April 28, 2016

Decision Making in Complex Environments
Final Project: BOCR Model & Report

Background:

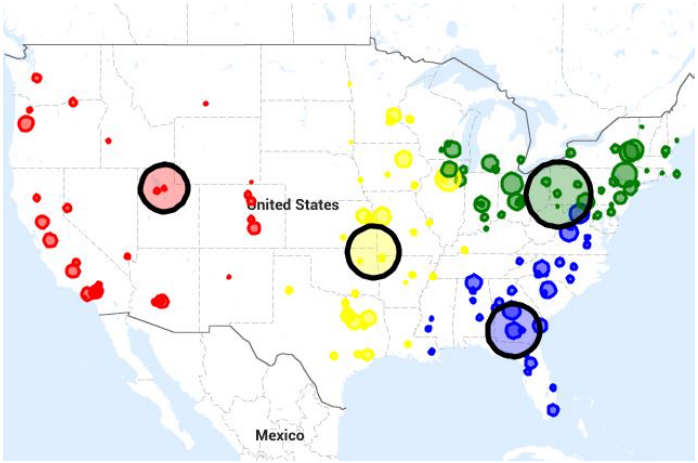
American Textile Company (ATC) is currently the second largest pillow manufacturer in the United States with their eyes set on becoming the number one pillow manufacturer in the US in terms of sales volume and revenue. Out of their four manufacturing and distribution centers spread across the US (Tifton, GA; Duquesne, PA; Salt Lake City, UT; and Dallas, TX), it is their Dallas, TX location that will be the area of focus to address the problem at hand. Due to tremendous growth and projections over the next five years (15% annually), ATC will soon be at capacity in a Dallas location that currently allows no room to expand at the current facility. Their 105k sq. ft. factory needs to be about 200k sq. ft. to account for their growth. Rather than simply constructing a larger facility in another part of Dallas, TX, our consulting group decided to look at other alternatives in the Midwest. The negative effects of Dallas' distance from customers, high overhead rents, and minimal tax incentives surely could be overcome from other positive effects of other locales.

To summarize, the goal is to find a new manufacturing and distribution center in the Midwest that meets all requirements of ATC.

The alternatives were decided upon after running a Center of Gravity model which analyzed the current customer list of ATC in an attempt to minimize the distance from ATC to the customers. The four alternatives that were evaluated were:

- Joplin, MO -> moderate sized city with a metropolitan area at the intersection of major highways (I-44 and I-49)
- Fairland, OK -> small, rural 'farm town' near I-44
- Fayetteville, AR -> moderate sized city, home of University of Arkansas, along I-49
- Dallas, TX -> current home of the ATC Midwest facility, extremely large city, major hub of the interstate highway system

Center of Gravity Model – optimal coordinates = Fairland, OK. This is not necessarily the choice for our new location due to the evaluation of distance, financial, and human capital criteria of other nearby locations. The BOCR model will evaluate and consider many factors to arrive at the final answer.



The following analysis will evaluate the BOCR (Benefits, Opportunities, Costs, and Risks) model that was created to identify the new location of ATC's Midwest operations. Distance, financial, and

human capital criteria were all compared, considering the 'internal impact' and 'external impact' of each of the locations and the benefits, opportunities, costs, and risks of such a decision.

Overview of the BOCR

- Benefits
  - Internal Impact
    - Transportation Cost Savings
    - Ability to Increase Operation Size
    - Better Employees
    - Brand Awareness
  - External Impact
    - Access to Highways/Interstates
    - Tax Incentives
    - Economic Environment
    - High Unemployment
    - New Markets/Customers
- Opportunities
  - Internal Impact
    - Increase Speed to Market
    - Opportunity for Growth (long term)
    - R&D
  - External Impact
    - Future Tax Incentives
    - Regional Impact
    - New Markets (customers)
- Costs
  - Internal Impact
    - Proximity to Raw Goods
    - Transportation Costs to Customers
    - Overhead Costs
    - Transition Costs
    - Utility Costs
    - Wage Expenses
  - External Impact
    - Truck Traffic
    - Population Demographics
    - Social Ill Will

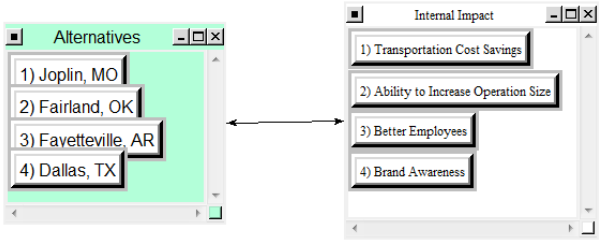
- Risks
  - Internal Impact
    - Cost of Manufacturing Increase

- Employee Dissatisfaction
- External Impact
  - Current Customer Instability
  - Economic Instability
  - Expense Rate Increase
  - Environmental Instability

Summary

After comparing all variables and alternatives in the BOCR model, the ultimate decision was to relocate the operations to the Joplin, MO location. The following pages will go into detail on each of the decisions that were made, reviewing the most heavily weighted variable of each set. The short and long term decisions and sensitivity analysis will also be reviewed.

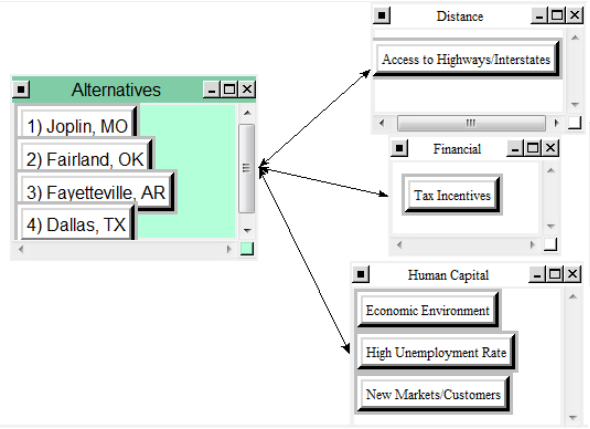
Benefits – Internal



Name	Graphic	Ideals	Normals	Raw
1) Joplin, MO		1.000000	0.311364	0.311364
2) Fairland, OK		0.915589	0.285081	0.285081
3) Fayetteville, AR		0.863361	0.268819	0.268819
4) Dallas, TX		0.432728	0.134736	0.134736

There were four primary variables that were considered in the Benefits – Internal section. The variable that carried the most weight was Transportation Cost Savings. Through our calculations, we found out that it costs $2.55/mile/delivery to deliver product to the customers. The Center of Gravity model showed that Fairland, OK happened to be 'the center of gravity', earning a perfect score for this variable. Joplin, MO (43 miles) and Fayetteville, AR (92 miles) both were fairly close, earning good scores, while Dallas, TX (318 miles) earned the lowest score. Despite Joplin not having the best score for Transportation Cost Savings, it was better than Fairland in the other three categories, propelling it to the top of the rankings for Benefits – Internal.

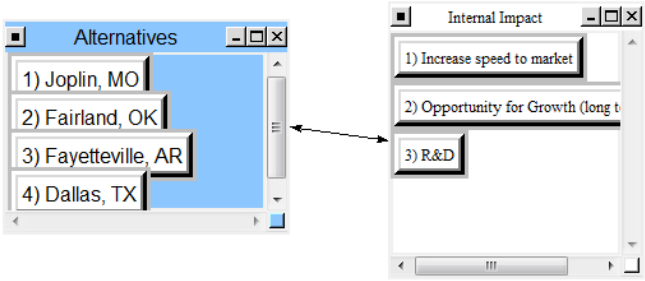
Benefits – External



Name	Graphic	Ideals	Normals	Raw
1) Joplin, MO		1.000000	0.295937	0.295937
2) Fairland, OK		0.993833	0.294112	0.294112
3) Fayetteville, AR		0.725303	0.214644	0.214644
4) Dallas, TX		0.659962	0.195307	0.195307

Broken down differently with main nodes and sub-nodes, the 'most important' main nodes were Financial and Human Capital at 40% each, with Tax Incentives being the most heavily weighted out of any individual sub-node. To evaluate the Tax Incentives in more detail, we reached out to the Chamber of Commerce of each alternative, inquiring about incentive plans that they would offer ATC. Fairland, OK provided the most favorable outcomes, with an estimate of $1.1M over the course of ten years. Joplin, MO wasn't quite as strong, with their Missouri Works program saving about $600,000 over ten years from the retention of state withholding tax. The other two alternatives scored much lower due to their stronger economies offering less incentives. Although extremely close in the end, Joplin earned the highest score for Benefits – External with its score from Access to Highways/Interstates helping to edge out Fairland, OK.

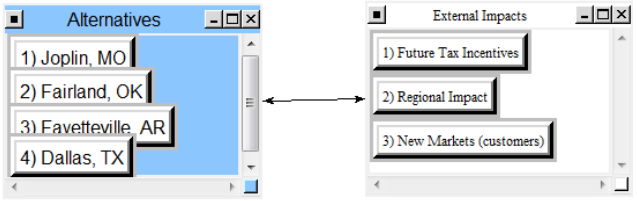
Opportunities – Internal



Name	Graphic	Ideals	Normals	Raw
1) Joplin, MO		1.000000	0.308687	0.308687
2) Fairland, OK		0.763284	0.235616	0.235616
3) Fayetteville, AR		0.940903	0.290444	0.290444
4) Dallas, TX		0.535343	0.165253	0.165253

Increased speed to market was one of the largest weights to the Opportunities – Internal Impact section. Considered in this was primarily the distance to customers and distance to major highways. Joplin, MO and Fayetteville, AR earned high scores due to their proximity to I-49, which runs North to South along the Mississippi River Valley, the same area where ATC's customers are currently. Fayetteville earned a very high score for R&D since it is a college town, but R&D was the lowest weighted variable in this cluster.

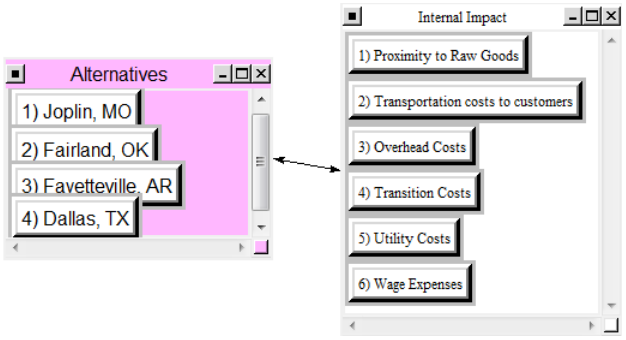
Opportunities – External



Name	Graphic	Ideals	Normals	Raw
1) Joplin, MO		0.797197	0.344191	0.344191
2) Fairland, OK		1.000000	0.431752	0.431752
3) Fayetteville, AR		0.367372	0.158614	0.158614
4) Dallas, TX		0.151574	0.065442	0.065442

Future Tax Incentives here carried the most weight. This included projections and expectations for tax incentives changing in the future to potentially become more beneficial. Fairland, OK earned the highest score for Future Tax Incentives. They are already currently high in Fairland, OK, but the opportunity for them to raise even higher exceeds that of other locations. Smaller, weaker economies typically offer more generous and long lasting incentive plans to bring jobs and growth to the region.

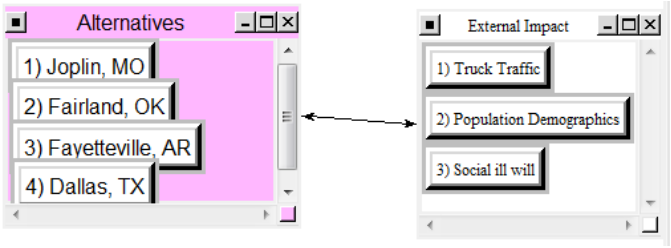
Costs – Internal



Name	Graphic	Ideals	Normals	Raw
1) Joplin, MO		0.382350	0.181423	0.181423
2) Fairland, OK		0.237433	0.112661	0.112661
3) Fayetteville, AR		0.487718	0.231420	0.231420
4) Dallas, TX		1.000000	0.474496	0.474496

The higher the cost, the worse that alternative is. The most important costs (which was already briefly touched upon before) were Transportation Costs. The next most heavily weighted costs were the Overhead Costs. For manufacturing facilities, Fairland, OK had the cheapest rent per sq. ft. in terms of NNN. NNN takes into consideration not only the rent, but insurance, taxes, and other operating costs that are tied directly to the building. Fairland's average overhead was $1.45/sq. ft. while Dallas, TX was $6.60/sq. ft. The costs to Dallas are a lot higher than the other three locations we're considering.

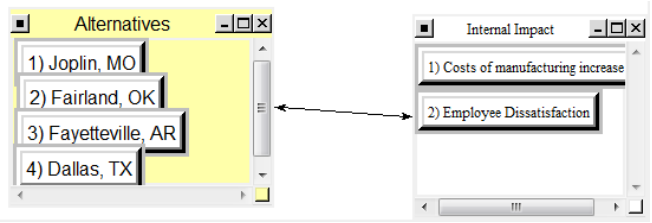
Costs – External



Name	Graphic	Ideals	Normals	Raw
1) Joplin, MO		0.745805	0.275450	0.275450
2) Fairland, OK		1.000000	0.369332	0.369333
3) Fayetteville, AR		0.776788	0.286893	0.286893
4) Dallas, TX		0.184995	0.068325	0.068325

Within Costs – External, Population Demographics was the highest. It was 'costly' not financially, but in terms of human capital. The less people that live in an area and the higher the education level, the less people we will have to select from to fill these low skill labor positions on the production lines. With Fairland, OK's workforce size (which is on average 62% of the town's population) of 68,000, that is less than half of any other alternative's workforce size. When combined with the people that don't have a college degree and the unemployment rate, ATC will have to hire 1:26 people eligible and looking for a job. That ratio is much higher, and thus, much easier to hire from, in the other three alternatives.

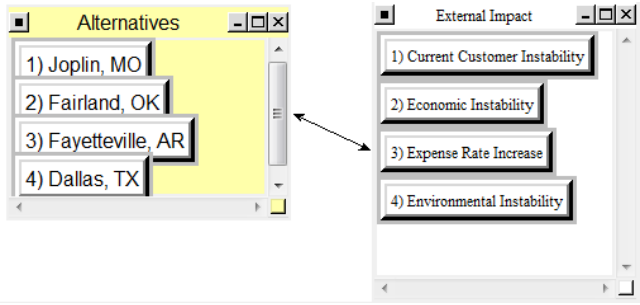
Risks – Internal



Name	Graphic	Ideals	Normals	Raw
1) Joplin, MO		0.595623	0.213810	0.213810
2) Fairland, OK		0.392600	0.140931	0.140931
3) Fayetteville, AR		1.000000	0.358969	0.358969
4) Dallas, TX		0.797533	0.286290	0.286290

We projected Cost of Manufacturing increase about 3x more significant than Employee Dissatisfaction. Things that directly impact the bottom line sometimes tend to carry the most weight. Fayetteville, AR earned the highest risk due to its high hourly rate for employees and the risk of other costs to the manufacturing and distribution process potentially increasing overtime.

Risks – External



Name	Graphic	Ideals	Normals	Raw
1) Joplin, MO		0.860033	0.317586	0.317586
2) Fairland, OK		1.000000	0.369272	0.369272
3) Fayetteville, AR		0.712547	0.263124	0.263124
4) Dallas, TX		0.135451	0.050018	0.050018

Economic instability had the highest weight here at .447 when compared to the other 3 nodes in the cluster. Economic stability in Fairland, OK was the highest due to its weak economy and limited exposure to manufacturing/distribution companies thus far. A new company coming into the city could definitely produce a bit of instability in the local economy, causing this option to become risky. Dallas, TX

had a very low risk level due to its size and the number of other companies that are currently located there. ATC starting operations in Fairland, OK would be much more of a risk.

Ratings for Corporate Objectives & BOCR

There were four corporate objectives directly tied to the goal, providing reasons and objectives for undergoing such a project.

1. Minimize distance to customers
2. Continue growth
3. Brand equity
4. Long term financial stability

These four objectives went through the comparison process similarly to how the other clusters and nodes went through a comparison process. The results revealed that 'minimize distance to customers' was the most important and most heavily weighted corporate objective, with a .374 weight. The least important object was brand equity, with a .089 weight.

The weights assigned to each objective were important because the 'winners' of each B, O, C, and R grouping were rated and compared to each objective. The 'winner' or highest score of benefits was Joplin, MO. Joplin was used to compare against the corporate objectives (minimize distance, continue growth, brand equity, and long term financial success). The rating system was a basic 'excellent' to 'poor' system. The same process continued through for opportunities, costs, and risks. The result of the ratings are below:

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Super Decisions Ratings

	Priorities	Totals	1) Minimize distance 0.374065	2) Continue growth 0.291372	3) Brand Equity 0.089419	4) Long term financ 0.245143
1.Benefits	0.330364	0.757861	Excellent	Above Average	Average	Above Average
2.Opportunities	0.275629	0.632297	Above Average	Above Average	Average	Above Average
3.Costs	0.246593	0.565690	Excellent	Average	Average	Average
4.Risks	0.147414	0.338170	Average	Average	Above Average	Average

End Result/Synthesis

Using the additive (negative) standard formula to synthesize the results, the results ranked in order were Joplin, MO; Fairland, OK; Fayetteville, AR; and Dallas, TX. The additive formula shows the short term best decision when relocating ATC's Midwest production facility. It was surprising that Dallas' scored extremely low, about 1.7% when normalized. The biggest factors in this were likely high rent, poor tax incentives, and the distance from the customers when compared with the other three alternatives. The graphic produced from the software is below:

Name	Graphic	Ideals	Normals	Raw
1) Joplin, MO		1.000000	0.397517	0.362404
2) Fairland, OK		0.922379	0.366662	0.334274
3) Fayetteville, AR		0.550072	0.218663	0.199348
4) Dallas, TX		0.043161	0.017157	0.015642

Using the multiplicative standard formula to synthesize the results, the end result was slightly different. They were ranked Fairland, OK; Joplin, MO; Fayetteville, AR; and Dallas, TX. Fairland, OK had a bit more 'upside' than Joplin, which was likely the factor that propelled Fairland ahead of Joplin in this long term ranking. The difference in two alternatives was extremely minimal. Normalized, Fairland is at 38.33% and Joplin is at 38.29%. With a bit more judgement or expertise in any of the fields analyzed, the decision could go either way. The graphic for the multiplicative ranking is below:

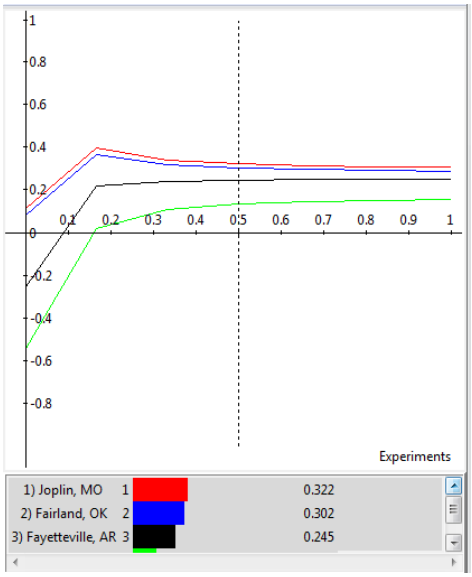
Name	Graphic	Ideals	Normals	Raw
1) Joplin, MO		0.999046	0.382928	2.708304
2) Fairland, OK		1.000000	0.383294	2.710890
3) Fayetteville, AR		0.428026	0.164060	1.160331
4) Dallas, TX		0.181892	0.069718	0.493090

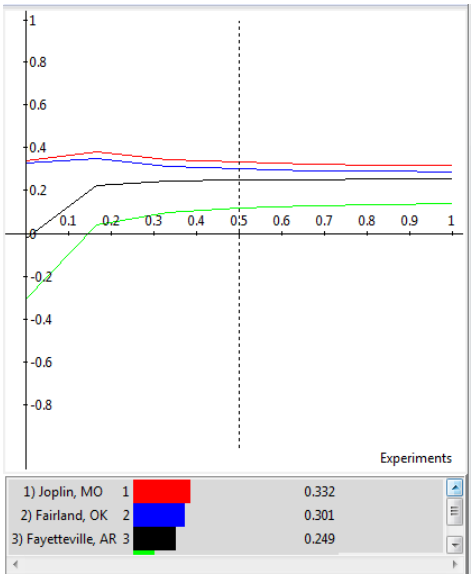
Sensitivity Analysis:

A sensitivity analysis was run on each the Benefits, Opportunities, Costs, and Risks priorities to see if the decision in any of the alternatives would change. The summarized results and graphs are below:

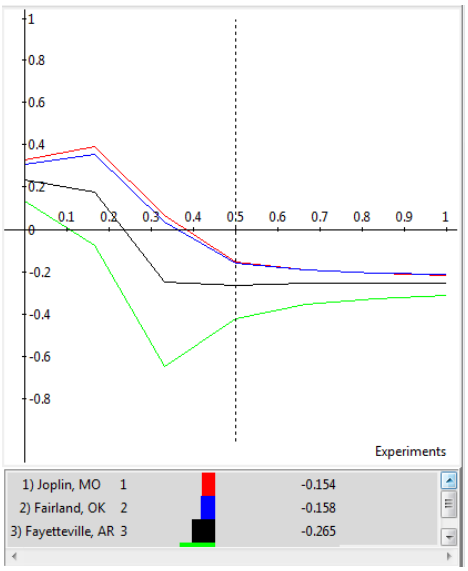
- A change in the Benefit priority will not have a change in Joplin, MO being the best 'highest benefit' alternative
- A change in the Opportunities priority will not have a change in Joplin, MO being the best 'highest opportunity' alternative
- A change in the Costs priority will not have a change in Dallas, TX being the best and 'lowest cost' alternative
- A change in the Risks priority will have a change from Dallas, TX to Fayetteville, AR being the best and 'lowest risk' alternative

Sensitivity Analysis for Benefits **Sensitivity Analysis for Opportunities**

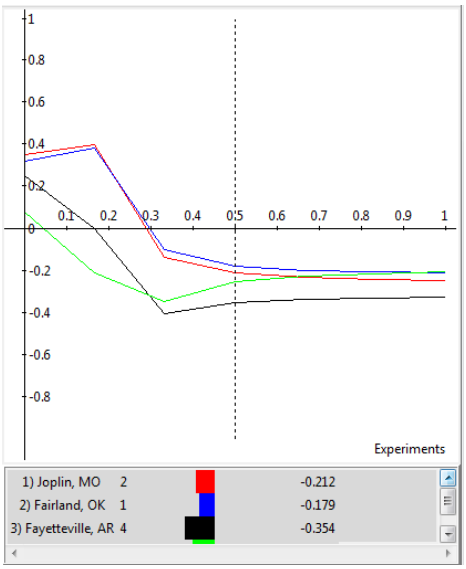




Sensitivity Analysis for Costs



Sensitivity Analysis for Risks



Conclusion

After running the BOCR model, it was determined that relocating ATC's Midwest operations to Joplin, MO was the best decision. The short term (additive) and long term (multiplicative) formulas both

gave that confirmation and backing. There are plenty of positives about moving to this location rather than the other three alternatives. The next best option, pretty close behind, would be Fairland, OK. Coming in third and fourth place was Fayetteville, AR and Dallas, TX respectively.

We presented a sample of this analysis (along with other analyses) to our client, who was thrilled with the level of detail and ultimate decision that was made. It will be interesting to see if they do end up using our recommendations in the near future.