cleaners was just RM 24.96. So, there was a huge gap between the purchased of paper and selling white paper in UM consequently. On the other hand, it will be possible that UM reduce this gap by applying proper recycling programme. The important key and stage for recycling programme is increasing the knowledge and information of the students, staff and the most important is cleaners.

4.6 A Case Study of Life Cycle Assessment (LCA) on Paper production process in Iran

4.6.1 Introduction

Forests play an important role on carbon concentration, unsustainable harvesting would cause increase in carbon concentration. World paper and paperboard demand is expected to grow to about 2.1% till year 2020 and the growth will be fastest in Eastern Europe, Asia (except Japan) and Latin America (Forsstrom et al, 2006). Paper and pulp sector are one of the main consumers of fibrous wood resources which, has significant impact on the climate change by affecting forest resources .There are two kinds of paper production: (a) using wood (virgin) as raw materials and (b) using non-virgin material like kanaf and bagasse (Honnold, 2009). There are several studies that applied LCA in pulp and paper products (Merrild et al., 2008; Murphy & Power, 2007; Schmidt et al., 2007; Holmgren and Hening, 2005; Dias, 2007; Wiegard, 2001; Fu et al., 2005 and Dias et al., 2002). In their research they discovered that energy and water consumption, Greenhouse Gases (GHG) and methane emissions, chlorine and raw materials used for non-virgin papers is less than virgin material.

This study focused on LCA of non-virgin material (baggasse) in Paper Factory in Iran. The Pars Paper Factory is a government owned factory located in Southwest Iran and is 500 m from Hafttapeh Sugarcane Factory. It was established in 1963 with a production capacity of 35,000 metric tonne per year. Nowadays, the production of this factory has reached 40,000 metric tonne per year. Hafttapeh Sugarcane Factory was

supplying bagasse to the paper factory. Water for this process is provided from the Dez River which is also near the factory. Source of energy for this factory is hydroelectricity and mazut. Mazut is a brownish-black petroleum fraction consisting largely of distillation residues from asphaltic-type crude oils, with a relative density of about 0.95 which is used as the source of energy for heating and steam-raising for furnace, kilns and boilers. Bagasse is the fibrous residue remaining after sugarcane is crushed to extract its juice and is currently used as a renewable resource in the manufacture of pulp and paper products. The fibers are about 1.7mm long and are well suited for tissue, corrugating medium, news print and writing paper. As shows in Figure 4.2, in general, the three stages of paper production are: preparation of non-virgin materials, pulp mill and paper mill process (Dias et.al, 2007; Pars paper factory). This factory has three production units as follows:

- Preparation of Bagasse
- Pulp Mill, and
- Paper Mill

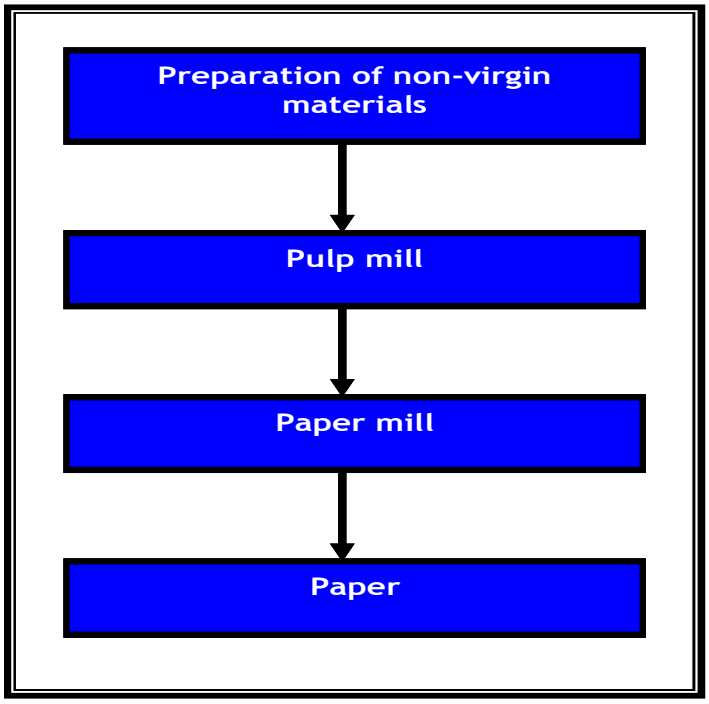

Figure 4.2: Paper production process

Preparation of Bagasse:

Non-virgin material used in paper factory is from farmed trees. The farmed trees are supplied by supplier and cut into small pieces. The farmed tree is known as a bagasse. It is provided by the sugarcane factory which is 500 meters from the Paper factory. The materials are sent to the paper factory through pipes or conveyer belts and the energy used for this is electricity (Figure 4.3).

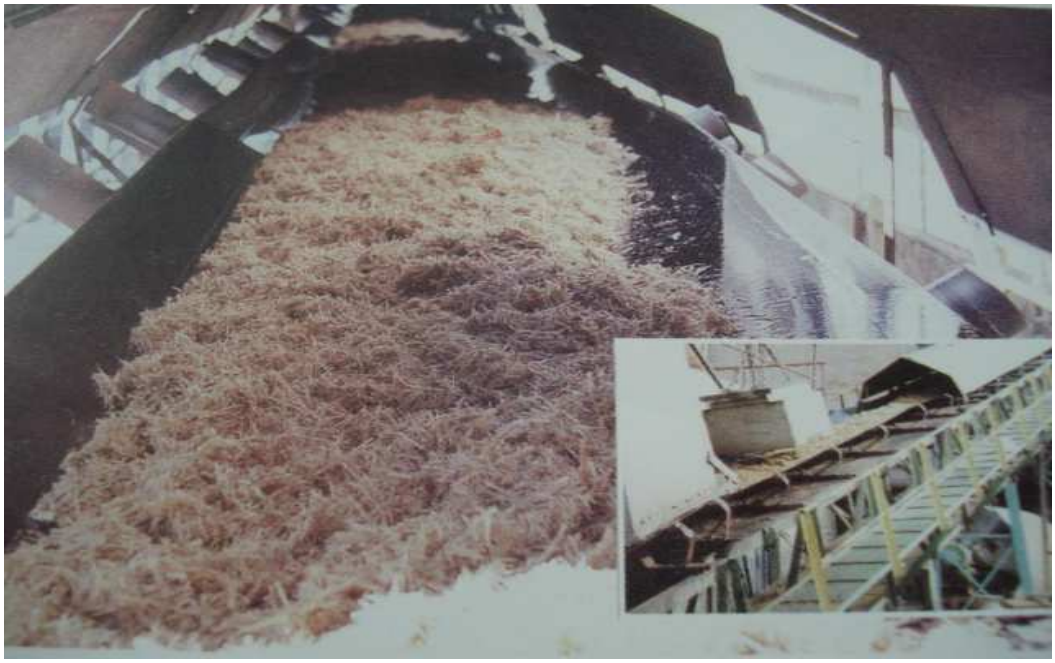

Figure 4.3: Transported the Bagasse through the conveyer belts from the sugarcane factory to the paper factory

Using agricultural crops rather than wood has the added advantage of reducing deforestation (Ekvall, 1999). Due to the fact that bagasse can be chemically pulped, bagasse requires less bleaching chemicals than wood pulp to achieve a bright, white sheet of paper (Kadam, 2002). Because of this, there are fewer impacts from the materials used in the bleaching section, such as chlorine, to the environment. The bagasse contains 65-68% fiber, 25-30% pith, 2% sugar and 1-2% minerals. It is passed through the process called Depithing where the fiber is separated from the pith. It is then cleaned up and is ready to be used for pulp and paper milling processes.

Pulp Mill: The aim of this process is to produce pulp that can be used for paper milling. During pulp milling, a few sub-processes such as cooking, washing, screening, ticking and bleaching are carried out (Figure 4.4 and 4.5).

Figure 4.4: Cooking process on pulp mill in Pars Paper Factory

Figure 4.5 : Pulp Screening and Cleaning in Pars Paper Factory

i. Cooking

The water in the fibers is reduced by cooking and the energy used for it is steam. Approximately 10-15 is minutes needed to cook the fibers. This factory has five boilers, however, currently it uses only three of them because the rest are out of service (Figure 4.6).

ii. Pulp Washing

The cooked fiber is called Pulp which is black in color. The black pulp, called Black Liquor, is then washed three times to change its color.

Figure 4.6: Cooking process on pulp mill in paper factory

iii. Pulp Screening and Cleaning

This is the third stage in the pulp milling process .In this stage all the sand and useless fibers are removed. This is shown in Figure 4.7.

Figure 4.7: Pulp Screening and Cleaning in the paper factory

iv. Pulp Thickening:

In this stage about 12% of the water in the pulp is removed.

v. Bleaching

In the final stage Cl (Chlorine gas) and NaOH are used to change the black liquor color to white color and the process is usually done three times.

C) Paper Mill

Paper milling is the last process in producing paper. The pulp will go through several processes to finally become paper. The paper which is white in color is cut to A4 size. At this stage, the moisture in the paper is reduced to 55-60% (Figure 4.8).

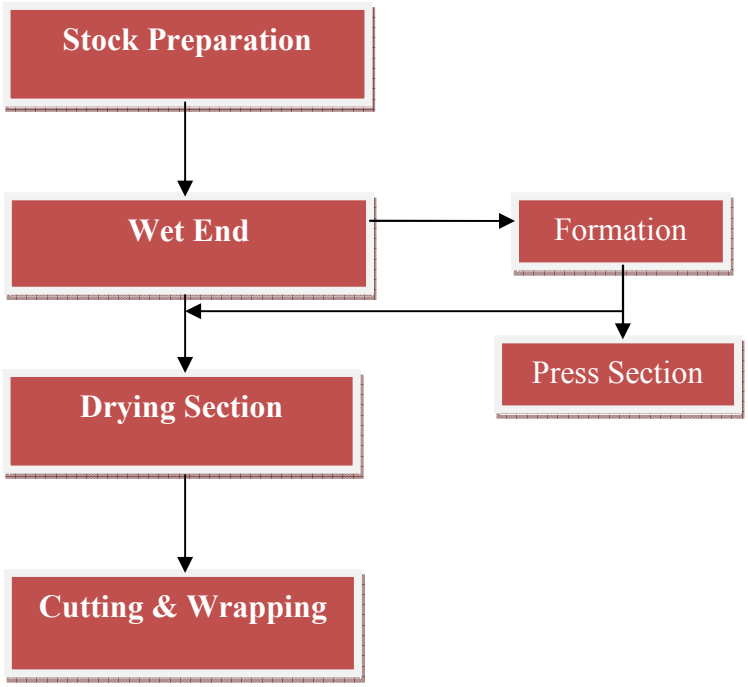

Figure 4.8: Paper Mill Process

i. Stock Preparation

Pulp is insufficient for making paper so in this section materials such as kraft are added to improve the pulp. These krafts are usually bought from Malaysia or Thailand.

ii. Wet End **:**This section is very sensitive in Paper mill so, it is divided to 2 subsections as follows:

- Formation
- Press Section

After materials are added to the pulp it will go to the Flow Box and be spread on the mantle. During this process the pulp gives up some water and it is then sent to the Drying Section (Figure 4.9 and Figure 4.10).

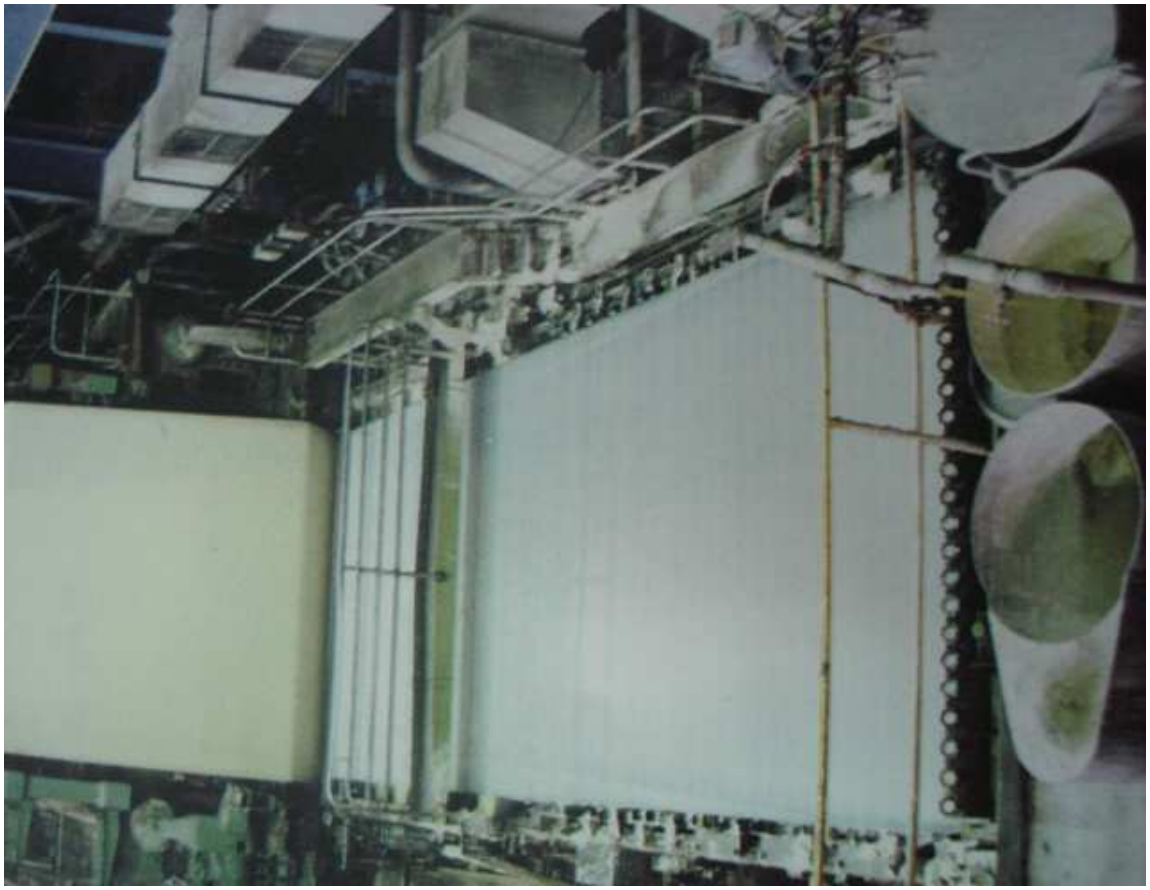

Figure 4.9: Wet End (Formation) section

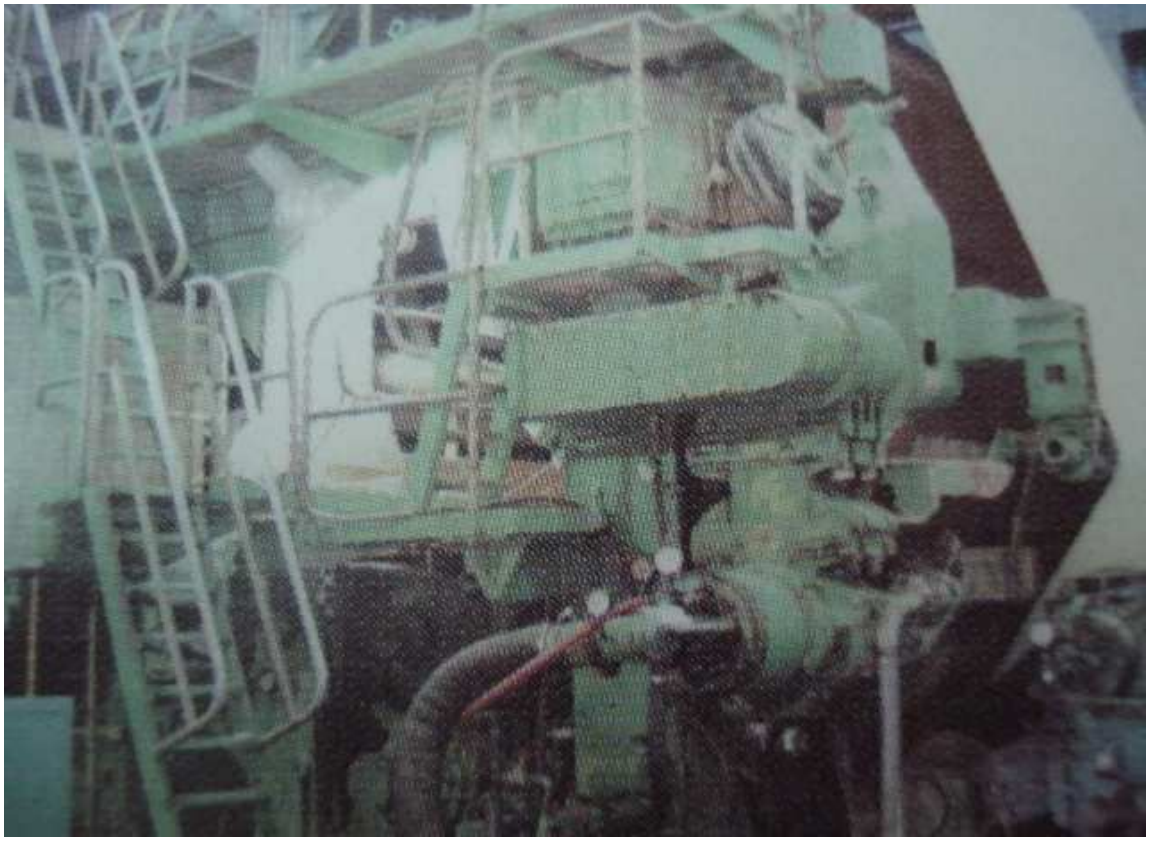

Figure 4.10: Wet End (Press Section) section

iii. Drying Section

Wet paper containing 55-60% moisture after going through the press section will be passed through some cylinders (Figure 4.11 and Figure 4.12) .These cylinders heat the paper using steam so, that the paper will lose all the moisture. In this stage, to improve the quality of printing and the surface of paper, the paper is passed through the Callevdering (using iron) section covered with starch. Inputs at this stage are corn starch and resin.

Figure 4.11: Drying Section

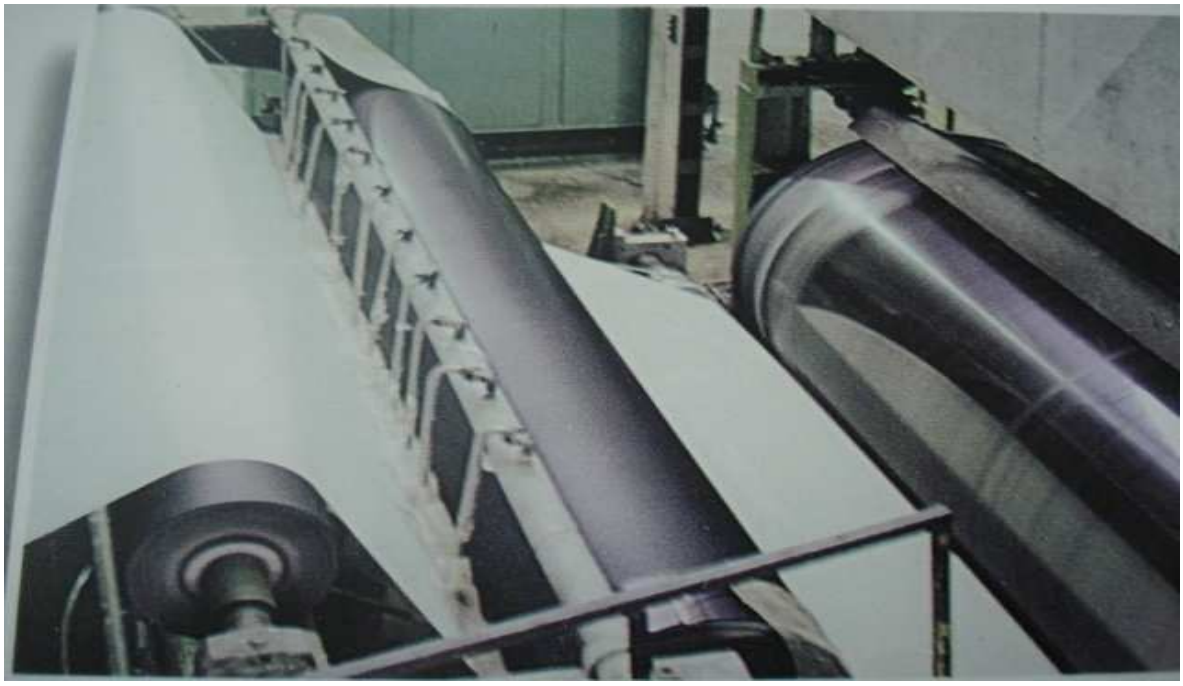

Figure4.12: Callevdering Section

iv. Cutting and Wrapping

This is the final stage in the Paper mill .The cutting of the paper to size depends on the requirements of customer. In the final stage (Bleaching); Cl (Chlorine gas) and NaOH are used to change the black liquor (black pulp) color to white color and the process is usually done three times.

Paper Mill:

Paper milling is the last process in producing paper. The pulp will go through several processes (stock preparation, wet end, draying section and cutting and wrapping) to finally become paper. Pulp is insufficient for making paper so; in this section materials such as kraft are added to improve the pulp.

The paper which is white in color is cut to A4 size. At this stage, the moisture in the paper is reduced to 55-60%.

Paper is made from plant fibers called cellulose, which are found in wood. Cellulose must be converted into pulp before, being used to manufacture paper. To begin the papermaking process, recovered fiber is shredded and mixed with water to make pulp. The pulp is washed, refined and cleaned, then turned to slush in a beater. Nowadays, by rapid economic development and population growth the demand for paper also increased in the world. More demand on paper needs more harvesting of woody materials. Unsustainable harvesting of wood can caused deforestation, climate change, etc. However, producing one metric tonne of paper from non virgin materials such as bagasse, kanaf and bamboo can save 17 trees, 3.3 cubic meter (m^3) of landfill space, 360 L of water, 100 L of gasoline, 60 pounds of air pollutants, 10401 kilowatt of electricity (Malaysian Newsprint Industries, 2007 and WasteCap, 2008). In additional, greenhouse

gases (GHGs) such as carbon dioxide ($CO_{2)}$, methane ($CH_{4)}$ and nitrous oxide (N_2O) are critical components of the earth's atmosphere. These gases act like a blanket, trapping heat around the earth and keep temperatures necessary for human life. However, anthropogenic activities such as fossil fuel burning, land clearing and deforestation can cause 'thickened the greenhouse blanket' which means can effected on climate changes.

4.6.2 LCIA Analysis

- Goals and Scope definition

The goals of the LCA study are to:

i. Evaluate the environmental performance of paper manufacturing process, and

ii. Identify inputs that have environmental potential from the paper manufacturing process of one metric tonne of paper for one year.

- Scopes of the LCA study

i. System boundary

In this study, the A4 size paper commonly used for writing, printing and copying a document was chosen as an assessing subject in the Life Cycle Assessment. The life cycle of an A4 paper which starts from the raw material extraction stage, production stage, use stage and end-up at the disposal stage (Figure 4.13). However, the system boundary of the study only focused on the paper production process stage (dotted line in Figure 4.13).

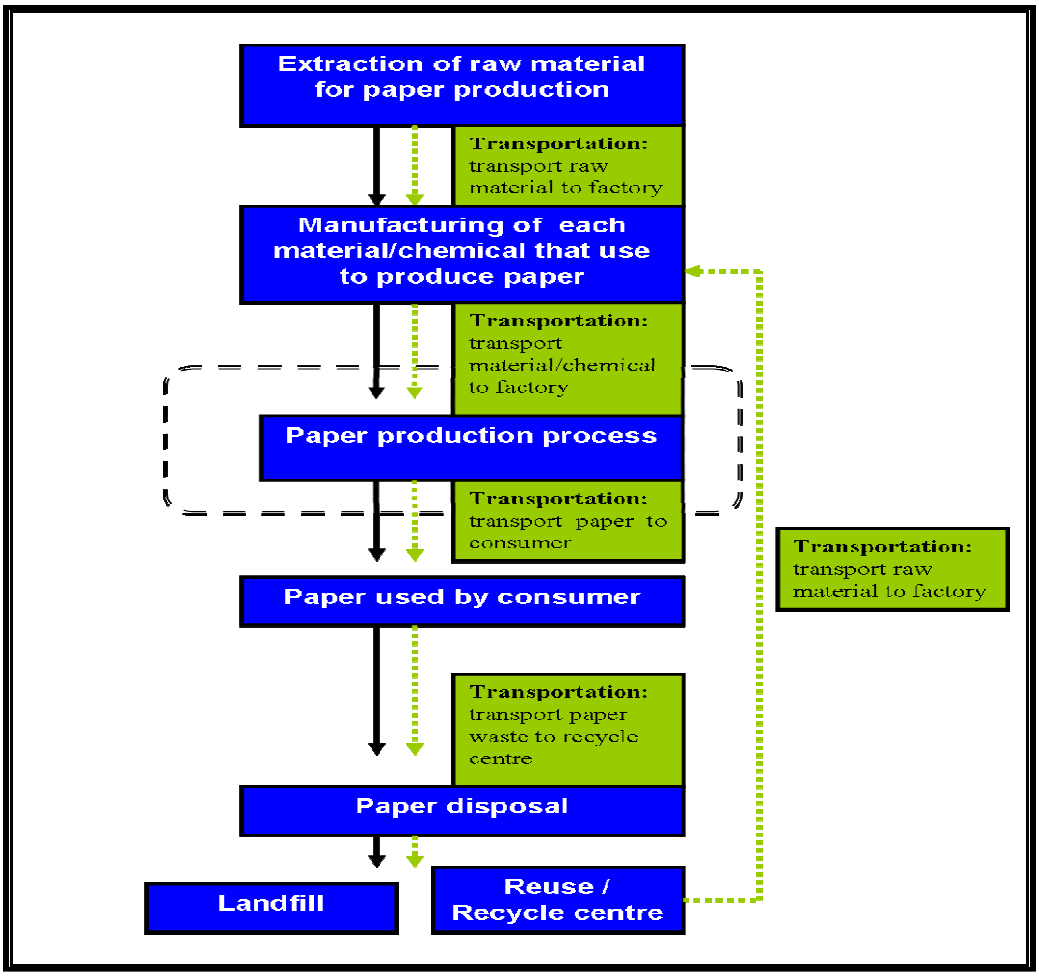

Figure 4.13: Life cycle of paper and system boundary of this study (dotted line)

- Functional Unit

The Functional Unit set is the production of one metric tonne of paper for one year.

ii. LCIA method

Impact assessment is an important step in measuring the environmental impacts in LCA. SimaPro comes with a large number of standard impact assessment methods. The impact assessment methods are as follow: Eco-indicator99,Eco-indicator 95,CML

92,CML2 Baseline (2000) ,EDIP/UMIP,EPS 2000,Ecopoints 97, Impact 2002+,TRAC,EPD method ,Cumulative Energy Demand, IPCC Greenhouse gas emission. Each method contains a number (usually 10 to 20) of impact categories. CML2Baseline 2000 method was chosen because this method elaborates the problem oriented (mid-point level). The CML Guide provides a list of impact assessment categories grouped into: Obligatory impact categories, additional impact categories and other impact categories (SimaPro7 manuals, 2006).

In this study, CML2 Baseline 2000 method was used for Life Cycle Impact Assessment (SimaPro7 manuals, 2006). The CML2 Baseline 2000 provides ten types of impact categories with its unit as follow (Table 4.6): A biotic depletion (Kg Sb eq), Acidification (kg SO_2eq), Eutrophication (Kg PO_4---eq), Global warming (kg CO_2 eq), Ozone layer depletion (kg CFC-11eq), Human toxicity (kg 1,4-DBeq), Fresh water aquatic eco toxicity (kg 1,4-DBeq), Marine aquatic eco toxicity (kg 1,4-DBeq), Terrestrial eco toxicity (kg 1,4-DBeq) and photochemical oxidation (kg C_2H_4).

Table 4.6: Impact Categories and Units

No	Impact category	Unit
1	Abiotic depletion	Kg Sb eq
2	Acidification	kg SO_2 eq
3	Eutrophication	Kg PO_4eq
4	Global warming	kg CO_2 eq
5	Ozone layer depletion	kg CFC-11 eq
6	Human toxicity	kg 1,4-DB eq
7	Fresh water aquatic ecotoxicity	kg 1,4-DB eq
8	Marine aquatic ecotoxicity	kg 1,4-DB eq
9	Terrestrial ecotoxicity	kg 1,4-DB eq
10	Photochemical oxidation	kg C_2H_4 eq

(Source: SimaPro 7 Mannuals, 2006)

Sb: Antimony CFC: Trichlorofluoromethane DB: Dichlorobenzene

The emissions inventory data are in terms of the mass released into the environment—such as 1 kg—per functional unit it also means the impact of a unit mass (1 kg) of an emission to the environment (Pennington et al.,2004).

- **Assumption**

In the LCA study, the following assumptions were made:

There were no wastes or emissions to air and water nor by-products during paper production process because lack of data.

4.6.3 Results and Discussion

All the data in SimaPro are structured in such a way that the practitioner can recognize between data that is relevant to the particular LCA project, and data that can be useful in other projects. There are a number of libraries in SimaPro software with all

kinds of data regarding used materials, production process, transport, energy and disposal processes (Goedkoop, et. al, 2003).

In LCA there are two kinds of data as follow: Background data and foreground data. Background data is all data that can provided from literature review, country reference or other database. These data collected from second source. Foreground data is data from primary sources of data such as questionnaire, site visit and interview. In this study the background data used from SimaPro 7 software and foreground data collected from the pars paper factory (refer to Table 4.7).

Table 4.7: Input from paper production process

No	Input	Item	Purpose
1	Non-virgin	Bagasse Kraft	Raw material Improve the pulp
2	Energy	Electricity from river Mazut	Steam, cutting
3	Water	Water from river	washing
4	Chemicals	Sodium hydroxide ; NaOH Aluminum sulphate ; $Al_2(SO_4)_3$ Optical brightness agent ;OBA Chlorine ;Cl	All the chemical are used for bleaching
5	Others	Clay Corn Starch Resin	Improve quality of paper

CML2 Baseline 2000 was used to analyze the potential environmental impact using Simapro 7.0 database (SimaPro7 manuals, 2006). The graph is scaled to 100% per

impact category, in order to allow the description of widely dispersed values per impact category in one diagram (Figure 4.14).

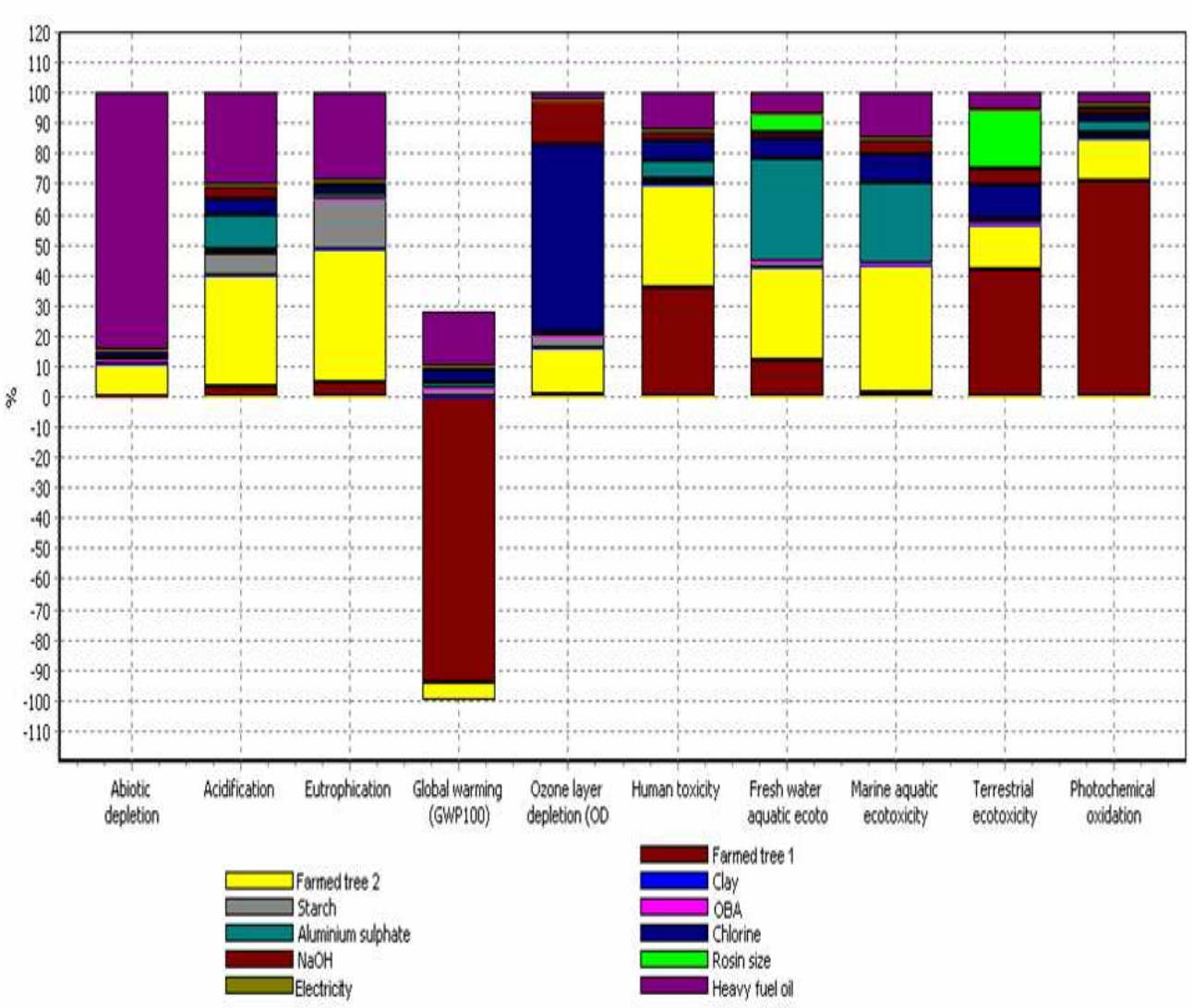

Figure 4.14: Impact of paper production process from all inputs for producing of one metric tonne of paper for one year.

Colour difference of the graph is representing the different types of input. The negative value of the impact means benefit to the environmental. The impact value for each impact was contributed from inputs that were used during the paper making process.

In this factory, there were 12 types of inputs involved in the process and had been analyzed. They were; Bagasse (farmed tree 1), Kraft (farmed tree 2), Electricity, Heavy fuel oil (Mazut), Water, Sodium hydroxide (NaOH), Aluminum sulphate ($Al_2(SO_4)_3$), Optical Brightness Agent (OBA), Chlorine (Cl), Clay, Corn Starch and Resin.

Abiotic depletion, acidification and eutrophication contribute 17.82 kg Sbeq, 3.43 kg SO_2eq and 0.71 kg PO_4--- eq, respectively, to each category of impact. For global warming, paper production process gives negative value -729.81 kg CO_2eq which means benefit to the environmental. Ozone layer depletion and human toxicity on the other hand give the impact values of 0.00015 kg CFC-11eq and 242.14 kg1, 4-DB eq respectively. Chlorofluorocarbons (eg. CFC-11 and CFC-12) act as a GHG in the troposphere but also damage the ozone layer in the stratosphere. The study shows that man-made chemicals can caused ozone layer depletion (Weigard, 2001). However, all inputs contribute 57.31kg 1, 4-DB eq to fresh water eco toxicity, marine aquatic eco toxicity by amount 81472.26 kg 1, 4-DB eq and terrestrial eco toxicity 7.34 kg 1, 4-DB eq to each category of impact. For photochemical oxidation, all inputs give impact value at 0.37 kg C_2H_4.From the LCIA results, assessment of paper making process shown, inputs that gives the lowest impact value to all types of impact is electricity except for global warming impact.

Global Warming

The total impact of global warming is-729.81 kg CO_2 eq. For global warming impact, farmed tree 1 (bagasse) gives the lowest impact (negative impact) value with amount of -951.414 kg CO_2 eq from all types of input (Figure 4.15). Negative impact

means environmental benefits. Electricity and bagasse contribute lowest impact value because both of these inputs were using renewable sources. The electricity is using hydroelectric sources, whereas bagasse is a by-product of sugarcane factory. The consumption of renewable sources will reduce environmental degradation (Fress et al., 2005). According to Ekvall (1999), using agricultural crops in paper production has the added advantage rather than wood. The consumption of bagasse as raw material for paper production (instead of virgin wood) may result in reduced deforestation and at the same time increased CO_2 absorption and has the potential to reduce global warming effect. Mazut on the other hand gives higher impact value to global warming with 25% from the total impact value.

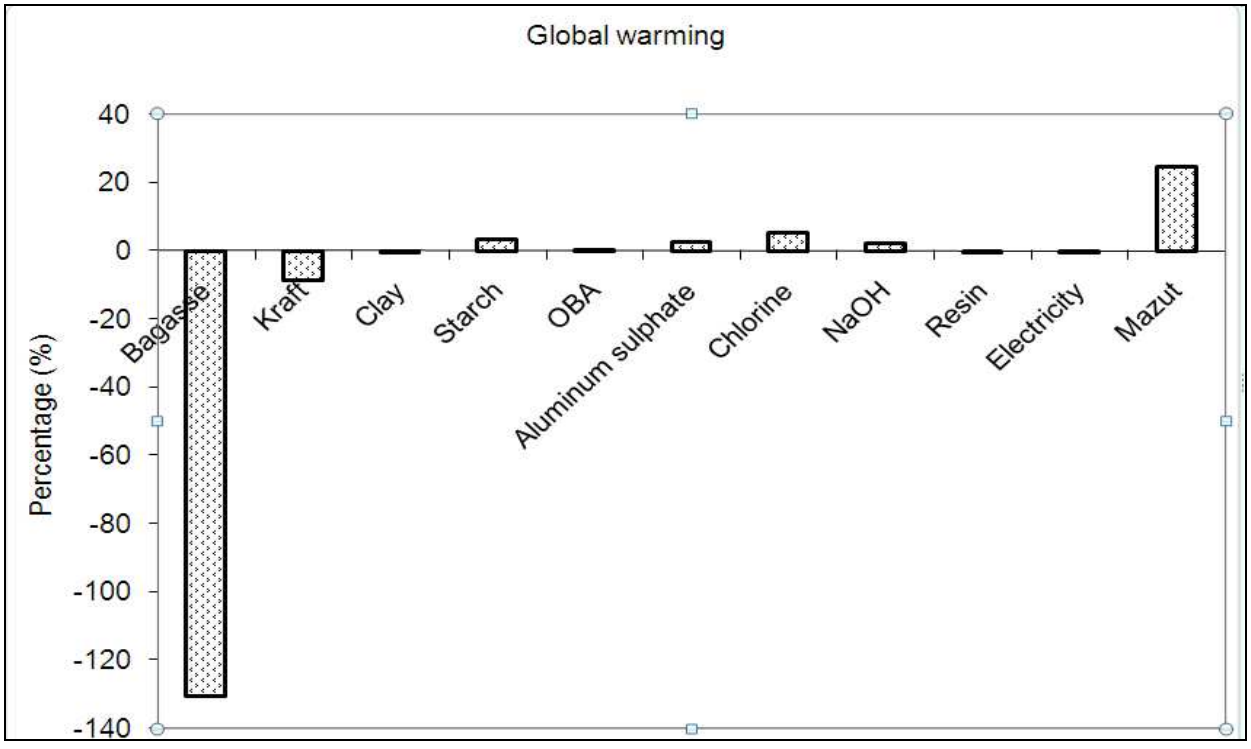

Figure 4.15: Input values in percentage for global warming impact for producing of one metric tonne of paper for one year.

Normally, in fuels, the amount of carbon per unit energy content varies significantly by fuel types. This means coal contains the highest amount of carbon per unit of energy, so it emits more greenhouse gases than the other fossil fuels. Burning fossil fuels can release 6.2 (GtC) into the atmosphere each year. (Wiegard, 2001). So, using mazut as source of energy, because of the high density of mazut, it can contribute for global warming. By changing the land use like deforestation it can result in increased emission of carbon into atmosphere. During making kraft, forest will be cleared and deforestation will happen and it can affect global warming (Wiegard,2001). However, at the same time using bagasse, as raw material can avoid deforestation, which is the positive point of using bagasse.

Abiotic depletion

The total impact of abiotic depletion is 17.82 kg Sb eq. From the total, mazut (fuel oil) contribute the highest impact value of 85% followed by kraft with 11%, of the total impact. The resin, bagasse, OBA (Optical Brightness Agent), NaOH, corn starch and Aluminum sulphate make up smaller impacts in a range of 0.1-2.0%. Clay and electricity contribute very little impact which are 2.90×10^{-3} kg Sb eq and 2.91×10^{-5} kg Sb eq, respectively and this is the reason why these two inputs give almost no impact value. It was identified that for abiotic depletion, mazut is the main input that contributes the highest impact value while electricity was the lowest. In the paper production process, mazut is used as an energy source for heating and steam-raising for furnaces, kilns and boilers. Mazut is a brownish-black petroleum fraction consisting largely of distillation

residues from asphaltic-type crude oils, with a relative density of about 0.95. This means coal contains the highest amount of carbon per unit of energy, so it emits more greenhouse gases than the other fossil fuels (Wiegard, 2001). The consumption of hydroelectric power will reduce environmental degradation because of renewable sources (Fress, et. al, 2005). Electricity derived from fossil fuels can increase global greenhouse gases (GHG) while hydroelectricity or nuclear electricity may not increase the GHG emissions (Wiegard, 2001; Eliasson, 2000).

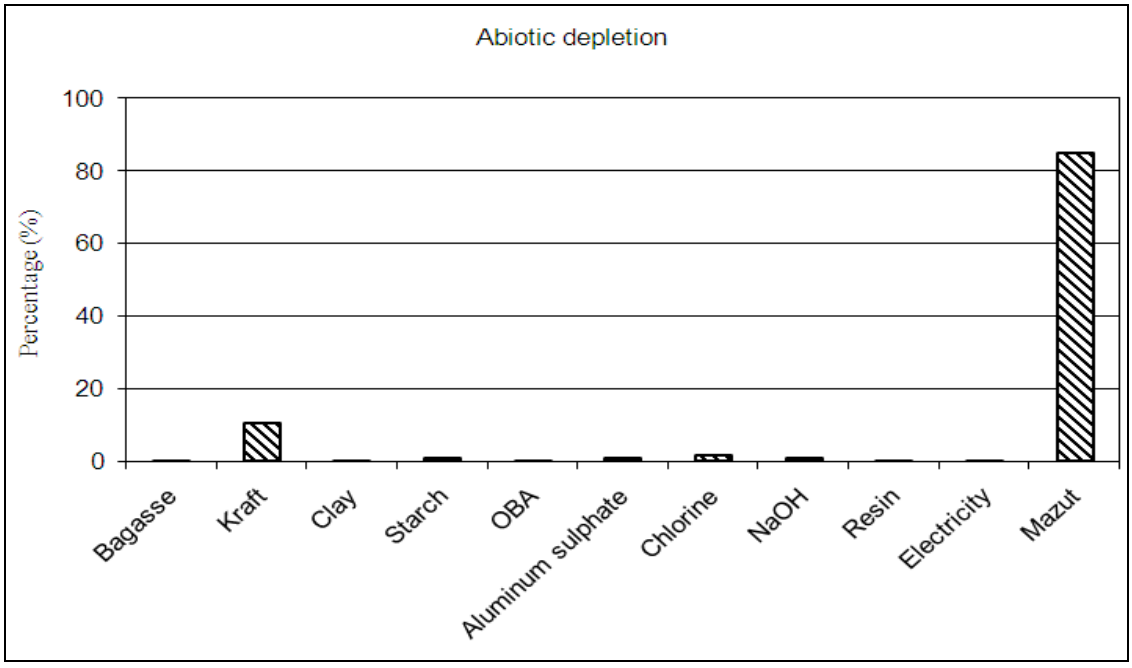

Figure 4.16: Input values in percentage for abiotic depletion for producing of one metric tonne of paper for one year.

Acidification

Acidic gases such as sulfur dioxide, nitrogen oxides (released during the burning of fossil fuels) contribute to the acidification of the soil and fresh water ecosystem. The

category indicator for acidification was measured in kilograms of sulfur dioxide equivalent (Kg SO_2 eq). Weigard, (2001) indicated that N_2O is produced naturally through human activities such as the burning of fossil fuels, deforestation, land-use changes and some industrial processes. This is also similar to the results of LCA which show that mazut and kraft contribute the highest impacts (Figure 4.17).

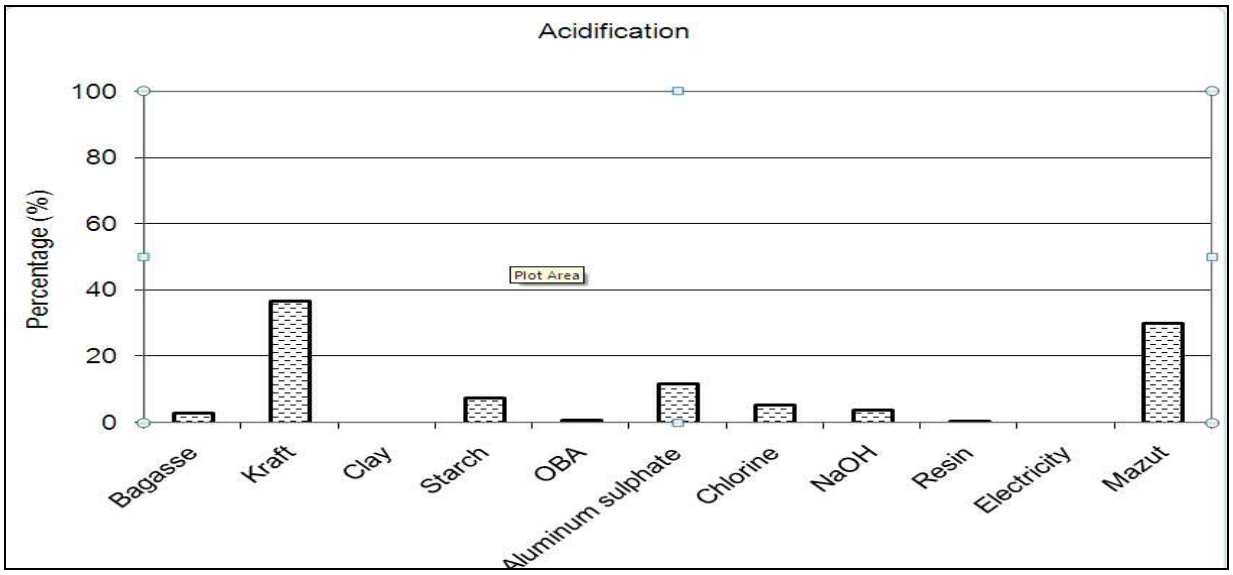

Figure 4.17: Inputs for Acidification impact

Kraft, mazut, Aluminum sulphate, starch and chlorine are the most important inputs which contribute 37%, 30%, 12%, 8% and 5%, respectively from the total impact of (10.30 Kg SO_2 eq). NaOH, bagasse, OBA and resin each contributes 4%, 3%, 1% and 1% respectively whereas the others contribute very little; clay (0.03 %) and electricity (0.0002%). As shown in Figure 2.23, Acidification produced the highest impact of 10.30 kg SO_2 eq while electricity produced the lowest impact with 0.0002%. This is because electricity is derived from the hydroelectric sources in this plant.

Eutrophication

Kraft gives the highest impact (44%) in eutrophication followed by mazut (29%), starch (16%), bagasse (5%), Aluminum sulphate (2%), chlorine (2%), resin (1%), NaOH (1%), OBA (1%), clay (0.3%) and electricity (0.0001%). Similar to acidification impact, kraft and electricity contribute the highest and lowest impact value with 44% and 0.0001% respectively from the total impact value of 2.15 Kg PO4 eq.

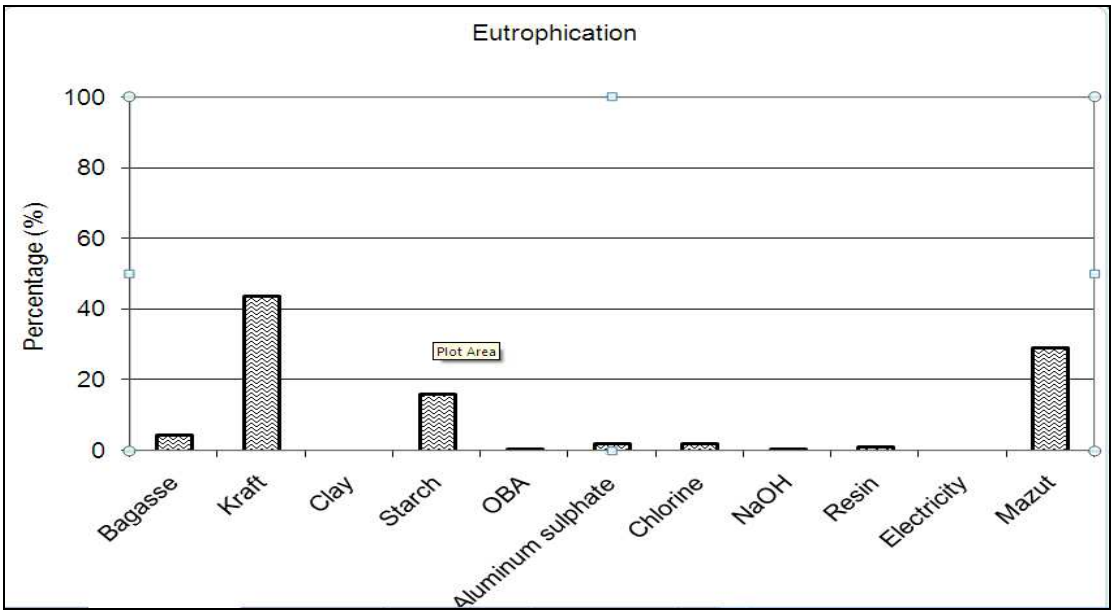

Figure 4.18: Inputs for Eutrophication impact

The enrichment of soil and water by nutrients is measured by the EP (Eutrophication) impact category. An increased EP could lead to algal blooms in lakes with reduction in sunlight penetration and other adverse consequences, and similar undesirable effects on soil. Release of nitrates and phosphates continuously to fresh water and marine water can cause increased nutrient buildup. During the combustion of fossil fuels and fuel production high NO_x is produced (Eriksson, et. al, 2007; Ally and Pryor, 2007). This can result in accumulation of nitrates, phosphates and dissolved oxygen

content (Gordon, 2003). These were similar to the results obtained in this LCA research which shows that mazut, kraft and starch contributes the highest impact to eutrophication

Ozone layer depletion

Ozone layer depletion was measured as CFC-11 equivalent. Inputs that contributed to this impact are shown in Figure 4.19. The total impact value contributed by the paper production process to ozone layer depletion was 0.00047 Kg CFC-11 eq.

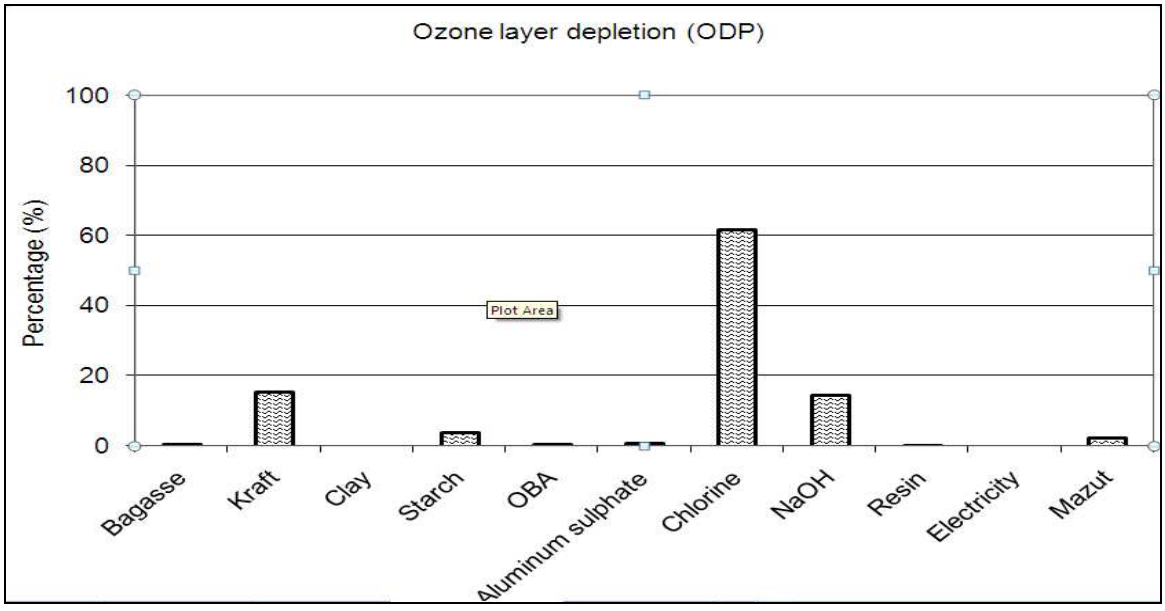

Figure 4.19: Inputs for Ozone layer depletion impact

Chlorine contributed the major impact value with 62% and electricity the lowest at (7.8x 10^{-05} %). Kraft was the second major contributor (16%) and NaOH was the third (14%). Others made up a small range of impacts which was less than 5% each; starch (4%), mazut (2%), aluminum sulphate (1%), OBA (0.4%), bagasse (0.4%), resin (0.2%) and clay (0.01%).

Before the 1980s and early 1990s, free chlorine was used to bleach paper; however, nowadays, the use of free chlorine has ceased and chlorine–dioxide or other means of bleaching such as ozone which have taken over (Villanueva and Wenzel, 2007).Chlorofluorocarbons (eg. CFC-11 and CFC-12) were first manufactured in the 1930's but were not present in the atmosphere in any appreciable quantity before 1950. Up until the 1990's, they were widely used as propellants, refrigerants and foaming agents. They act as a GHG in the troposphere but also damage the ozone layer in the stratosphere. The study shows that man-made chemicals can cause ozone layer depletion (Weigard, 2001). This is similar to the result of this study that shows that chlorine contributed the highest impact to the ozone layer depletion compared to other inputs.

Photochemical oxidation

Figure 4.20 shows the impact value of each input for photochemical oxidation. Bagasse gave the highest impact value in photochemical oxidation with 71%. Kraft contributed 14%, aluminum sulphate and mazut 4% each which chlorine and resin contributed 2% each, starch and NaOH 1% each. OBA, clay and electricity were at the lower and of the range at 0.2%, 0.008% and 0.001% respectively.

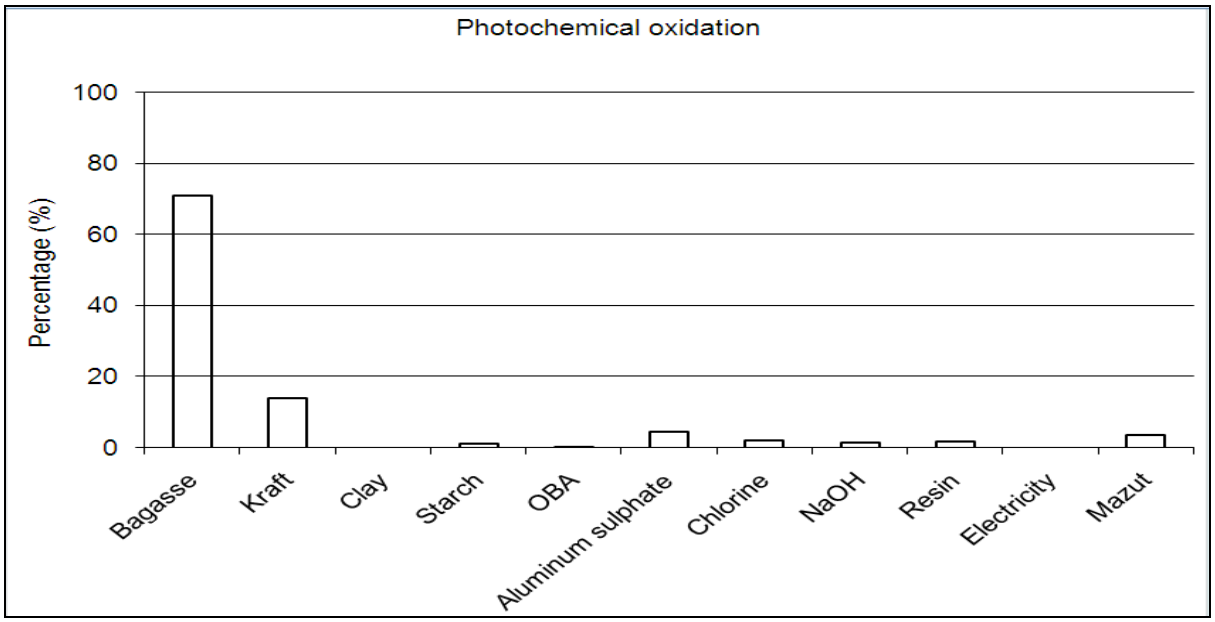

Figure 4.20: Inputs for photochemical oxidation impact

Toxicity

The toxicity impact was measured as 1, 4-DichloroBenzene equivalents/ kg emission (Kg 1,4-DB eq). In the CML2BaseLine2000 method for LCIA, toxicity to human environment, fresh water, marine and terrestrial ecosystem were considered. Figure 4.21 explains the toxicity impacts of the various materials/elements. From the total impact, kraft contributed the highest impact of about 42%. Aluminum sulphate was in second place with 26% followed by mazut (15%), chlorine (10%), NaOH (4%), bagasse (1%), starch (1%), resin (1%), OBA (0.2%), clay (0.02%) and electricity (0.0005%).

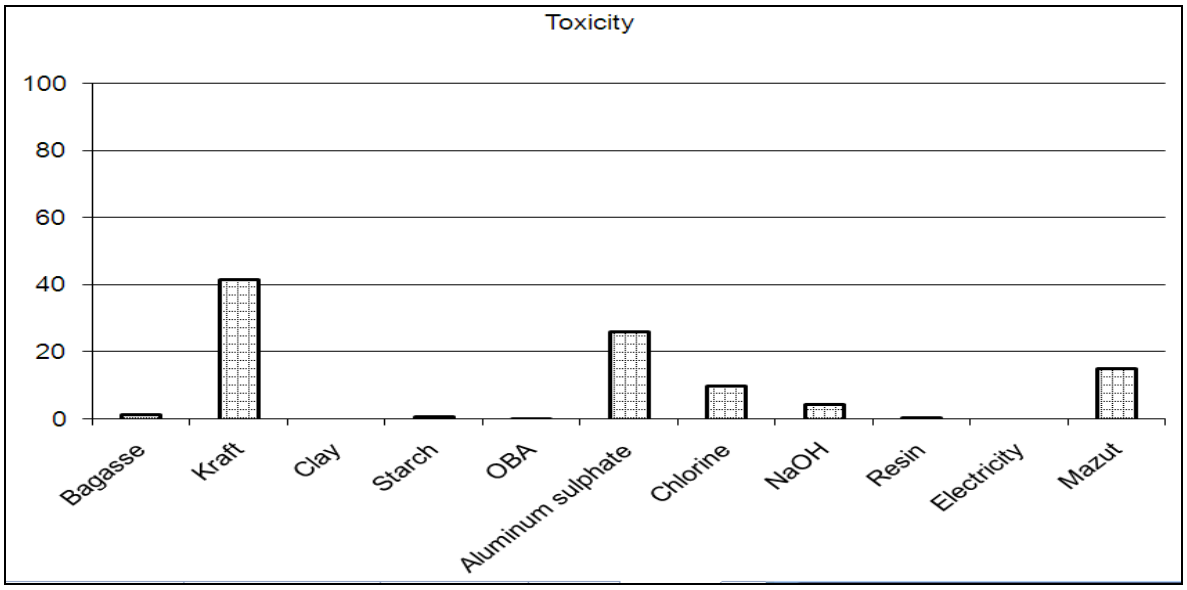

Figure 4.21: Inputs for human, freshwater, marine and terrestrial ecotoxicity impacts

4.6.4 General Conclusion

Paper has a life cycle like other products (Figure 4.22). This cycle starts with the extraction of material which is followed by manufacturing, use stage and final disposal stage. In each stage of the life cycle of paper harmful emission may be released to air, water and soil and cause pollution to the ecosystem which can cause negative effects to human health (Bedard, 2008). Most of the data was collected from the reports, plant survey and site visit. LCA was carried out using SimaPro7 software. The functional unit was set as production of one tonne of paper for one year. CML2Baseline200 was chosen as the assessment method as consideration on environmental impacts on paper production process. Data from library databases was used to fill in as secondary data along with information gathered through articles, reports and internet sites. The lack of background database was pointed out as the main problem towards the development of LCA in Japan by Nobuhiko(2005) and this was also similar in Iran. Library database were referred to

as there were no local database information available. In this LCA study, primary data via site visit and other local data were incorporated as much as possible to minimize the amount of data uncertainty. There have been several studies done on LCA of waste paper. These researches indicate that recycling is the better option compare to other options for paper. Results of research show that paper and pulp industries emit the greatest amount of CO_2 and CH_4 because they consume the most amounts of energy and water in the world. (Dias et.al, 2007; Merrlid et.al, 2008; Wiegard, 2001; Bedard, 2008). Another LCA on paper and packaging waste management carried out by Grant, et.al (2001) studied the total impacts and benefits of recycling waste paper and packaging wastes by subtracting the impacts of landfilling of such wastes from the impacts of their recycling. Based on the paper production process, it was found that mazut was one of the major inputs that contribute the highest impact to environment while using hydroelectricity had less impact on the environment for all types of impact categories. These results were similar with the results that shown burning of fossil fuel increases the amount of greenhouse gasses and using hydroelectricity instead of fossil fuel contribute less impact to environment (Wiegard, 2001; Eliasson,2000). The most benefits of using bagasse instead of virgin materials is had the negative impacts on environment for global warming impact which means benefits to environment. A similar scenario was selected in this LCA study (Weigard, 2001).

Copy Paper Lifecycle

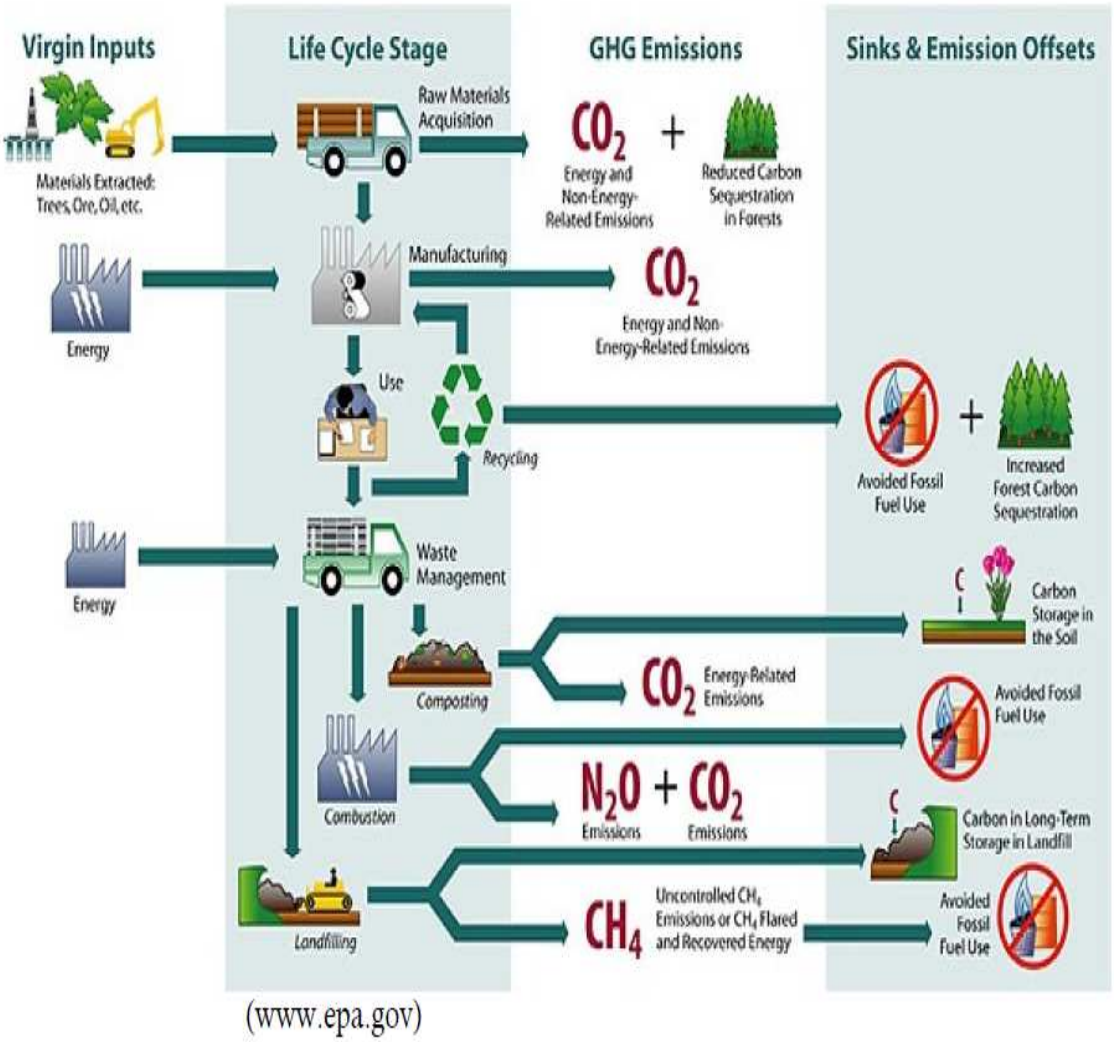

Figure 4.22: Life Cycle of copy paper

(Source: www.epa.go)

4.7 Summary

During this research it was observed that staff from Residential Colleges, Faculties, Institute, research Center and Administration offices didn't have enough information and knowledge about the proper using of paper. In some places it cleared that they just used one side of the paper instead of using both side.

Cleaners play an important role in recycling paper in UM however, lack of information and knowledge on how they can improved this programme caused that the income from this activity didn't look much. UM as an educational place should improve the recycling programme by applying training for students, staff and cleaners increase the no of recycle bins and the important one is to centralize the recycling items. For this part UM can provide a proper place that is suitable for keeping the recyclable item and give some rewards for the places that has the best recycling programme.

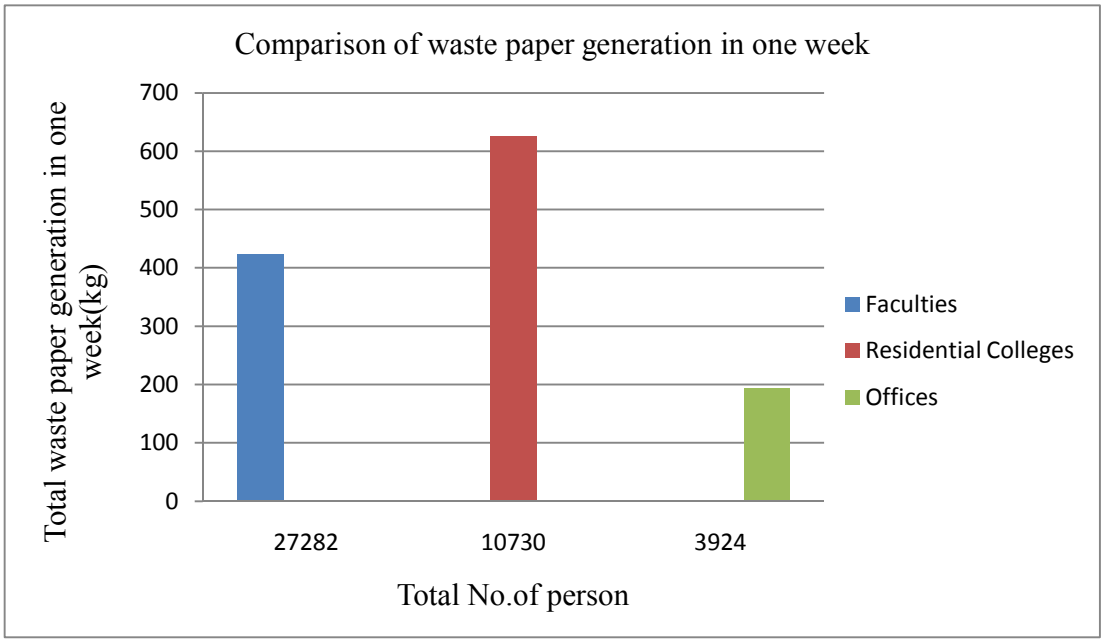

Figure4.23: Comparison of waste paper generation in one week

Figure 4.23 shows the comparison of waste paper generation in different places in UM in one week. It is indicate that Residential Colleges with total person of 10730 person generated 625.15 kg of waste paper during one week while, Offices (Art Asia Museum, Examination Building, Institute of Post Graduate Studies (IPS), Culture Center or Perdanasiswa, Department of Development and Asset Maintenance (JPPHB) and Chancellery Building) generated 194.77 kg of waste paper with total No.of 3924 person and finally, Faculties generated 423.94 kg of waste paper with 27282 person including the staff and the students. There were different research studies done in the other universities based on waste paper.

one study that done at Rhodes University in South Africa shows the use of paper by academics and student computer laboratories as a basis for identifying areas to reduce the amounts used and increase rates of recycling. A sample of 50 academic staff was chosen for this study. The duration of this research was for 5 months. The mean of usage of paper per one working day was 34±20 new sheets of paper . from this no of paper, 3% were shredded , 15% were kept for later use and 79% were given out as notes to students, or posted out as a mail to other places. This university saved approximately UD$ 7000 per year for every 10%reduction in usage of paper. Reduction of usage of paper could be achieved via increasing in reusing of paper , use both side of paper for printing (Amutenya et.al,2009). UM may reduce the usage of paper by applying the same strategy in Residential Colleges, Offices and Faculties. It could be possible also by reducing the margins of paper. A study was done by Berdad, (2008) on the usage of paper in Kansas University (KU) (Table 4.8). For this study 1000 persons were selected

at random from the Faculties and the offices for two weeks (28th of April till 13th May 2008).

The results showed that 50 percent of the staff printed 11-50 pages during a typical workday. However, in the faculties students used only about 24 sheet of paper per semester. The total number of reams of paper purchased by KU in 2007 was 114,080 which in 2008 it was lesser at 30,587 reams of paper. There was a meeting of the managers of Administration &Finance Division Registration Department which was conducted on 5th of May 2009. According to the information provided at the meeting, University of Malaya ordered 50,000 reams of paper in 2008 and this was increased to 70,000 reams of paper in 2009. The results from KU and UM in the purchase of paper are not similar; the KU tried to reduce the purchase of paper, however, the UM increased the purchase of paper from year to year.

Table 4.78: Comparison of paper purchased between KU and UM

Kansas University (KU)*		University of Malaya(UM)	
Year	Reams	Year	Reams
2007	114,080	-	-
2008	30,587	2008	50,000
		2009	70,000

*Source: Berdad, 2008

Table 4.8, Shows that the University of Malaya with approximately 27,000 students purchased 50,000 reams of paper for 2008 and this amount increased to 70,000 reams in 2009. The University of Kansas with a total number of 26,300 students purchased only 30,587 reams of paper in 2008. In 2007 KU bought 114,080 reams of paper while UM purchased 70,000 reams of paper for 2009. The comparison between

these two universities, with approximately the same number of students, shows that KU reduced their purchase of paper by 83,493 reams of paper during one year while UM, increased the purchased of paper by 20,000 reams for the same period.