Cluster Analysis for TFT LCD Display Mobile Phones

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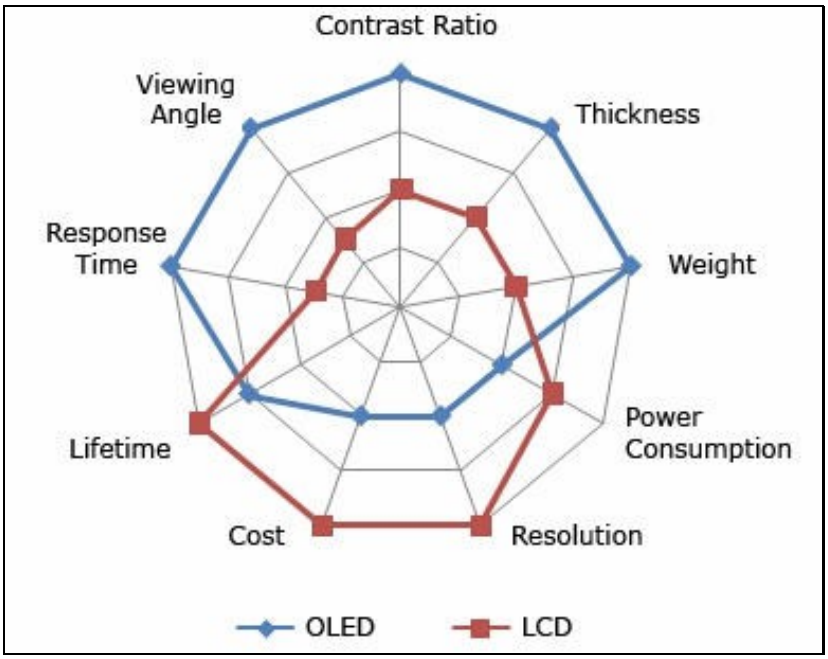
Objective

To identify the appropriate cluster of smart-phones which are likey to be launched with AMOLED screens

A Comparison of LCD and OLED technologies

The two technologies can be compared on various attributes.

The *radar graph* here shows the comparison between OLED and TFT LCD.



ComparisonSource

The graph depicts the following things:

1. OLEDs are *thinner* than LCDs.
2. OLEDs are *lighter* in weight.
3. OLEDs consume *more power* than LCDs: Power Consumption is a measure of the amount of power required by a display to produce a certain level of brightness. In theory, OLEDs have an inherent advantage in that they only consume power when they emit light. For example, a black OLED pixel consumes no power. An LCD backlight consumes constant power regardless of the image being displayed. However, LCDs still hold a slight advantage over the OLEDs currently in production. Future generations of OLED displays will be far more efficient than their LCD counterparts.
4. OLEDs *cost more*: The Cost of an AM-LCD is currently about half that of a comparable AM-OLED display. This is again due to the maturity of the LCD manufacturing processes and facilities. The components comprising a typical LCD display are actually more expensive than those in an OLED display. However, OLED manufacturing facilities suffer from low yields, currently at 60%-70%. The higher cost and low output of OLED panels due to faulty yield closes off large portions of the potential market to panel makers. Also contributing to the cost is simply the inability of manufacturers to deliver enough units to satisfy large orders.
5. OLEDs have a *shorter lifespan* as compared to LCDs.
6. OLEDs have a *faster response time*. They have a response time of .01ms while LCDs have a response time about 8-12ms.
7. OLEDs have a *superior viewing angle* of 180 degree while LCDs have a lower viewing angle.

Cluster Analysis

Methodology

Sample Definition: The sample space consists of moblie phones by leading players in the smart-phone mobile category. These models were identified from Gartner reports. The models of smart-phones launched in the last three years in North America were considered.

Sample Space: After defining the sample, the various key attributes of smart-phones like camera, display, etc. were defined. The data for these attributes for all the models was collected from the company websites as well as the following websites:

- www.phonearena.com
- www.phonegg.com

- www.mobile.am

The pricing information was obtained from

- www.fonearena.com
- www.india-cellular.com
- www.naaptaol.com
- www.mobilestore.com
- www.indiatimes.com.

After aggregating the data we used the **k-clustering** method to identify the different clusters for the samples. This technique aims to partition *n* observations into *k* clusters in which each observation belongs to the cluster with the nearest mean. Hence clusters of phones with similar attributes is achieved.

Samples were segregated into two broad categories - candy-bar phones and clamshell or sliding phones - with thickness being the differentiating parameter. This was done in order to mitigate any error due to the design of the phone(i.e. candybar,clamshell,slider), since the thicknes of the mobile could be a cause for erroneous results.

Results

The sheet below shows the clusters formed for the candy-bar phones.

				CLUSTER 1					
Model No.	Camera	Input	Display Size	WLAN	Color	Resolution	Thickness	Price	Cluste
Apple iPhone 3G(8GB)	2	2	3.5	1	16	320x480	12.3	31000	1
i910	5	2	3.2	1	256	240x400	12.5	37249	1
				CLUSTER 2					
Model No.	Camera	Input	Display Size	WLAN	Color	Resolution	Thickness	Price	Cluste
HTC P3470	2	2	2.8	0	65	240x320	15.7	18500	2
HTC Touch Cruise	3	2	2.8	1	65	240x320	15.5	24800	2
HTC Touch Diamond	3.2	2	2.8	1	65	480x640	11.5	26500	2
HTC Touch Viva	2	2	2.8	1	65	240x320	15.8	18490	2
HTC X7510	3	2	5	1	65	480x640	16	24999	2
i780	2	2	2.6	1	256	320x320	13.3	20449	2
				CLUSTER 3					
Model No.	Camera	Input	Display Size	WLAN	Color	Resolution	Thickness	Price	Cluste
5320 Express Music	2	0	2	0	16	240x320	15	10200	3
5800 Express music	3.2	2	3.2	1	16	360x640	15.5	21000	3
6124 Classic	2	0	2	0	16	240x320	15	9000	3
6220 Classic	5	0	2.2	0	16	240x320	15	17600	3
E63	2	1	2.36	1	16	240x320	13	12000	3
i200	2	0	2.3	0	65	240x320	11.8	11499	3
i450	2	0	2.3	0	256	240x320	11.8	14000	3
N 6120	2	0	2	0	16	240x320	15	16600	3
N78	3.2	0	2.4	1	16	240x320	15.1	14900	3
N79	5	0	2.4	1	16	240x320	15	21000	3
Pearl 8100	1.3	0	2	0	65	240x260	14.5	21999	3
				CLUSTER 4					
Model No.	Camera	Input	Display Size	WLAN	Color	Resolution	Thickness	Price	Cluste
E71	3.2	1	2.36	1	16	240x320	10	19800	4
i550w	3.2	0	2.6	0	256	240x320	13.8	14990	4
N 5700	2	0	2.2	0	16	240x320	17	11025	4
N73	3.2	0	2.4	0	65	240x320	19	11000	4
N82	5	0	2.4	1	16	240x320	17.3	19200	4
BlackBerry 7130c / 7130g	0	0	2.6	0	65	240x260	18	14990	4
				CLUSTER 5					
Model No.	Camera	Input	Display Size	WLAN	Color	Resolution	Thickness	Price	Cluste
Curve 8310	2	1	2.65	0	65	240x320	15.5	24990	5
BlackBerry 8820	0	1	2.6	1	65	240x320	14	31990	5
Curve 8300	2	1	2.65	0	65	240x320	15.5	23999	5
BlackBerry 8800	2	1	2.6	0	65	240x320	14	29990	5
BlackBerry Bold 9000	2	1	2.85	1	65	480x320	15	34900	5
BlackBerry Curve 8330	2	1	2.65	0	65	240x320	15	24990	5



Candy bar
The sheet below shows the cluster formed for the clamshell/sliding phones.

				Cluster 1						
S.No.	Model No	Camera	Input	Display Si	WLAN	Color	Resolutio	Thickness	Price	Clusters
1	N 6650	5	0	2.2	0	1	1	25	20000	1
2	N95 8GB	5	0	2.8	1	1	1	21	24500	1
3	E66	3.2	0	2.4	1	1	1	13.6	20000	1
4	6210 Navi	3.2	0	2.4	0	1	1	14.9	16000	1
5	N85	5	0	2.6	1	1	1	16	22500	1
				Cluster 2						
S.No.	Model No	Camera	Input	Display Si	WLAN	Color	Resolutio	Thickness	Price	Clusters
1	N96	5	0	2.8	1	1	1	18	34999	2
2	N97	5	3	3.5	1	1	2	15.9	33500	2
				Cluster 3						
S.No.	Model No	Camera	Input	Display Si	WLAN	Color	Resolutio	Thickness	Price	Clusters
1	HTC Drear	3.2	3	3.17	1	3	7	17	20000	3
				Cluster 4						
S.No.	Model No	Camera	Input	Display Si	WLAN	Color	Resolutio	Thickness	Price	Clusters
1	N76	2	0	2.4	1	1	1	13.7	14100	4
2	N 6290	2	0	2.2	0	1	1	20.8	13875	4
3	N75	2	0	2.4	0	1	1	20	17538	4
4	HTC Shad	2	1	2.6	1	3	1	15	7500	4
6	E65	2	0	2.2	1	1	1	15.5	12500	4
7	i620	2	1	2.2	1	3	1	11.8	16250	4
8	N 6110	2	1	2.2	0	1	1	20	13200	4



Clamshell_slider
Definition of Attributes:

- **Camera** : resolution in Megapixels
- **Input method**: two types of input methods - touchscreen and keyboard
- **Display size**: diagonal length of the displeay screen
- **Resolution**: display resolutions
- **Color**: display color
- **Thickness**: total thickness of the phone

Conclusion

The matrices presented here show the common attributes for each cluster identified above and list the smart-phone models for each. The *outliers* are the models which could have fallen into some other cluster barring a particular attribute. This has been explained in the notes.

Candy-bar Phones

Clusters	Camera	Type of Input	Display Size	WLAN	Color	Resolution	Thickness	Price	
1		TOUCHSCREEN	HIGH	YES			LOW	HIGH	Ap 3G
2	LOW	TOUCHSCREEN	HIGH	YES			HIGH	LOW	iPho P347 Cruis Dia Tou X
3		NO	LOW				AVERAGE		53 M Cl Class 0,i450 8,N7
4		NO	AVERAGE			LOW	HIGH	LOW	i550w 3,N8 713 71
5	LOW	KEYBOARD	AVERAGE				AVERAGE	HIGH	831 8 830 880 900 C



Clamshell/Slider Matrix

Clamshell/Sliding Phones

CLUSTER	CAMERA	INPUT	DISPLAY SIZE	WLAN	COLOR	RESOLUTION	
1	HIGH	NO	AVERAGE				
2	HIGH			YES			
3		TOUCHSCREEN and KEYBOARD	HIGH				
4	LOW						


Clamshell/Slider Matrix

Selection of model

Using the analysis, one cluster of smart-phones likely to move to OLED technology was identified for each of the two categories. For the next stage of the research - that of forecasting sales of AMOLED display phones - would need the historical sales data of one particular model. For this purpose, **Apple iPhone** from the 2nd cluster of candy-bar phones was selected because of constraint of availabilty of sales data for other models like Blackberry, Nokia N96, HTC Dreamers etc.

Prices for AMOLED screens

Market data was collected for the prices of OLED screens by various manufacturers

Company Name	Model Number	Size	Resolution	Colors	Price/unit(in USD)		
					0-99	100-999	1000 ++
Chung Yuan Technology Co., Ltd		2.2"	220x176		20.00	16.5	
Digiprotek Markcom India P Ltd.(Densitron)	C0201QILK-C	2	176xRGBx220	262K	25.69	24.92	20.67
	C0240QGLA-T	2.4	240xRGBx320	262K	35.97	34.9	27.83
	P0340WQLC-T	3.45	480xRGBx272	16M	85.65	83.1	47.72
	P0430WQLC-T	4.3	480xRGBx272	16M	119.90	116.32	85.84
GLYN GmbH & Co. KG(CMEL)	C0201QILKC	2	176x220	262K	25.00		15
	C0240QGLAT	2.4	240xRGBx320	262K	30.00		20
	C0283QGLDT	2.83	240xRGBx320	262K	38		26
	P0340WQLCT	3.4	480xRGBx272	16M	60.00		35
	P0430WQLCT	4.3	480xRGBx272	16M	90		63
A4G Technologies(OSD)	OSD020AMQCIF	2	176x220	262K	22.50	20.98	19.10
	OSD024AMQV	2.4	240x320	262K	30.20	28.57	25.40
	OSD0283AMQV	2.83	240x320	262K	38.30	36.16	33.63
	OSD0340WQLC	3.4	480x272	16M	69.50	67.25	42.48

	OSD0430WQLC-T	4.3	480x272	16M	109.00	87.00	72.00
Blaze Technology	BDO-0240QGLA-T	2.4	240xRGBx320	262K			20.8
	BDO-0283QGLD-T	2.83	240xRGBx320	262K			26.85
	BDO-0340WQLA-T	3.4	480x272	16M			39.5
	BDO-0430WQLA-T	4.3	480x272	16M			90.6