BLD62304103247 Building Science and Services

Assignment 2: Indoor Comfort Design and 'Invention' (40%)

Task 2a Recording and measurement of 4 facings of external walls of chosen building (10%)

Task 2b Passive/ Green Insulation Product Development (30%)

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School: The Design School

Programme: Bachelors of Arts (Honours) Interior Architecture

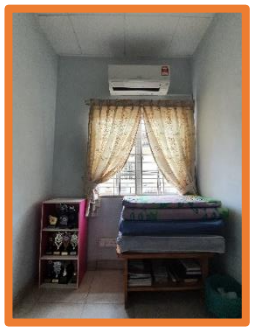
Batch: April 2020

Lecturer: Ms. Sharon

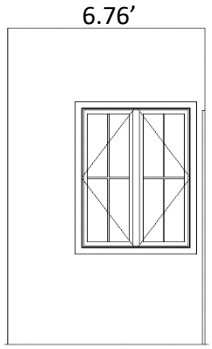
Part 2a Recording and measurement of 4 facings of external walls of chosen building (10%)

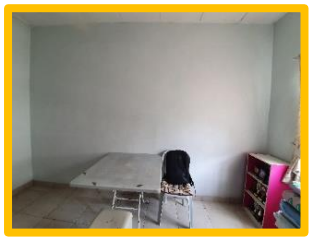
Students are to use their current home or a convenient residential building as their site.
Identify the facings (N, E, S, W) of the 4 external walls. Identify their materials and estimate/ measure their dimensions. Measure each wall's internal and external temperature at 3 different times of the day: 7am, 12pm and 5pm. Calculate the heat transfer and conclude/ reflect briefly by identifying the wall panel that is most critical/ highest heat gain/ most utilised space for Part 2b.

Plan and Pictures of Chosen Room

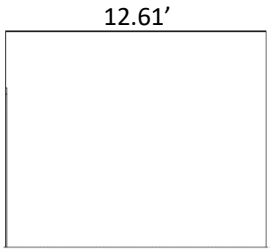


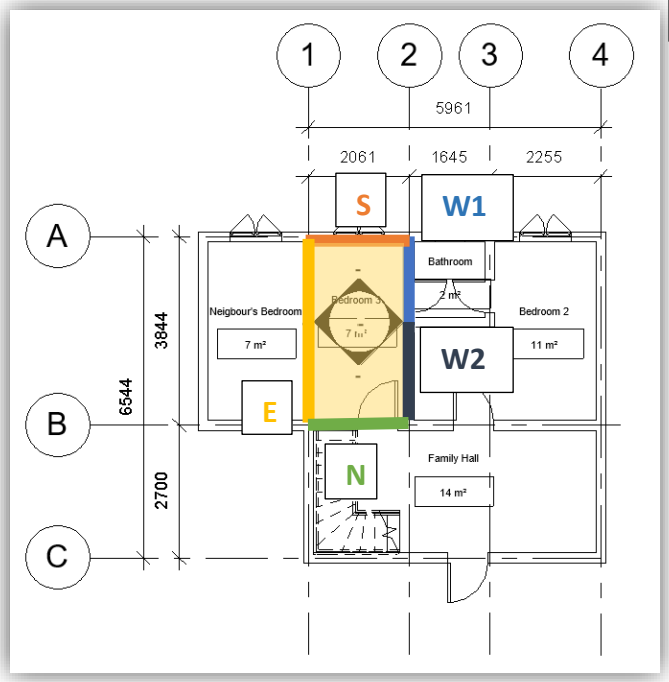
SOUTH WALL





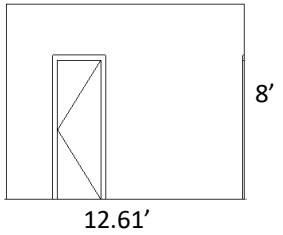
EAST WALL





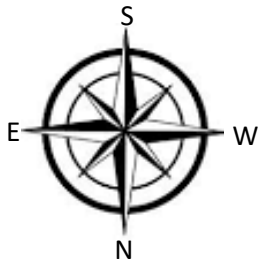
PVC Door is assumed as Plywood Door as relevant R-Value can't be found

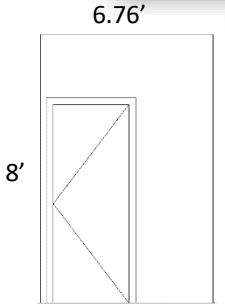
WEST WALL



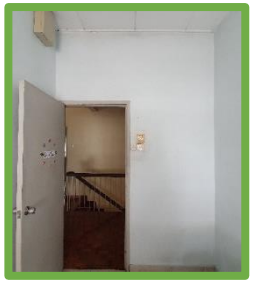
EXTERNAL- BATHROOM

EXTERNAL- BEDROOM 2





NORTH WALL



EXTERNAL- FAMILY HALL

BEDROOM 3 (Overall Photo)

Information & Calculation Table

R-Value Reference Link: https://www.archtoolbox.com/materials-systems/thermal-moisture-protection/rvalues.html

Wall/ Aspects	Material	Dimension (ft.² X inches)	R-value of Material	Total R-Value
N	Brick Wall with Paint Finish	6.76 ‘ (L) X 8‘ (Ht.) X 8“ (THK.) = 432.64	Concrete Masonry Unit 8”: 1.11 Concrete Masonry Unit (CMU) 8" 1.11	1.11
	Hollow Core Plywood Door	2.67‘ (L) X 6.67‘ (Ht.) X 3 ½ “ (THK.) = 62.3312 *Given Door Spec thickness: Plywood ½”, then air 1”, then Plywood 2”	Plywood ½ : 0.62 Plywood 1/2" 0.62 Air > ½ : 1.0 Air Space Minimum 1/2" up to 4" 1.00	0.62 + 1.0 + (0.62 X 4) = 4.1
E	Brick Wall with Paint Finish	12.61‘ (L) X 8 ‘ (Ht.) X 8“ (THK.) = 807.04	Concrete Masonry Unit 8”: 1.11 Concrete Masonry Unit (CMU) 8" 1.11	1.11
S	Brick Wall with Paint Finish	6.76 ‘ (L) X 8‘ (Ht.) X 8“ (THK.) = 432.64	Concrete Masonry Unit 8”: 1.11 Concrete Masonry Unit (CMU) 8" 1.11	1.11
	Double Leaf Casement Window	5‘ (L) X 3 ¼ ‘ (Ht.) X 1/2“ (THK.) = 8.125	Window: 0.91 Internal Film= 0.68 External Film= 0.17 Single Pane 1/4" 0.91	0.91 X (½ / ¼)= 1.82 Total R= 0.17 + 1.82 + 0.68 = 2.67
W1	Brick Wall with Paint Finish	5‘ (L) X 8‘ (Ht.) X 8“ (THK.) = 320	Concrete Masonry Unit 8”: 1.11 Concrete Masonry Unit (CMU) 8" 1.11	1.11
	Hollow Core Plywood Door (Originally PVC but can’t find irrelevant data)	2.67‘ (L) X 6.67‘ (Ht.) X 3 ½ “ (THK.) = 62.3312 *Given Door Spec thickness: Plywood ½”, then air 1”, then Plywood 2”	Plywood ½ : 0.62 Plywood 1/2" 0.62 Air > ½ : 1.0 Air Space Minimum 1/2" up to 4" 1.00	0.62 + 1.0 + (0.62 X 4) = 4.1
W2	Brick Wall with Paint Finish	7.31‘ (L) X 8‘ (Ht.) X 8“ (THK.) = 467.84	Concrete Masonry Unit 8”: 1.11 Concrete Masonry Unit (CMU) 8" 1.11	1.11
	Built in Cupboard (Other side of wall/ room)	3 ½ ‘ (L) X 4 ½ ‘ (Ht.) X 12 “ (THK.) = 189 *Given Front and Back panels thickness each ½ “ and air in between 11 ”	Plywood ½ : 0.62 Plywood 1/2" 0.62 Air > ½ : 1.0 Air Space Minimum 1/2" up to 4" 1.00	(0.62 X 2) + 1.0 = 2.24

Temperature Calculations (7am, 12pm, 5pm)

Wall/ Time Temperature(°F)	7am			12pm			5pm		
	Internal	External	Difference	Internal	External	Difference	Internal	External	Difference
N	71.6	71.6	0	60.8 (A/C)	84	23.2	60.8 (A/C)	80	19.2
E	71.6	71.6	0	60.8 (A/C)	60.8 (A/C) Neighbour	0	60.8 (A/C)	60.8 (A/C) Neighbour	0
S	71.6	71.6	0	60.8 (A/C)	86	25.2	60.8 (A/C)	82.4	21.6
W1	71.6	71.6	0	60.8 (A/C)	84	23.2	60.8 (A/C)	80	19.2
W2	71.6	71.6	0	60.8 (A/C)	60.8 (A/C)	0	60.8 (A/C)	60.8 (A/C)	0

q Calculation, Btu/hr

Formula: $q = \frac{A * \Delta T}{R}$

Wall/ Time	7am	12pm	5pm
N	No heat transfer （No A/C is on）	Brick Wall $q = \frac{(423.64 - 62.3312) \times 23.2}{1.11} = 7551.6794$BTU/hr Hollow Core Wood Door $q = \frac{62.3312 \times 23.2}{4.1} = 352.7034$ BTU/hr Total 7551.6794 + 352.7034 = 7904.3828 BTU/hr	Brick Wall $q = \frac{(432.64 - 62.3312) \times 19.2}{1.11} = 6405.3414$ BTU/hr Hollow Core Wood Door $q = \frac{62.3312 \times 19.2}{4.1} = 291.8924$ BTU/hr Total 6405.3414 + 291.8924 = 6697.2338BTU/hr
E	No heat transfer （No A/C is on）	No heat transfer (same temperature as neighbour)	No heat transfer (same temperature as neighbour)
S	No heat transfer （No A/C is on）	Brick Wall $q = \frac{(432.64 - 8.125) \times 25.2}{1.11} = 9637.6378$ BTU/hr Double Leaf Casement Window $q = \frac{8.125 \times 25.2}{2.67} = 76.6854$ BTU/hr	Brick Wall $q = \frac{(432.64 - 8.125) \times 21.6}{1.11} = 8260.8324$ BTU/hr Double Leaf Casement Window $q = \frac{8.125 \times 21.6}{2.67} = 65.7303$ BTU/hr

		Total 9637.6378 + 76.6854 = 9714.3232 BTU/hr	Total 8260.8324 + 65.7303 = 8326.5627 BTU/hr
W1	No heat transfer （No A/C is on）	Brick Wall q = (320– 62.3312) X 23.2 = 5385.51 BTU/hr 1.11 Hollow Core Wood Door q = 62.3312 X 23.2 = 352.7034 BTU/hr 4.1 Total 5385.51 + 352.7033 = 5738.2133 BTU/hr	Brick Wall q = (320– 62.3312) X 19.2 = 4456.9738 BTU/hr 1.11 Hollow Core Wood Door q = 62.3312 X 19.2 = 291.8924 BTU/hr 4.1 Total 4456.9738 + 291.8924 = 4748.8662 BTU/hr
W2	No heat transfer （No A/C is on）	No heat transfer （No A/C is on）	No heat transfer （No A/C is on）

Conclusion

Wall S has the highest heat rate transfer, which are 9714.3232 BTU/hr in the afternoon and 8326.5627 BTU/hr in the evening because it is directly in contact with outdoor and the double leaf casement window has higher heat rate transfer which allows more heat gain in the wall. Both East and West 2 Wall do not have much excessive heat gaining problems because their exteriors are connected to an adjacent bedroom which have their A/C on with the same temperature over day except in the morning where both A/C are turned off. North Wall is still connected to an interior family hall while West 1 Wall is still connected to a bathroom (even if the sun sets in the direction) so it still happens to be cooler than contacting the outdoor temperature like the South Wall. Generally, there aren't any temperature difference in any walls in the morning as the A/C is not turned on yet. Thus, as recorded, they have the same temperature.

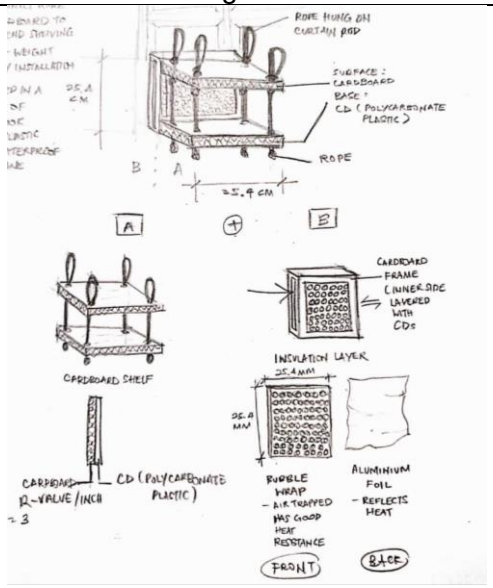
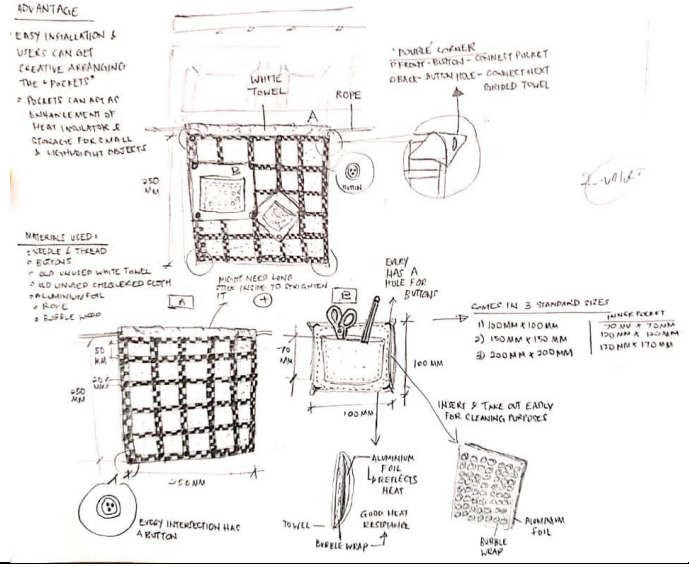
Part 2b Passive/ Green Insulation Product Development (30%)

Using the critical wall identified from Part 2a, students are to come out with an original idea design solution to reduce the heat transfer that has no constraints in terms of material usage, size, type of installations (permanent fixture/ mobile) as long as the usage is justified.

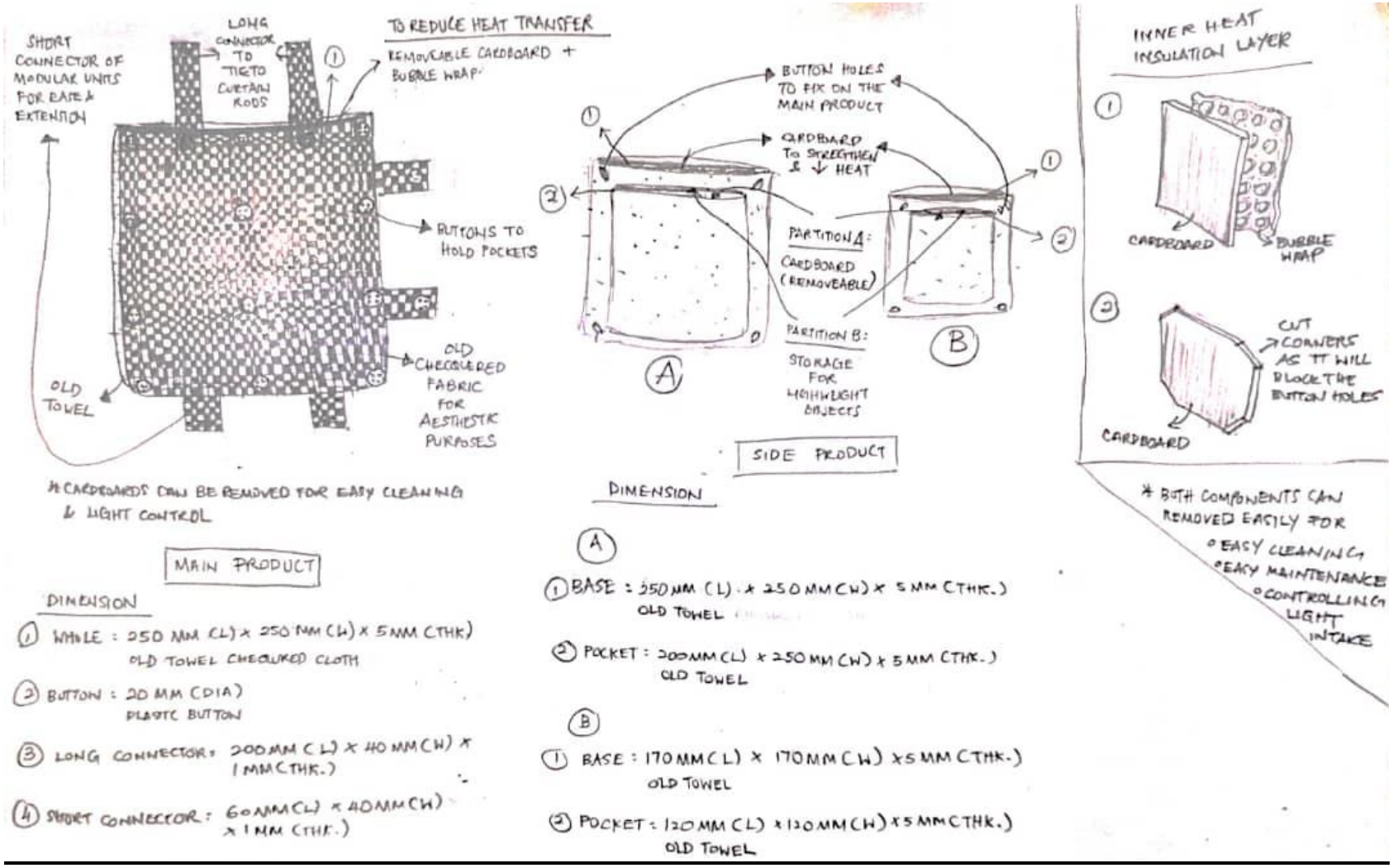
Your product may also have enhanced features such as audio comfort/ noise control/light control/ visual comfort. Evidence of quantitative benefit (reduced heat transfer etc) should be included in the report and verbally presented during the formal presentation.

Record down the costs/tools together with receipts and evidence in the report.

Initial Idealisation Sketch

Proposal 1: Curtain Hung Shelf with Insulation Layer	Proposal 2: Flexible Cloth Shelf Curtain with Insulation Layer
	
Advantage: 1) Flexible in Modular Unit: Lengthen rope and connect more cardboard to extend the shelving 2) Lightweight and easy installation 3) Wrapped in a layer of thin plastic book cover for waterproof purposes 4) Put small and lightweight objects on the cardboard shelf	Advantage: 1) Flexible in Modular Unit: Button up the next modular unit to extend accordingly to the window size 2) Lightweight, easy Installation and users can get creative arranging the 'pockets' 3) Pockets can act as enhancement of heat insulator and storage for small and lightweight objects
Materials Proposed: 1) Cardboard 2) CD 3) Bubble Wrap 4) Aluminium Foil 5) Rope	Materials Proposed: 1) Buttons 2) Old Unused White Towel 3) Old Unused Chequered Cloth 4) Bubble Wrap

Finalised Idealisation Sketch



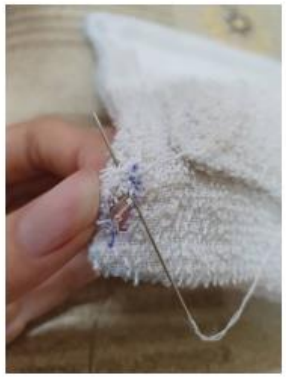
Reasons of settling down to this idea:

1. Ready sources like old white towels and old chequered fabric are available at my house
2. Comparatively more innovative than first proposal as it gives freedom for clients to arrange the pockets according to their preference
3. Better light control as cardboards can be removed however you like in the different compartments but shelf only has one compartment to remove
4. Washable and lighter than the cardboard shelf, easy installations as you only have to button up the modular units together
5. Easy maintenance as only the cardboards and the bubble wraps are needed to be changed if necessary

Making Process

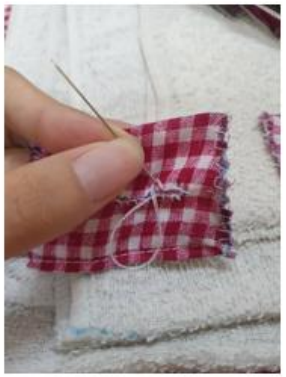
Pockets

Close up of button hole



Sewing button holes

Connectors



Sewing button holes

Sewn button holes

Cut and sewn

Sewn at the base

Base

Base Stencil

Cut out Old Towel

Cut out Chequered Cloth and button sewn

With Short Connectors

With Long and Short Connectors

Inner Insulation Layers: Cardboard & Bubble Wrap

Close up Back Side

Just to demonstrate how it is hung

Buttoned Pocket onto the base

Final Product

Backside of connected modular units

Big Pocket with stationaries

Upright placement of Pocket

Diamond shape placement of pocket

Final Product

Singular Unit hung on Window Grills

Singular Unit Close Up

Connected Units hung on Window Grills

Connected Units Close Up

Material Selection Reasonings

1. Old Unused Towel: White Towel rather than black and dark fabrics as black fabrics absorb more hear and make the room much warmer
2. Old Unused Red and White Chequered Cloth: Leftovers used for aesthetic purposes so white towel doesn't look too plain
3. Bubble Wrap: Has air films trapped inside so heat gain can be reduced
4. Plastic Buttons: Easy mechanism to connect fabrics and modular units

Reference Links

Bubble wrap- https://www.howtogosolar.org/keep-the-heat-in-with-bubblewrap/

'Financial Value of the design idea' reflection

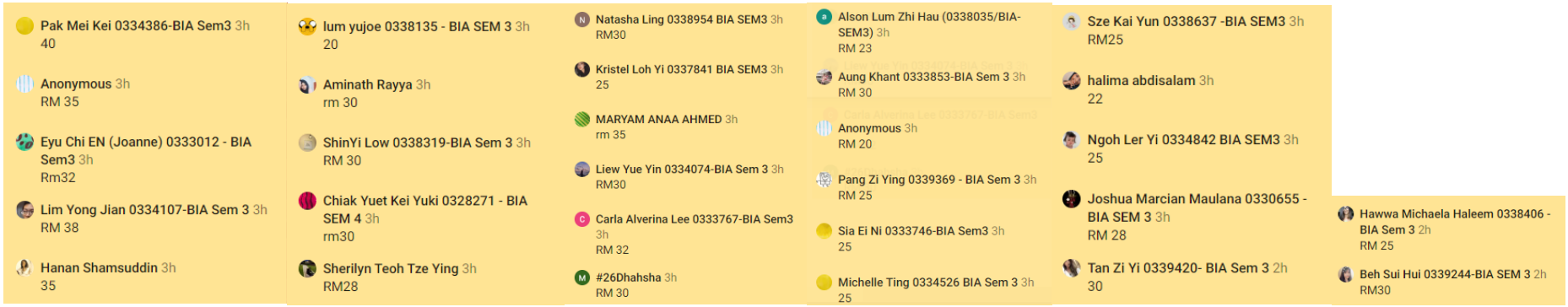
No.	Material	Pcs/ Dimension	Total Cost (RM)
1	Old Unused White Towel	1	0, because these are old towels used when I was little
2	Old Unused Red and White Chequered Cloth	1	0, these are the leftover fabrics that belongs to my sister's previous project
3	Bubble Wrap	1	2.90, bought at Mr. DIY
4	Buttons	21	6.00

Total Costs: RM 2.90 + RM6.00= RM 8.90

Average Price Totalled by Classmates' Feedbacks:

RM 40+35+32+38+35+20+30+30+30+28+30+25+35+30+32+30+23+30+20+25+25+25+25+22+25+28+30+25+30/47 = RM833/29= RM 28.70

Evidence:



Design Value (quantitative): RM 28.70 – RM 8.90= RM 19.80

Reflection

Generally, I was satisfied with the result as my idea of flexible placement of pockets work out better than I thought. Honestly, I didn't know much about sewing and this project has actually given me an opportunity to acquire this skill from my mother who used to be a tailor before when she was young. It was a great experience learning something you were previously poor at. However, after completion of my product, I only found out that my thin pieces of fabrics are not sturdy enough to hold the cardboards in place pleasantly. Therefore, I ought to be more critical in strengthening the shape of the modular unit so it doesn't look lumpy and unpleasing. Next, I should consider more insulation layers like sponge because it is a good choice for heat insulating and sound absorption. About the short connector I have sewn on the right side and bottom side of the modular unit, it would be better if I have figured out to sew the joint part on the inside so its appearance would be enhanced and therefore attract more customers for its aesthetic and simplistic value. From this project, I have learnt to develop my critical thinking skills in making something useful from scratch by using only available resources found at my home, especially the recyclable ones, which also prompted me to reflect on practising the 3R concept, which are Reuse, Reduce and Recycle, in my daily life. I realised it is essential for designers to opt for recyclable materials for their designs to help promote the idea of turning "trash" into "gold".