Supply Chain Management Formulas

The Newsvendor Model:

The Critical Fractal = $C_u/(C_u + C_o)$

$C_u = p - c$

$C_o = c - s$

Converting a Critical Fractal to a order Quantity; Look up or calculate the z score. Multiply the z score times the standard deviation, then add the total to the mean of the distribution. Note if a z score is negative you will be adding a negative number to a positive number.

Economic Order Quantity, Reorder Point, and Order Up to

EOQ $(Q^*) = SQRT((2*d*s)/h)$, where d = demand, s = order costs, and h = holding costs

ROP $= (d_{(LT)} * LT) +$ safety stock, where $d_{(LT)} =$ demand during the lead time, and LT = Lead Time

Safety Stock $= z * SD * SQRT(LT)$, where z = z score, SD = the standard deviation, and LT = Lead Time

Order Up to levels Assuming a Normal Distribution = NORMINV function in excel

Exponential Smoothing

$F(t+1) = F(t) +$ smoothing constant$*(A(t)-F(t))$

Measures of Forecast Error:

Running Some of Forecast Error (RSFE) = SUM (At - Ft)

Mean Forecast Error (Bias) (MFE) = RSFE/N

Mean Absolute Deviation (MAD) = (SUM of the Absolute Value (At - Ft))/N

Tracking Signal (TS) = RSFE/MAD

Measures of Forecast Error (Pasted Formulas)

- RSFE – Running Sum of Forecast Error $\quad RSFE = \sum(A_i - F_i)$

- MFE – Mean Forecast Error (Bias) $\quad MFE = \dfrac{\sum(A_i - F_i)}{N} = \dfrac{RSFE}{N}$

- MAD – Mean Absolute Deviation $\quad MAD = \dfrac{\sum|A_i - F_i|}{N}$

- TS – Tracking Signal $\quad TS = \dfrac{RSFE}{MAD}$

Reading

https://www.supplychain247.com/article/a_blueprint_for_supply_chain_optimization

https://www.scmdojo.com/supply-chain-processes/

Read the Philips vs. Matsushita Case in the HBSP course pack and be prepared to discuss the following questions.

Case Summary

This case traces the history of Philips and Matsushita as they evolve during the pre- and post-war era to emerge as major competitors in the global consumer electronics industry from the 1970s into the twenty-first century. It begins with a capsuled history of Philips, a company that dominated the global consumer electronics industry in the post-war era, by building highly independent, fully integrated national organizations (NOs) able to sense and respond to local market needs. This strategy begins to run into difficulties in the mid 1970s, and over three decades Philips is shown to be struggling to integrate and coordinate independent NOs to allow them to deliver a more scale-intensive and competitively coordinated response to global competitors such as Matsushita. The case describes the actions taken by a succession of seven CEOs between 1971 and 2009 as they try to initiate the changes necessary to restore Philips to its former competitiveness.

In contrast, the case describes the growing worldwide expansion of Matsushita around a very centralized scale-intensive model. It is this global scale efficiency and coordinated global strategy that allows Matsushita to overtake Philips in the 1980s. By the turn of the century, however, the case describes how the Japanese company is also struggling to adjust its strategy to pressures from national markets and host governments

to respond to their local needs. Furthermore, a strengthening yen puts at risk the highly centralized sourcing strategy, forcing Matsushita to close some of its central operations and build organizational capabilities that are much more like Philips' decentralized model.

By 2009 however, both companies are being challenged by competitors from Korea and China, and are forced to undergo radical rethinking of their respective strategies and organizations. The choices they make represent major strategic bets for their future, and the case concludes by questioning whether either company is positioned to regain its former greatness.

By tracing the organizational development of each company and its implications on that company's distinctive strategic capabilities, the case allows students to observe how the development of these two organizational mirror images is reflected in their opposite strategic capabilities. By the end of the case, it is clear that both companies have endured great strategic and organizational turmoil as they try to build sources of competitive advantage very different from those around which they had developed their original strength. And by 2009, both companies are facing the question of whether to embrace the benefits bestowed by their historic roots, or continue trying to overcome those constraints.

Discussion Questions for the Video Conference

PHILIPS vs. MATSUSHITA Questions

1. How did Philips become a successful organization, i.e., (i) what organizational capabilities did they build to drive their competitiveness, and (ii) what were their distinctive strategic competencies/strengths? Also, what were their (i) organizational disabilities, and (ii) resulting strategic incompetencies?

2. How did Matsushita succeed as an organization, i.e., what were their (i) key organizational capabilities, (ii) strategic competencies, (iii) organizational disabilities, and (iv) strategic incompetencies?

3. Summarize your overall _analysis_ of the key strategic changes attempted by each company over the years, and if the changes worked or didn't work, as well as the impact of these changes.

4. What recommendations would you make to the organizational leaders of both companies?

Z Table For Normal Distribution

TABLE A.2 Cumulative normal distribution (z table)
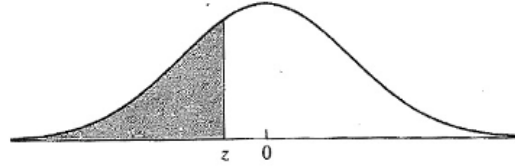
z	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
−3.6	.0002	.0002	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001
−3.5	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002
−3.4	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0002
−3.3	.0005	.0005	.0005	.0004	.0004	.0004	.0004	.0004	.0004	.0003
−3.2	.0007	.0007	.0006	.0006	.0006	.0006	.0006	.0005	.0005	.0005
−3.1	.0010	.0009	.0009	.0009	.0008	.0008	.0008	.0008	.0007	.0007
−3.0	.0013	.0013	.0013	.0012	.0012	.0011	.0011	.0011	.0010	.0010
−2.9	.0019	.0018	.0018	.0017	.0016	.0016	.0015	.0015	.0014	.0014
−2.8	.0026	.0025	.0024	.0023	.0023	.0022	.0021	.0021	.0020	.0019
−2.7	.0035	.0034	.0033	.0032	.0031	.0030	.0029	.0028	.0027	.0026
−2.6	.0047	.0045	.0044	.0043	.0041	.0040	.0039	.0038	.0037	.0036
−2.5	.0062	.0060	.0059	.0057	.0055	.0054	.0052	.0051	.0049	.0048
−2.4	.0082	.0080	.0078	.0075	.0073	.0071	.0069	.0068	.0066	.0064
−2.3	.0107	.0104	.0102	.0099	.0096	.0094	.0091	.0089	.0087	.0084
−2.2	.0139	.0136	.0132	.0129	.0125	.0122	.0119	.0116	.0113	.0110
−2.1	.0179	.0174	.0170	.0166	.0162	.0158	.0154	.0150	.0146	.0143
−2.0	.0228	.0222	.0217	.0212	.0207	.0202	.0197	.0192	.0188	.0183
−1.9	.0287	.0281	.0274	.0268	.0262	.0256	.0250	.0244	.0239	.0233
−1.8	.0359	.0351	.0344	.0336	.0329	.0322	.0314	.0307	.0301	.0294
−1.7	.0446	.0436	.0427	.0418	.0409	.0401	.0392	.0384	.0375	.0367
−1.6	.0548	.0537	.0526	.0516	.0505	.0495	.0485	.0475	.0465	.0455
−1.5	.0668	.0655	.0643	.0630	.0618	.0606	.0594	.0582	.0571	.0559
−1.4	.0808	.0793	.0778	.0764	.0749	.0735	.0721	.0708	.0694	.0681
−1.3	.0968	.0951	.0934	.0918	.0901	.0885	.0869	.0853	.0838	.0823
−1.2	.1151	.1131	.1112	.1093	.1075	.1056	.1038	.1020	.1003	.0985
−1.1	.1357	.1335	.1314	.1292	.1271	.1251	.1230	.1210	.1190	.1170
−1.0	.1587	.1562	.1539	.1515	.1492	.1469	.1446	.1423	.1401	.1379
−0.9	.1841	.1814	.1788	.1762	.1736	.1711	.1685	.1660	.1635	.1611
−0.8	.2119	.2090	.2061	.2033	.2005	.1977	.1949	.1922	.1894	.1867
−0.7	.2420	.2389	.2358	.2327	.2296	.2266	.2236	.2206	.2177	.2148
−0.6	.2743	.2709	.2676	.2643	.2611	.2578	.2546	.2514	.2483	.2451
−0.5	.3085	.3050	.3015	.2981	.2946	.2912	.2877	.2843	.2810	.2776
−0.4	.3446	.3409	.3372	.3336	.3300	.3264	.3228	.3192	.3156	.3121
−0.3	.3821	.3783	.3745	.3707	.3669	.3632	.3594	.3557	.3520	.3483
−0.2	.4207	.4168	.4129	.4090	.4052	.4013	.3974	.3936	.3897	.3859
−0.1	.4602	.4562	.4522	.4483	.4443	.4404	.4364	.4325	.4286	.4247
−0.0	.5000	.4960	.4920	.4880	.4840	.4801	.4761	.4721	.4681	.4641

1

TABLE A.2 Cumulative normal distribution (continued)
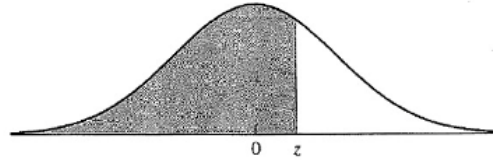
z	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	.5000	.5040	.5080	.5120	.5160	.5199	.5239	.5279	.5319	.5359
0.1	.5398	.5438	.5478	.5517	.5557	.5596	.5636	.5675	.5714	.5753
0.2	.5793	.5832	.5871	.5910	.5948	.5987	.6026	.6064	.6103	.6141
0.3	.6179	.6217	.6255	.6293	.6331	.6368	.6406	.6443	.6480	.6517
0.4	.6554	.6591	.6628	.6664	.6700	.6736	.6772	.6808	.6844	.6879
0.5	.6915	.6950	.6985	.7019	.7054	.7088	.7123	.7157	.7190	.7224
0.6	.7257	.7291	.7324	.7357	.7389	.7422	.7454	.7486	.7517	.7549
0.7	.7580	.7611	.7642	.7673	.7704	.7734	.7764	.7794	.7823	.7852
0.8	.7881	.7910	.7939	.7967	.7995	.8023	.8051	.8078	.8106	.8133
0.9	.8159	.8186	.8212	.8238	.8264	.8289	.8315	.8340	.8365	.8389
1.0	.8413	.8438	.8461	.8485	.8508	.8531	.8554	.8577	.8599	.8621
1.1	.8643	.8665	.8686	.8708	.8729	.8749	.8770	.8790	.8810	.8830
1.2	.8849	.8869	.8888	.8907	.8925	.8944	.8962	.8980	.8997	.9015
1.3	.9032	.9049	.9066	.9082	.9099	.9115	.9131	.9147	.9162	.9177
1.4	.9192	.9207	.9222	.9236	.9251	.9265	.9279	.9292	.9306	.9319
1.5	.9332	.9345	.9357	.9370	.9382	.9394	.9406	.9418	.9429	.9441
1.6	.9452	.9463	.9474	.9484	.9495	.9505	.9515	.9525	.9535	.9545
1.7	.9554	.9564	.9573	.9582	.9591	.9599	.9608	.9616	.9625	.9633
1.8	.9641	.9649	.9656	.9664	.9671	.9678	.9686	.9693	.9699	.9706
1.9	.9713	.9719	.9726	.9732	.9738	.9744	.9750	.9756	.9761	.9767
2.0	.9772	.9778	.9783	.9788	.9793	.9798	.9803	.9808	.9812	.9817
2.1	.9821	.9826	.9830	.9834	.9838	.9842	.9846	.9850	.9854	.9857
2.2	.9861	.9864	.9868	.9871	.9875	.9878	.9881	.9884	.9887	.9890
2.3	.9893	.9896	.9898	.9901	.9904	.9906	.9909	.9911	.9913	.9916
2.4	.9918	.9920	.9922	.9925	.9927	.9929	.9931	.9932	.9934	.9936
2.5	.9938	.9940	.9941	.9943	.9945	.9946	.9948	.9949	.9951	.9952
2.6	.9953	.9955	.9956	.9957	.9959	.9960	.9961	.9962	.9963	.9964
2.7	.9965	.9966	.9967	.9968	.9969	.9970	.9971	.9972	.9973	.9974
2.8	.9974	.9975	.9976	.9977	.9977	.9978	.9979	.9979	.9980	.9981
2.9	.9981	.9982	.9982	.9983	.9984	.9984	.9985	.9985	.9986	.9986
3.0	.9987	.9987	.9987	.9988	.9988	.9989	.9989	.9989	.9990	.9990
3.1	.9990	.9991	.9991	.9991	.9992	.9992	.9992	.9992	.9993	.9993
3.2	.9993	.9993	.9994	.9994	.9994	.9994	.9994	.9995	.9995	.9995
3.3	.9995	.9995	.9995	.9996	.9996	.9996	.9996	.9996	.9996	.9997
3.4	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9998
3.5	.9998	.9998	.9998	.9998	.9998	.9998	.9998	.9998	.9998	.9998
3.6	.9998	.9998	.9999	.9999	.9999	.9999	.9999	.9999	.9999	.9999

Read the Paper and More Case in the HBSP course pack and be prepared to discuss the case.

Case Summary

The "Paper and More" is focused on a number of decisions related to determining appropriate inventory order-up-to policies for staple items (as opposed to fashion item) through a number of scenarios about a hypothetical paper and paper-related goods retail store. The case begins with the storeowner Kevin Brown contemplating learning inventory management principles given his desire to open more stores. Brown has sale and inventory data on his retail products for the past two years and seeks to use this data to pick up insights about how he should go about managing his inventory. Initial scenarios cover three criteria for setting inventory order-up-to levels: fill-rate, in- stock rate and profit maximization, and approaches for determining these order-up-to levels for a single product. The approaches for determining these order-up-to levels include simulating performance using historical data and fitting a normal probability distribution to historical data both without and with fitted trendlines. Subsequent scenarios cover predicting lost sales and multi- product management without and with shelf-space constraints.

We will only discuss Analyses 1 and 2 during the video conference.

Discussion Questions for the Video Conference

Paper and More

1. What are the assumptions that Kevin Brown has made in order to set up the inventory models examined in the Analysis?

2. What is in-stock rate and fill-rate? Why is fill-rate greater than in-stock rate? Could fill-rate be less than in-stock rate?

3. We have three criteria for making decisions here. Kevin Brown considers actually managing the "Great White SKU". Which policy should he choose? What are the pros and cons of each criterion?

Installing Add-Ins in EXCEL.

1. Select File > Options and subsequently Add-ins.
2. Select Excel Add-ins in the Manage box.
3. Select GO.
4. Select the "Analysis" add-in (or other add-in) checkbox.
5. Select OK.

Analysis #1a

1. Enter the numbers 0 through 85 in cells N3 – N88. This is the range of order-up-to points.
2. Highlight cells **N2 – R88**.
3. Select "Data", then "What-If Analysis", followed by "Data Table".
4. Leave the "Row Input cell" blank and enter K3 in the "Column Input cell". Click OK to calculate the different metrics for each order-up-to level (no need to hit F9).

Analysis #1b

1. The cost of overage (Co) is denoted by c – s, the actual cost of the product minus the salvage value, if any.
2. The cost of underage (Cu) is denoted by p – c, the retail price of the product minus the cost of the product.
3. The critical fractile is calculated as Cu / (Co + Cu).

Analysis #2a

1. Install the Analysis Add-In (if necessary).
2. Enter the numbers 10, 20, ..., 80 in cells K26 – K33.
3. Click "Data Analysis".
4. Select "Histogram".
5. Enter B2 – B51 in the "Input Range" cell and K26 – K33 in the "Bin Range" cell.
6. Check the "Cumulative Percentage" and "Chart Output" boxes. Then click "OK".

Analysis #2b.

1. Calculate the mean (AVERAGE) and the sample standard deviation (STDEV.S) of the demand and use them in the calculations of the Store Order-Up-To points. Don't forget to make them absolute, e.g. R3 in the formula. You can use the formula ROUNDUP(NORM.INV(in-stock rate, calculated average, calculated standard deviation), 0).

<u>Analysis #2c.</u>

In step 5, click "What-If Analysis" followed by Data Table, enter the requested values in the "Column Input cell" and leave the "Row Input cell" empty. Click OK (no need to hit F9).