Material Requirements Planning

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Introduction

The main purpose of green matrices is to trace the carbon footprint. In this project we will use Material Requirement Planning (MRP) as a tool to aggregate the university inventory. MRP will help us to see the big picture of what kind of waste each student is producing and how much energy and CO_2 each student is producing. To apply this MRP system it will need to pull out the forecast inventory data from Bill of Material (BOM) and allocate them by location.

Material Requirements Planning (MRP)

Material Requirements Planning (MRP) is a computer-based information system designed to handle ordering and scheduling of dependent-demand inventories (such as raw materials, component parts, and subassemblies that will be used in the production of a finished product). MRP is designed to answer three questions: *what* is needed, *how much* is needed, and *when* is it needed. The primary inputs of MRP are a *bill of materials*, which tells what goes into a finished product; a *master schedule*, which tells how much finished product is desired and when; and an *inventory-records file*, which tells how much inventory is on hand or on order. This information is processed, using various computer programs to determine the net requirements for each period of the planning horizon. Outputs from the process include planned-order schedules, order releases, changes, performance-control reports, planning reports, and exception reports (Waldner and Jean-Baptiste, 1992).

MRP works backward from the due date using lead times and other information to determine *when* and *how much* to order. MRP begins with a schedule for finished goods that is converted into a schedule of requirements for subassemblies, component parts and raw materials needed to produce the finished items in the specified time frame.

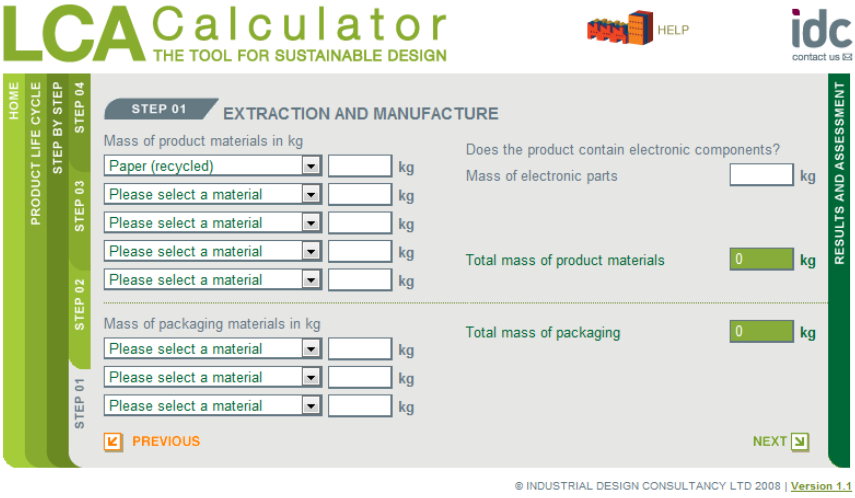
Calculate Carbon footprint

From the research there are three references that look reliable to use their calculator as a reference to our model. The first one is from Industrial Design Consultancy (IDC) and the second one is from Carbonify.com and the last one is from University of California-Berkeley.

Industrial Design Consultancy (IDC)

This calculator (figure 1) can calculate all energy use and CO_2 produce in each material such as paper, plastic, aluminum, etc. which will be useful in our model.

Figure 1 LCAcalculator



Source: http://lcacalculator.com

Carbonify.com

This calculator (figure 2) can calculate CO_2 produce from each transportation determine by size (from the assumption in our model we use medium car size for calculation).

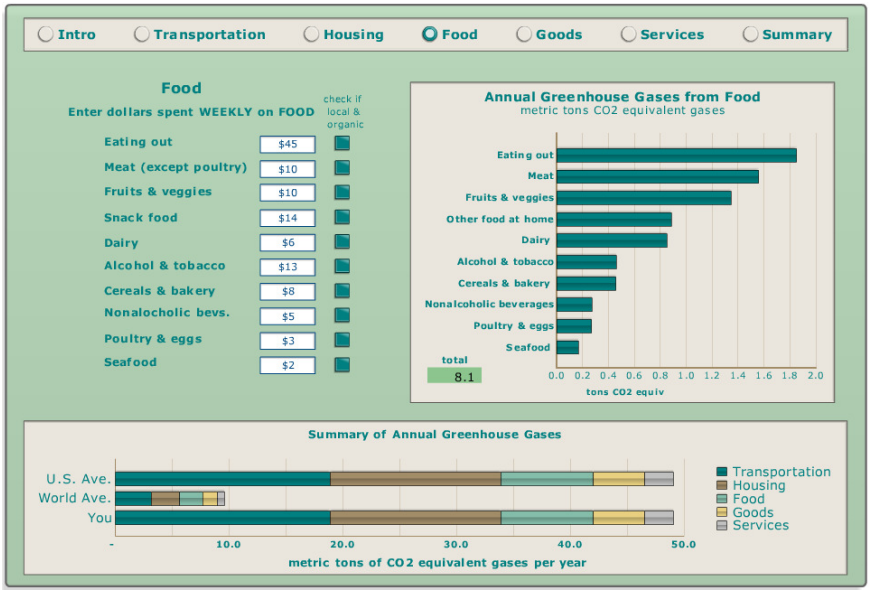
Figure 2 Carbon dioxide calculator

Source: http://www.carbonify.com/carbon-calculator.htm

University of California-Berkeley

This calculator (figure 3) can calculate CO_2 from transportation, housing, food, goods, and service. This will be useful in the model if housing and food disposal items are also concern (not include in our model). In the future the developer of this model can use this calculator to calculate the student dormitory and other concern facilities.

Figure 3 Lifecycle Climate Footprint Calculator



Source: http://bie.berkeley.edu/files/ConsumerFootprintCalc.swf

Assumption

The assumption for this model;

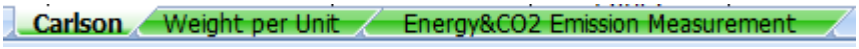
- Every student has the same amount consumption
- All the unit weight is by estimation
- All transportation is medium size car

MRP Model

To indentify the amount waste produce from the university we will use a spreadsheet to calculate. This spreadsheet contains data forecast from bill of material (BOM) as a base amount. The objective for this spreadsheet is to calculate the amount energy use and CO_2 produce from each student per semester.

There are several tabs in this spreadsheet which indicate the location, weight per unit, and Energy and carbon dioxide emission measurement for each unit type as shown in figure 4.

Figure 4 Tab



First, we need to know the weight of each unit. In this model we base our assumption on estimation as shown in figure 5 (in weight per unit tab).

Figure 5 Weight per Unit

Items List	Unit	lb/unit
Paper White	Sheet	0.040
Newspaper/Magazine	Each	0.344
Mailing Supplies	Each	0.048
Paper Container	Each	0.100
Plastic Bottle	Each	0.047
Plastic Cups	Each	0.031
Plastic Baggy	Each	0.031
Cans	Each	0.031
Textbook	Each	1.969
Book	Each	1.969
Paper Color	Sheet	0.040
Bottle Water	Gallon	0.150
Cartridge	Each	1.000
Toner	Each	1.000
Master	Each	0.070
Soy Ink	Each	0.020
Cardboard Box for pen	Each	0.844
Items List	**Unit**	**mile/lbs**
Cars	Miles	1 mile/CO2 14.55 lbs

Next, we go to the location we want to determine (in this case is Carlson). In this spreadsheet tab it can be divided by its location, sources, amount of people. In figure 6 it shows that the location is Carlson and the source is on-campus student with 3,000 students and in figure 7 it shows that the source is faculty with 100 staff. After that we can classified the bill of materials into product type, sub material type, and items list. For Product type there are 3 main types which are Transportation (green frame in figure 6), Material (blue frame in figure6), and Electricity (yellow frame in figure 7).

Figure 6 Product type of On-campus Student

	A	B	C	D	E	F
1	**Number of observation: 38 peoples**			**Bill of Materials (BOM)**		
2	**Location**	**Sources**	**People (MPS)**	**Product Type**	**Sub Material Type**	**Items List**
3	Carlson	On-campus Student	3000	Transportation		Cars
4				Paper		Paper White
5						Newspaper/Magazine
6						Mailing Supplies
7						Paper Container
8				Plastic	HDPE (High-density Polyethylene)	Plastic Bottle
9						Plastic Cups
10					LDPE (Low-density Polyethylene)	Plastic Baggy
11				Aluminum		Cans

Figure 7 Product type of Faculty

	A	B	C	D	E	F
1	Number of observation: 38 peoples			Bill of Materials (BOM)		
2	Location	Sources	People (MPS)	Product Type	Sub Material Type	Items List
21	Carlson	Fuculty	100	Transportation		Cars
22				Paper		Textbook
23						Book
24						Newspaper/Magazine
25				Electricity		Electricity for PC

Next, the weight per unit data from figure 5 will show in column I as shown in figure 8 and figure 9. The model will now calculate the energy (red frame in figure 8 and blue frame in figure 9) by using the formula below.

Formula for Energy (MJ) per student

For Items (red frame in figure 8)

Energy = Amount x Weight per Unit x Energy Produce in each Unit

= (Unit/Semester) x (lb/Unit) x (MJ/lb)

= MJ/Semester

Figure 8 Energy use from On-campus Student

	F	G	H	I	J	K	L	M	N
1	)	Unit		Weight per Unit	Energy (MJ)				
2	Items List	Amount (Unit/Student/Semester)	Unit	lb/Unit	Unit (MJ/hour)	Use	Unit (MJ/lb)	Disposal	Total Energy
3	Cars	124	Miles	-	-	-	-	-	-
4	Paper White	59	Sheet	0.040	-	-	2.04	4.81	4.81
5	Newspaper/Magazine	2	Each	0.344	-	-	2.04	1.40	1.40
6	Mailing Supplies	0	Each	0.048	-	-	2.04	0.00	0.00
7	Paper Container	1	Each	0.100	-	-	2.04	0.20	0.20
8	Plastic Bottle	8	Each	0.047	-	-	20.00	7.52	7.52
9	Plastic Cups	25	Each	0.031	-	-	20.00	15.50	15.50
10	Plastic Baggy	0	Each	0.031	-	-	20.00	0.00	0.00
11	Cans	1	Each	0.031	-	-	20.00	0.62	0.62

For Electricity (blue frame in figure 9)

Energy = Amount x Energy Produce in each Unit

= (Hour/Semester) x (MJ/Hour)

= MJ/Semester

Figure 9 Energy use from Faculty

	F	G	H	I	J	K	L	M	N
1	)	Unit		Weight per Unit	Energy (MJ)				
2	Items List	Amount (Unit/Student/Semester)	Unit	lb/Unit	Unit (MJ/hour)	Use	Unit (MJ/lb)	Disposal	Total Energy
21	Cars	704	Miles	-	-	-	-	-	-
22	Textbook	125	Each	1.969	-	-	2.04	502.10	502.10
23	Book	10	Each	1.969	-	-	2.04	40.17	40.17
24	Newspaper/Magazine	133	Each	0.344	-		2.04	93.33	93.33
25	Electricity for PC	240	Hour	-	82.22	19732.80	-	-	19732.80

In figure 9 Note that energy is not produce in transportation. Energy is produce only when the item is disposal and when electronic is used.

The multipliers of energy and CO_2 produce (figure 10) in each unit type are calculated from LCA calculator (in energy & CO_2 emission measurement tab) as mention in the previous topic.

Figure 10 Energy & CO_2 Emission Measurement

Energy & CO_2 Emission Measurement					
	Energy (MJ)		CO_2 Emission (lb)		
List	Use	Disposal	Transportation	Use	Disposal
Transportation	-	-	14.55	-	-
Paper	0.00	2.04	-	0.00	0.82
Card board	0.00	20.00	-	0.00	8.00
HDPE	0.00	20.00	-	0.00	8.00
LDPE	0.00	20.00	-	0.00	8.00
Aluminum	0.00	20.00	-	0.00	8.00
Glass	0.00	20.00	-	0.00	8.00
Steel	0.00	20.00	-	0.00	8.00
Electricity	82.22	0.00	-	33.33	0.00

Next, the model will calculate the CO_2 for transportation (orange frame in figure 11), items (green frame in figure 11), and electricity (yellow frame in figure 12) by using the formula below.

Formula for CO_2 Emission (lb) per student

For Items (orange frame in figure 11)

CO_2 Emission = Amount x Weight per Unit x CO_2 Produce in each Unit

= (Unit/Semester) x (lb/Unit) x (CO_2/lb)

= CO_2/Semester

For Transportation (green frame in figure 11)

CO_2 Emission = Amount x CO_2 Produce in each Unit

= (Mile/Semester) x (CO_2/Mile)

= CO_2/Semester

Figure 11 CO_2 Emission from On-campus Student

	O	P	Q	R	S	T	U	V
1		CO_2 Emission (lb)						
2	Items List	Unit (CO_2/mile)	Transportation	Unit (CO_2/hour)	Use	Unit (CO_2/lb)	Disposal	Total CO_2 Emission
3	Cars	14.55	1804.20	-	-	-	-	1804.20
4	Paper White	-	-	-	-	0.82	1.94	1.94
5	Newspaper/Magazine	-	-	-	-	0.82	0.56	0.56
6	Mailing Supplies	-	-	-	-	0.82	0.00	0.00
7	Paper Container	-	-	-	-	0.82	0.08	0.08
8	Plastic Bottle	-	-	-	-	8.00	3.01	3.01
9	Plastic Cups	-	-	-	-	8.00	6.20	6.20
10	Plastic Baggy	-	-	-	-	8.00	0.00	0.00
11	Cans	-	-	-	-	8.00	0.25	0.25

For Electricity (yellow frame in figure 12)

CO_2 Emission = Amount x CO_2 Produce in each Unit

= (Hour/Semester) x (CO_2/Hour)

= CO_2/Semester

Figure 12 CO_2 Emission from Faculty

	O	P	Q	R	S	T	U	V
1		CO_2 Emission (lb)						
2	Items List	Unit (CO_2/mile)	Transportation	Unit (CO_2/hour)	Use	Unit (CO_2/lb)	Disposal	Total CO_2 Emission
21	Cars	14.55	10243.20	-	-	-	-	10243.20
22	Textbook	-	-	-	-	0.82	201.82	201.82
23	Book	-	-	-	-	0.82	16.15	16.15
24	Newspaper/Magazine	-	-	-	-	0.82	37.52	37.52
25	Electricity for PC	-	-	33.33	7999.20	-	-	7999.20

Finally we will get the total energy use and CO_2 produce from each item per student per semester. We can see which item produces most energy and CO_2 emission.

Conclusion

In conclusion this spreadsheet will benefit the university in term of showing all energy and CO2 produce by each student in Carlson, which this spreadsheet can be a model for other facility in the university to calculate the same output (energy and CO_2). This model can also be used to track down some product that produce lots of waste and try to change its supplier to have greener product to the university.

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