Optimize Budget Planning at East Bay Logistics

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Summary

The optimization model presented is for maximizing budget allocation for East Bay Logistics under new guidelines from East Bay Logistics management.

The company often needs to invest in IT capabilities, modern handling equipment or additional warehouse space to improve the efficiency of their operations. To optimize these capabilities, it has been allocating budgets to its current projects.

With the new restriction on the carbon dioxide (CO2) emission by the United States Environmental Protection Agency (EPA), management and proper decision making is critical to the selection of projects that do not violate the restriction. Also, they have decided to include advanced technology such as the inclusion of IOT, Analytics, and Digital Transformation into the consideration of the budget allocation.

The team has worked under the requirements and have translated the business objective into a linear programming optimization problem. We used MS Excel with add-in solver and solver table to build an Integer Linear Programming model with binary variables to maximize the return on investment (ROI) from budget allocations on projects under the new guidelines.

We finished with thinking about how the model would follow all the guidelines given by management and at the same time provide maximum ROI with the budget allocations.

Introduction

Company:

East Bay Logistics is one of the biggest logistics companies in North America that specializes in projects for purposes of sustainability, digital transformation, and/or operational excellence. These projects cater to customers in automotive, fast-moving consumer goods, industrial, pharmaceutical, retail, and HVAC markets just to name a few. East Bay Logistics operations managers allocate expenditure money to projects based on specific budget constraints and non-financial objectives which serves as a decision point in the project selection process. With 17 warehouses located in 4 countries and with 58 projects, an ILP model is of high importance to facilitate better allocation of annual budgets to selected projects.

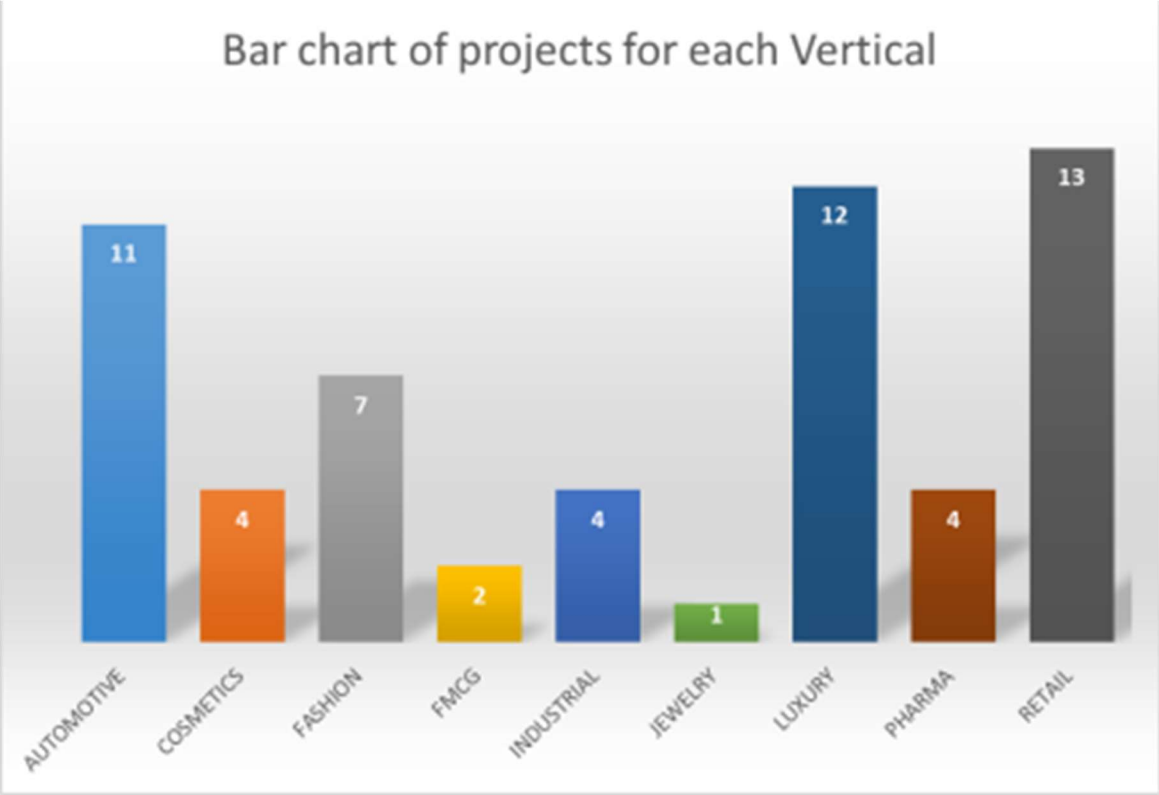
Problem Statement:

East Bay Logistics wants to maximize their ROI but at the same time wants to focus on its non-financial objectives, sustainability initiative, specifically related to greenhouse gas (CO2) emissions. At East Bay Logistics, leaders are increasingly realizing the power of sustainable business strategies not only addressing one of the world's most pressing challenges but driving their firm's success. Sustainability and financial success are closely associated for many businesses. One of the reasons is because the increased consumer awareness about sustainability and their focus on purchasing from sustainable sources is on the rise. Therefore, formulating a linear programing model that would suggest a viable budget allocation ensuring optimal ROI and maximum allocation for sustainable projects were key considerations for the team.

Main Chapter

Data Collection:

The data available for East Bay Logistics is contained in a data warehouse and is available via tools such as MicroStrategy and direct SQL. The data used in this analysis was retrieved from github. The data is saved in an xlsx format file, which has a main primary sheet named "Projects" with 20 columns and 58 rows (Projects). Each row provides a detailed description of the project including the targeted customer market segments, yearly costs, projected return on investment, and different initiative budgets reached. Below is a bar graph depicting the allocation of the number of projects that target each customer market segment.

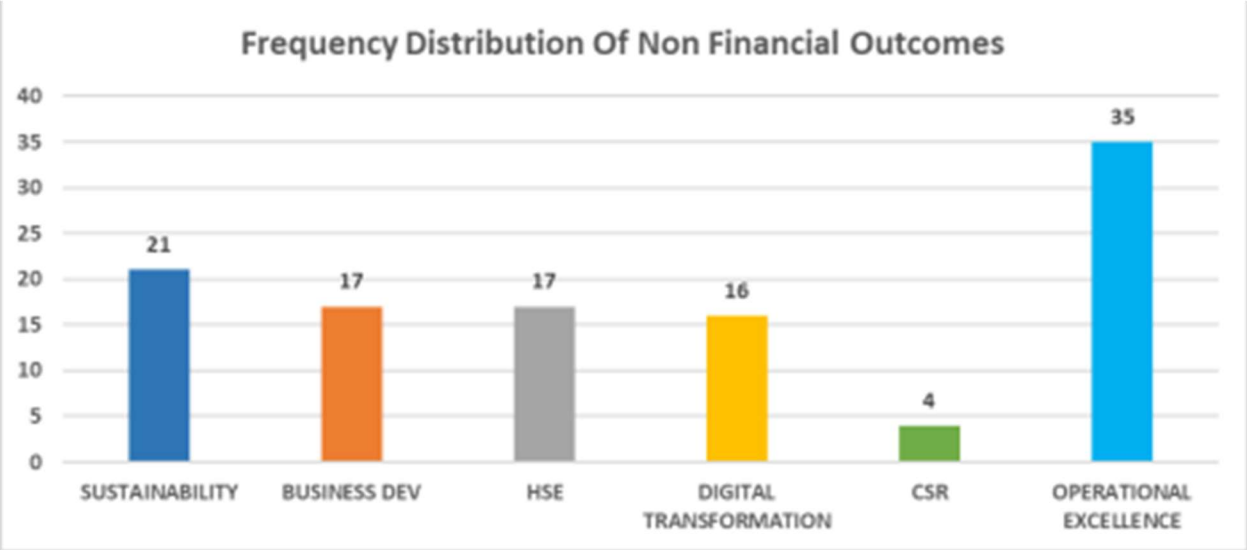


Frequency Distribution of The Projects for The Customer Market Segments Targeted in East Bay Logistics

Data Analysis:

Analyzing the data will take multiple steps and iterations. First, we need to identify the management guidelines for the non-financial outcomes: Sustainability, Digital Transformation and Operational Excellence. We will utilize this information for the new budget allocation, and then formulate the objective function to maximize the ROI.

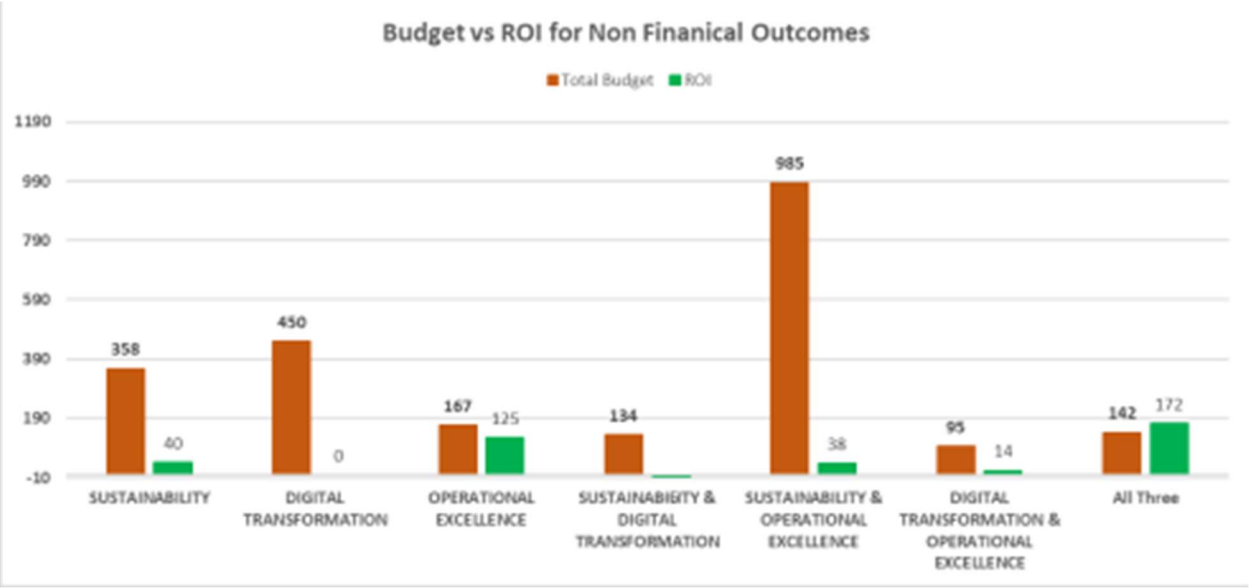
To identify the guidelines, we need to consider the outcome of each project. We need to analyze each project. The team has collected the company's data for all current projects with their relevance to six non-financial objectives. These outcomes are Sustainability, Business Dev, Hse, Digital Transformation, CSR, Operational Excellence. Any project can lead to one or more of these six outcomes. The bar graph below shows the frequency distribution of the six different outcomes with respect to the number of projects.



Frequency Distribution of The Projects for The Six Non-Financial Objectives

Out of the above six objectives we will focus on Sustainability, Digital Transformation, and Operational Excellence for the budget allocation. Therefore, we have done an analysis to visualize the budget allocation and ROI earned from projects for each of these categories and

combinations of them. The bar graph below depicts the total budgets and ROI for each of the outcomes.



Budget Vs ROI in Thousands of Dollars

- We can observe from the graph above that for Sustainability and Operational Excellence projects the total allocation budget has been the highest, at $985,000.
- We can also observe that for Digital Transformation projects, the ROI is $0.
- The best ROI has come from projects that are associated with all three types of non-financial objectives (121.51%). The ROI is greater than the allocated budget.

Optimization Model:

East Bay Logistics has in total 58 projects underway. Our objective is to help the company to build a simple Integer Linear Programming model with binary decision variables to select the projects for the budget allocation that maximizes the company's ROI keeping management guidelines into consideration.

Decision Variables:

As mentioned previously, the decision variables in our model are binary i.e. either selection or rejection. Selection or rejection of all 58 Projects will be our 58 decision variables.

X_1 = selection of project 1, X_1=1 if project 1 is selected , and X_1= 0 if not

X_2 = selection of project 2, X_2=1 if project 2 is selected , and X_2= 0 if not

X_3 = selection of project 3, X_3=1 if project 3 is selected , and X_3= 0 if not

….

X_{57} = selection of project 57, X_{57}=1 if project 57 is selected , and X_{57}= 0 if not

X_{58} = selection of project 58, X_{58}=1 if project 8 is selected , and X_{58}= 0 if not

Below is the table of all 58 decision variables for all the projects:

PROJECT DESCRIPTION	DECISION VARIABLES	PROJECT DESCRIPTION	DECISION VARIABLES
5S VISUAL MANAGEMENT	X1	NEW MODERN CANTEEN	X30
ADDITIONAL SPACE WITH RACKING	X2	NEW MODERN CANTEEN	X31
ADDITIONAL SPACE WITH RACKING	X3	NEW UNIFORMS FOR OPERATORS	X32
ADDITIONAL SPACE WITH RACKING	X4	NEW UNIFORMS FOR OPERATORS	X33
ADDITIONAL SPACE WITH RACKING	X5	ORDER MANAGEMENT SYSTEM (PROD, LESS PAPER)	X34
ADDITIONAL RACKING	X6	ORDER MANAGEMENT SYSTEM (PROD, LESS PAPER)	X35
AIR CONDITIONING FOR OFFICE (HSE)	X7	PALLETIZATION ROBOT (PRODUCTIVITY)	X36
AUTOMATED ACCESS POINT WITH FINGERPRINT FOR WORKFORCE MANAGEMENT	X8	PALLETIZATION ROBOT (PRODUCTIVITY)	X37
AUTOMATED GUIDED VEHICLES	X9	PASSIVE EXOSKELETON (CSR)	X38

AUTOMATED ORDER PICKER (PRODUCTIVITY)	**X10**	**RENEWABLE ENERGY FOR WAREHOUSE (SUSTAINABILITY)**	**X39**
AUTOMATED WRAPPING MACHINE (SUSTAINABILITY, PRODUCTIVITY)	**X11**	**SPRINKLER IN RACKS (CSR, SAFETY, BUSINESS OPPORTUNITIES)**	**X40**
AUTOMATED WRAPPING MACHINE (SUSTAINABILITY, PRODUCTIVITY)	**X12**	**SPRINKLER IN RACKS (CSR, SAFETY, BUSINESS OPPORTUNITIES)**	**X41**
AUTOMATIC DIMENSIONING SYSTEM TO MEASURE INBOUND CARTONS	**X13**	**TRANSPORT MANAGEMENT SYSTEM**	**X42**
AUTONOMOUS ROBOT FOR INVENTORY STOCK COUNT (PRODUCTIVITY)	**X14**	**TRANSPORT MANAGEMENT SYSTEM**	**X43**
AUTONOMOUS SCALE FOR PARCEL DOUBLE CHECK BEFORE PACKING	**X15**	**TRANSPORT MANAGEMENT SYSTEM**	**X44**
BUILDING RENOVATION (THERMAL ISOLATION, SUSTAINABILITY)	**X16**	**WAREHOUSE SAFETY BARRIERS**	**X45**
COLD ROOM RENOVATION (CSR, BUSINESS OPPORTUNITY)	**X17**	**WMS VOICE PICKING (PRODUCTIVITY)**	**X46**
CONTAINER LOADING OPTIMIZATION SOFTWARE	**X18**	**WMS VOICE PICKING (PRODUCTIVITY)**	**X47**
CONVEYOR FOR BULK UNLOADING (PRODUCTIVITY)	**X19**	**WMS VOICE PICKING (PRODUCTIVITY)**	**X48**
CONVEYOR FOR BULK UNLOADING (PRODUCTIVITY)	**X20**	**WMS VOICE PICKING (PRODUCTIVITY)**	**X49**
CO-PACKING SUSTAINABLE PACKAGING MACHINE	**X21**	**WMS VOICE PICKING (PRODUCTIVITY)**	**X50**
ECO-FRIENDLY PACKAGING MACHINE	**X22**	**WMS VOICE PICKING (PRODUCTIVITY)**	**X51**
ELECTRIC PALLET JACKS (PRODUCTIVITY, HSE)	**X23**	**MACHINE TO CREATE FILLING MATERIAL FROM USED CARTONS**	**X52**

ELECTRIC SHUTTLE BUS FOR WORKERS (CSR, SUSTAINABILITY)	**X24**	**RENEWABLE ENERGY FOR WAREHOUSE (SUSTAINABILITY)**	**X53**
FLEET OF ELECTRIC TRUCK (SUSTAINABILITY, CSR)	**X25**	**CAGES FOR SPECIAL DANGEROUS GOODS STORAGE**	**X54**
HUMAN RESSOURCES SYSTEM (CSR, COSTS)	**X26**	**CARTON RECYCLING MACHINE (FILLING MATERIAL)**	**X55**
IT HARDWARE UPGRADE	**X27**	**RENEWABLE ENERGY FOR WAREHOUSE (SUSTAINABILITY)**	**X56**
MACHINE TO CREATE FILLING MATERIAL FROM USED CARTONS	**X28**	**BUILD VOLUMES FORECASTING CAPABILITIES FOR THE CUSTOMER**	**X57**
MEZZANINE CONSTRUCTION (SPACE, COSTS)	**X29**	**IMPLEMENT RFID SOLUTION TO FACILIATE THE STORE RECEIVING FOR THE CUSTOMER**	**X58**

Objective Function: The total maximized ROI from the selected projects.

Maximize ($750*X_1 + 180{,}000*X_2 + 213{,}600*X_3 ... +6{,}700*X_{58}$)

$$\textbf{ROI} = \sum_{I=0}^{58} Xi * Ri$$

Constraints:

The management along with non-financial objective has also provided the constraint on the total budget allocation amount for these objectives, which are as follows:

1. Total Available Budget is $5 M
    a. First Year budget allocation should not exceed $1.4 M
    b. Second Year budget allocation should not exceed $1.7 M
    c. Third Year budget allocation should not exceed $1.9 M
2. Total Budget for Sustainability projects should be at least $1.5 M

3. Total Budget for Digital Transformation projects should be at least $1 M
4. Total Budget for Operational Excellence projects should be at least $1 M
5. All projects of Transport Management Systems must be selected because they generate high ROI in all three non-financial objectives as can be seen in the data above.
6. All values of the decision variable are binary i.e., either 1 or 0.

Constraints Estimation:

Constraint	Equation	Explanation
Budget Limitations	$\sum_{i=0}^{58} Xi * Ci,j \leq Lj$ ***Ci, j* = cost of the project *i* for the year j** ***Lj* = budget limit for the year *j*** **Budget Year 1 ≤ $1.4 million** **Budget Year 2 ≤ $1.7 million** **Budget Year 3 ≤ $1.9 million**	**The company has a budget of $5 million which was split in three years:** **a. Year 1 - $1.4 million** **b. Year 2 - $1.7 million** **c. Year 3 - $1.9 million**
Non-Financial Objectives	$\sum_{j=0}^{2}\sum_{i=0}^{55} Xi * Ci,j * 0i \geq 0min$ $\sum_{j=0}^{2}\sum_{i=0}^{55} Xi * Ci,j * Si \geq Smin$ $\sum_{j=0}^{2}\sum_{i=0}^{55} Xi * Ci,j * Di \geq Dmin$	**The non-financial objectives of the company are as follows:** **The minimum budget is as follows:** **a. Sustainable Development - $1.5 million.** **b. Digital Transformation and Operational Excellence - $1M each.**

	***Omin*: minimum budget for operational excellence.** ***Smin:* minimum budget for sustainability** ***Dmin:* minimum budget for digital transformation**	
Transport Management Systems	**X_{42}, X_{43}, X_{44} have to go together**	**If X_{42} is selected, then X_{43}, X_{44} must be selected.**

Initial Budget Allocation:

Before running Solver, we decided to see what budget allocations we would see if we built the model without management's new guidelines for non-financial objectives. The following results were observed:

1. Out of 58, 36 projects were selected.
2. $4,069,150 were used for total budget allocation (81% of total budget).
3. Total ROI on the investment was $1,050,977.

Solution Results and Analysis:

We ran our Integer Linear programming Model in MS excel and observed the following results.

1. Out of 58, 35 projects were selected.
2. $4,579,150 were used for total budget allocation (91.5% of total budget).
3. Total ROI on the investment was $889,653.

PROJECT NUMBER	PROJECT DESCRIPTION	Decision variables	ROI	Value	Cost of project YEAR 1	Cost of project YEAR 2	Cost of project YEAR 3	SUSTAINABILITY	DIGITAL TRANSFORMATION	OPERATIONAL EXCELLENCE	Cost of 3 year total
1	5S VISUAL MANAGEMENT	X1	- 750	0	$ 11,500	$ 3,500	$ 2,450	0	0	1	$ 17,450
2	ADDITIONAL SPACE WITH RACKING	X2	180,000	1	$ 200,000	$ 250,000	$ 300,000	0	0	0	$ 750,000
3	ADDITIONAL SPACE WITH RACKING	X3	213,600	1	$ 220,000	$ 320,000	$ 350,000	0	0	0	$ 890,000
4	ADDITIONAL SPACE WITH RACKING	X4	49,875	0	$ 75,000	$ 100,000	$ 110,000	0	0	0	$ 285,000
5	ADDITIONAL SPACE WITH RACKING	X5	70,620	1	$ 90,000	$ 110,000	$ 130,000	0	0	0	$ 330,000
6	ADDITIONAL RACKING	X6	51,750	0	$ 115,000	$ 115,000	$ 115,000	0	0	0	$ 345,000
7	AIR CONDITIONING FOR OFFICE (HSE)	X7	- 17,500	0	$ 35,000	$ 35,000	$ 35,000	0	0	0	$ 105,000
8	AUTOMATED ACCESS POINT WITH FINGERPRINT FOR WORKFORCE MANAGEMENT	X8	- 3,750	0	$ 1,875	$ 1,875	$ 1,875	0	1	0	$ 5,625
9	AUTOMATED GUIDED VEHICLES	X9	- 30,000	0	$ 200,000	$ 200,000	$ 200,000	0	1	1	$ 600,000
10	AUTOMATED ORDER PICKER (PRODUCTIVITY)	X10	16,500	1	$ 65,000	$ 50,000	$ 50,000	0	1	1	$ 165,000
11	AUTOMATED WRAPPING MACHINE (SUSTAINABILITY, PRODUCTIVITY)	X11	3,150	1	$ 3,000	$ 3,000	$ 3,000	1	1	1	$ 9,000
12	AUTOMATED WRAPPING MACHINE (SUSTAINABILITY, PRODUCTIVITY)	X12	3,150	1	$ 3,000	$ 3,000	$ 3,000	1	0	1	$ 9,000
13	AUTOMATIC DIMENSIONING SYSTEM TO MEASURE INBOUND CARTONS	X13	-	1	$ 2,000	$ 2,000	$ 2,000	0	1	1	$ 6,000
14	AUTONOMOUS ROBOT FOR INVENTORY STOCK COUNT (PRODUCTIVITY)	X14	9,375	1	$ 12,500	$ 12,500	$ 12,500	0	1	1	$ 37,500
15	AUTONOMOUS SCALE FOR PARCEL DOUBLE CHECK BEFORE PACKING	X15	443	1	$ 3,250	$ 2,800	$ 2,800	0	1	1	$ 8,850
16	BUILDING RENOVATION (THERMAL ISOLATION, SUSTAINABILITY)	X16	- 15,000	0	$ 100,000	$ 25,000	$ 25,000	1	0	1	$ 150,000
17	COLD ROOM RENOVATION (CSR, BUSINESS OPPORTUNITY)	X17	- 15,000	0	$ 100,000	$ 100,000	$ 100,000	1	0	1	$ 300,000
18	CONTAINER LOADING OPTIMIZATION SOFTWARE	X18	33,750	1	$ 2,250	$ -	$ -	1	0	1	$ 2,250
19	CONVEYOR FOR BULK UNLOADING (PRODUCTIVITY)	X19	2,775	1	$ 1,850	$ -	$ -	0	0	1	$ 1,850
20	CONVEYOR FOR BULK UNLOADING (PRODUCTIVITY)	X20	10,350	1	$ -	$ 4,500	$ -	0	0	1	$ 4,500
21	CO-PACKING SUSTAINABLE PACKAGING MACHINE	X21	1,620	1	$ 5,400	$ 5,400	$ 5,400	1	0	1	$ 16,200
22	ECO-FRIENDLY PACKAGING MACHINE	X22	13,200	1	$ 22,000	$ 22,000	$ 22,000	1	0	1	$ 66,000
23	ELECTRIC PALLET JACKS (PRODUCTIVITY, HSE)	X23	225	1	$ 9,800	$ 9,800	$ 9,800	0	0	1	$ 29,400
24	ELECTRIC SHUTTLE BUS FOR WORKERS (CSR, SUSTAINABILITY)	X24	- 18,000	0	$ 14,500	$ 14,500	$ 14,500	1	0	0	$ 43,500
25	FLEET OF ELECTRIC TRUCK (SUSTAINABILITY, CSR)	X25	- 45,000	1	$ 300,000	$ 300,000	$ 300,000	1	0	1	$ 900,000
26	HUMAN RESSOURCES SYSTEM (CSR, COSTS)	X26	2,250	1	$ -	$ 15,000	$ 15,000	0	0	1	$ 30,000
27	IT HARDWARE UPGRADE	X27	19,800	1	$ 75,000	$ 45,000	$ 45,000	0	1	1	$ 165,000
28	MACHINE TO CREATE FILLING MATERIAL FROM USED CARTONS	X28	- 1,555	0	$ 11,400	$ 9,850	$ 9,850	1	0	1	$ 31,100
29	MEZZANINE CONSTRUCTION (SPACE, COSTS)	X29	- 15,750	0	$ 150,000	$ 200,000	$ 220,000	0	0	0	$ 570,000
30	NEW MODERN CANTEEN	X30	- 45,000	0	$ 22,000	$ 22,000	$ 22,000	0	0	0	$ 66,000
31	NEW MODERN CANTEEN	X31	- 26,250	0	$ 8,750	$ 8,750	$ 8,750	0	0	0	$ 26,250
32	NEW UNIFORMS FOR OPERATORS	X32	- 2,250	0	$ -	$ -	$ 2,250	0	0	1	$ 2,250
33	NEW UNIFORMS FOR OPERATORS	X33	- 2,200	0		$ 2,200		0	0	1	$ 2,200
34	ORDER MANAGEMENT SYSTEM (PROD, LESS PAPER)	X34	75,000	1	$ 5,000	$ 5,000	$ 5,000	1	1	1	$ 15,000
35	ORDER MANAGEMENT SYSTEM (PROD, LESS PAPER)	X35	32,970	1	$ 6,250	$ 800	$ 800	1	0	1	$ 7,850
36	PALLETIZATION ROBOT (PRODUCTIVITY)	X36	1,065	1	$ 7,100	$ 7,100	$ 7,100	0	1	1	$ 21,300
37	PALLETIZATION ROBOT (PRODUCTIVITY)	X37	4,973	1	$ 11,050	$ 11,050	$ 11,050	0	0	1	$ 33,150
38	PASSIVE EXOSKELETON (CSR)	X38	- 29,400	0	$ 9,800	$ 9,800	$ 9,800	0	0	0	$ 29,400
39	RENEWABLE ENERGY FOR WAREHOUSE (SUSTAINABILITY)	X39	- 22,500	0	$ 150,000	$ 150,000	$ 150,000	1	0	0	$ 450,000
40	SPRINKLER IN RACKS (CSR, SAFETY, BUSINESS OPPORTUNITIES)	X40	1,050	0	$ 34,000	$ 35,000	$ 35,000	0	0	0	$ 104,000
41	SPRINKLER IN RACKS (CSR, SAFETY, BUSINESS OPPORTUNITIES)	X41	- 36,750	0	$ 24,500	$ 24,500	$ 24,500	0	0	0	$ 73,500
42	TRANSPORT MANAGEMENT SYSTEM	X42	36,000	1	$ 15,000	$ 15,000	$ 15,000	1	1	1	$ 45,000
43	TRANSPORT MANAGEMENT SYSTEM	X43	40,000	1		$ 25,000	$ 25,000	1	1	1	$ 50,000
44	TRANSPORT MANAGEMENT SYSTEM	X44	18,400	1	$ 11,500	$ 11,500		1	1	1	$ 23,000
45	WAREHOUSE SAFETY BARRIERS	X45	- 1,500	0	$ -	$ -	$ 12,000	0	0	0	$ 12,000
46	WMS VOICE PICKING (PRODUCTIVITY)	X46	4,050	1	$ 9,000	$ 9,000	$ 9,000	0	1	1	$ 27,000
47	WMS VOICE PICKING (PRODUCTIVITY)	X47	19,800	1	$ 12,000	$ 12,000	$ 12,000	0	0	1	$ 36,000
48	WMS VOICE PICKING (PRODUCTIVITY)	X48	5,310	1	$ 6,000	$ 6,000	$ 6,000	0	0	1	$ 18,000
49	WMS VOICE PICKING (PRODUCTIVITY)	X49	15,938	1	$ 8,500	$ 8,500	$ 8,500	0	0	1	$ 25,500
50	WMS VOICE PICKING (PRODUCTIVITY)	X50	17,160	1	$ 8,800	$ 8,800	$ 8,800	0	0	1	$ 26,400
51	WMS VOICE PICKING (PRODUCTIVITY)	X51	49,280	1	$ -	$ 11,200	$ 11,200	0	0	1	$ 22,400
52	MACHINE TO CREATE FILLING MATERIAL FROM USED CARTONS	X52	1,800	1	$ 12,000	$ 12,000	$ 12,000	1	0	0	$ 36,000
53	RENEWABLE ENERGY FOR WAREHOUSE (SUSTAINABILITY)	X53	3,000	0	$ 20,000	$ 20,000	$ 20,000	1	0	0	$ 60,000
54	CAGES FOR SPECIAL DANGEROUS GOODS STORAGE	X54	11,700	0	$ 45,000	$ 45,000	$ 66,000	0	0	0	$ 156,000
55	CARTON RECYCLING MACHINE (FILLING MATERIAL)	X55	100	1	$ 2,000	$ -	$ -	1	0	0	$ 2,000
56	RENEWABLE ENERGY FOR WAREHOUSE (SUSTAINABILITY)	X56	32,000	1	$ 120,000	$ 100,000	$ 100,000	1	0	0	$ 320,000
57	BUILD VOLUMES FORECASTING CAPABILITIES FOR THE CUSTOMER	X57	-	1	$ 150,000	$ 150,000	$ 150,000	0	1	0	$ 450,000
58	IMPLEMENT RFID SOLUTION TO FACILIATE THE STORE RECEIVING FOR THE CUSTOMER	X58	- 6,700	0	$ 85,000	$ 37,000	$ 12,000	1	1	0	$ 134,000
	BUDGET				$ 1,400,000	$ 1,700,000	$ 1,900,000				$ 5,000,000
											$ -
	Objective function - MAXIMIZE TOTAL ROI			$ 889,652.50							

Constraints	LHS		RHS
Year 1 budget	$ 1,399,250	<=	$ 1,400,000
Year 2 budget	$ 1,547,950	<=	$ 1,700,000
Year 3 budget	$ 1,631,950	<=	$ 1,900,000
Sustainability budget	$ 1,501,300	>=	$ 1,500,000
Digital transformation budget	$ 1,022,650	>=	$ 1,000,000
Operational excellent budget	$ 1,801,150	>=	$ 1,000,000
X42,43,44 has to go together	2	>=	2

Initial vs New Budget Allocation Comparison:

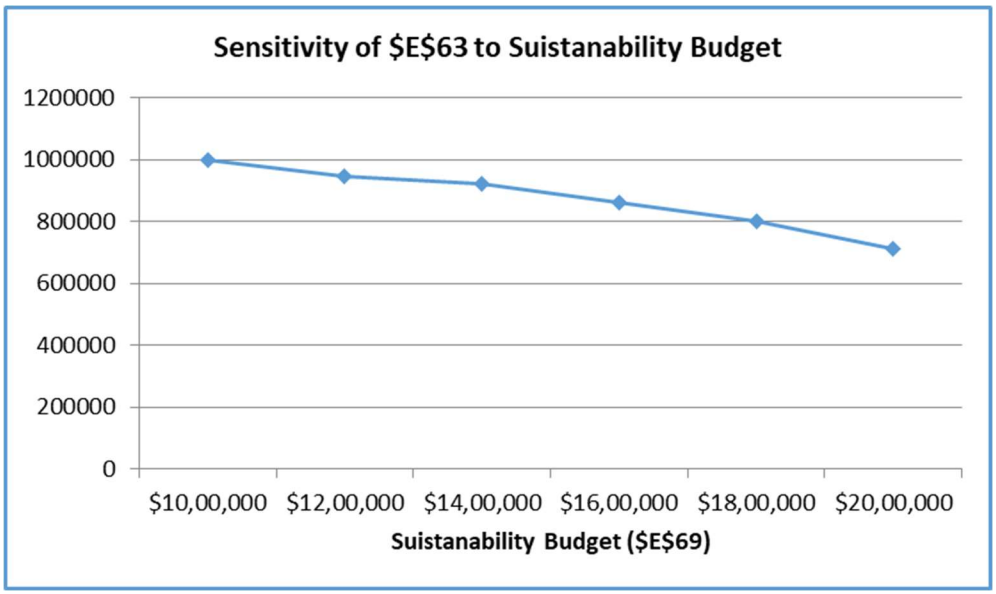
1. With new guidelines the utilization of available total budget has increased from 81% to 91.5% of the total budget.
2. The ROI has decreased from $1 M to $0.8 M. The decrease in the ROI is resulted from management's consideration of non-financial objectives.
3. The number of projects used for budget allocation has decreased from 36 to 35 projects.

Sensitivity Analysis:

One-way sensitivity analysis:

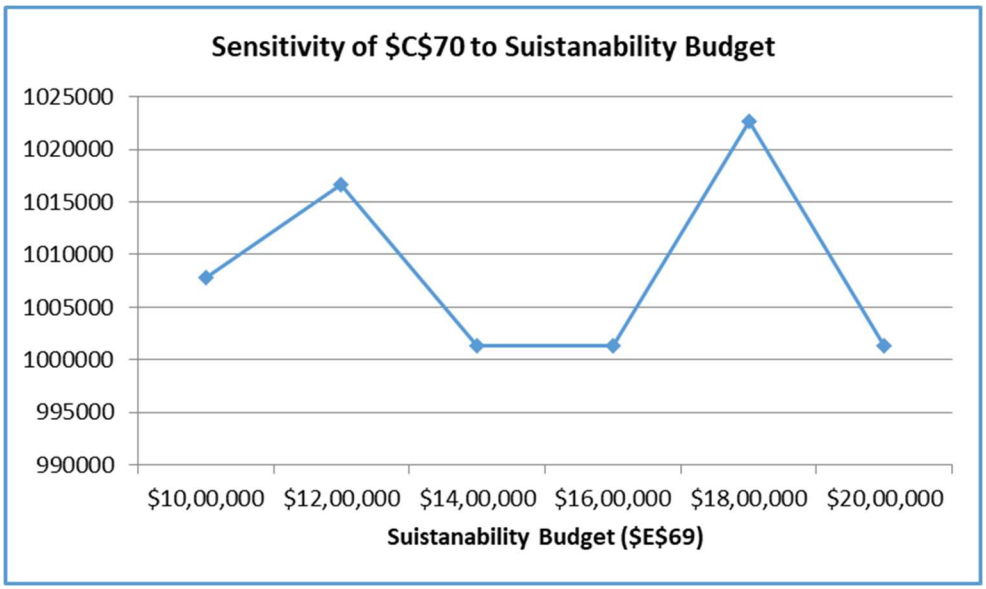
Using solver table for the non-linear programming model, we study how the value of the objective function (ROI) changes with respect to the change in allocated budget for sustainability

projects. We observe this change for the budget allocation for sustainability projects from $1 M to $2 M.

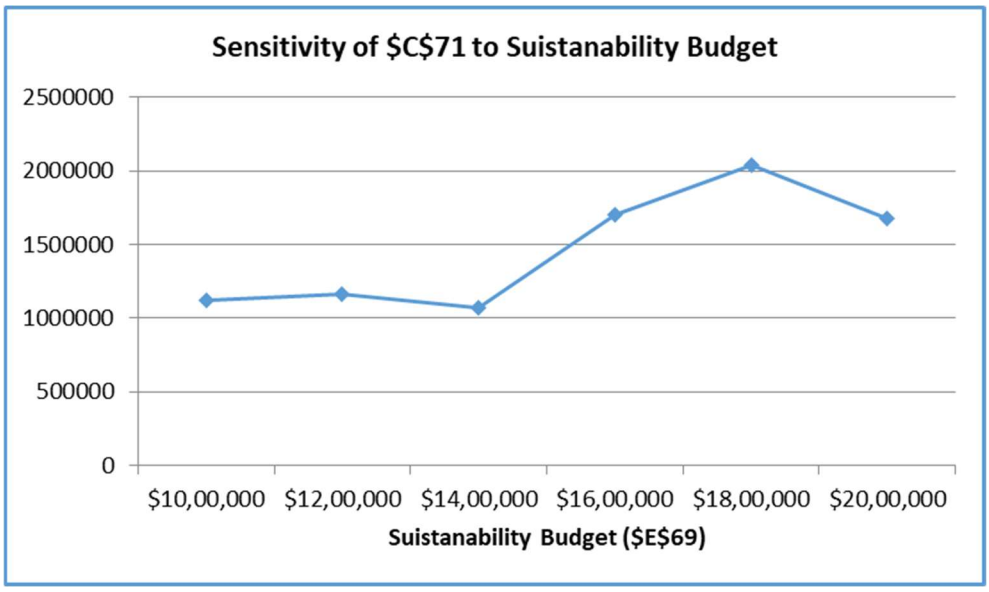


We can see that the value of the objective function(ROI) decreases as the minimum allocated budget for the sustainability project increases.

We can observe the impact of this budget change for sustainability projects on the Data Transformation and Operational Excellence as well.



Digital transformation budget gets least impacted with respect to change in the Sustainability allocated budget constraint.



Operational Excellent budget exceeds more than $ 2,000,000 when Sustainability budget at $1,800,000.

Oneway analysis for Solver model in LP Model worksheet

Suistanability Budget (cell E69) values along side, output cell(s) along top

	E63	C70	C71
$ 1,000,000	$ 1,000,637.50	$ 1,007,800	$ 1,123,750
$ 1,200,000	$ 944,902.50	$ 1,016,650	$ 1,165,750
$ 1,400,000	$ 922,417.50	$ 1,001,350	$ 1,073,800
$ 1,600,000	$ 863,080.00	$ 1,001,350	$ 1,699,300
$ 1,800,000	$ 800,035.00	$ 1,022,650	$ 2,038,600
$ 2,000,000	$ 712,417.50	$ 1,001,350	$ 1,673,800

The maximize optimal solution is sensitive to the minimum requirement of the sustainability budget, the more money required to spend on the Sustainability budget, the lower ROI we receive.

Two-way sensitivity analysis:

We also wanted to see how the budget allocation for the model will change if we change the Total minimum available budget for the 1st year along with change in the sustainability projects. We observed the sensitivity for following two parameters:

a. Total available budget for first year from $1M to $2M with a gap of $200K.

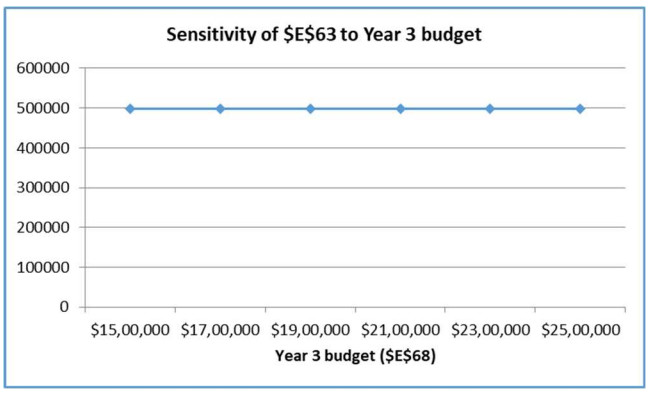
b. Minimum budget for sustainability projects from $1.5M to $2.5M with a gap of $200K.

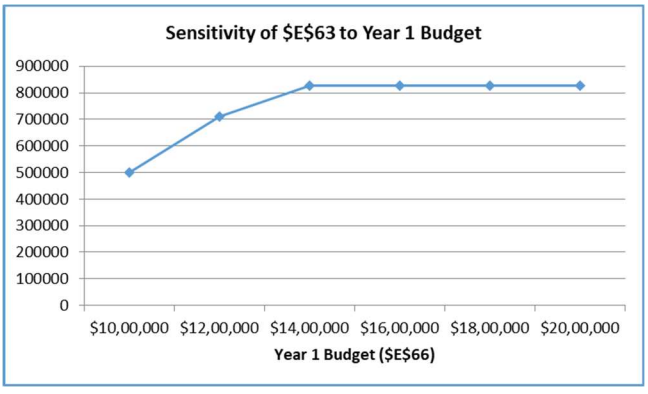
For two-way analysis, we can see the result in the following table:

E63	$ 1,500,000	$ 1,700,000	$ 1,900,000	$ 2,100,000	$ 2,300,000	$ 2,500,000
$ 1,000,000	$ 499,052.50	$ 499,052.50	$ 499,052.50	$ 499,052.50	$ 499,052.50	$ 499,052.50
$ 1,200,000	$ 709,652.50	$ 709,652.50	$ 709,652.50	$ 709,652.50	$ 709,652.50	$ 709,652.50
$ 1,400,000	$ 825,600.00	$ 889,652.50	$ 889,652.50	$ 889,652.50	$ 889,652.50	$ 889,652.50
$ 1,600,000	$ 825,600.00	$ 940,852.50	$ 977,122.50	$ 977,122.50	$ 977,122.50	$ 977,122.50
$ 1,800,000	$ 825,600.00	$ 941,662.50	$ 977,122.50	$ 977,122.50	$ 977,122.50	$ 977,122.50
$ 2,000,000	$ 825,600.00	$ 941,662.50	$ 977,122.50	$ 977,122.50	$ 977,122.50	$ 977,122.50

We can clearly observe that the value of the objective function has increased from $889,652 to $977,122.

- For Sustainability budget > $1.9 M and First Years budget > $1.6M, the value of the objective function is insensitive to further increments in the minimum budget for both parameters.
- Below is a graphical representation of the impact of the First Year and Third Year budget change on the ROI.





Conclusion

In this project using excel solver and excel solver table, we as a team demonstrated the optimal solution by selecting the right projects to achieve the maximum ROI and by adhering to the new guidelines by East Bay Logistic management.

We observed the new guidelines impact on the business of East Bay Logistics. The revenue has decreased whereas budget allocation from the total available budget has increased. The increment in the total budget allocation is 10.5% and the total decrement in the ROI is $161,324.

We concluded from the model result that out of $1.4 M available budget for the first year, $1.39 M should be used. Out of $1.7 M for the second year, $1.6 M should be used. For the last year, out of $1.9 M only $1.6 should be allocated for the optimal solution.

The sustainability projects, digital transformation, and operational excellence should receive $1.5 M, $1 M, and $1.8 M respectively.

Conclusion Highlights:

1. To maximize return on investment, 91.5% of the available budget should be used.
2. Only 35 projects from the given 58 projects are selected to achieve the objective of the business requirement.
3. The maximum return on investment is $800 K for the optimize linear programing model.

Limitations:

- We assume that once the projects are started, they would not be stopped.
- In reality, when conditions become unideal, there is a possibility that the company can withdraw from the project to save money.

- The Excel Solver only works with 200 variables. In this case, if the company had more than 200 projects, the model would not work.

Citations

Githubm, 15 Apr. 2022, https://github.com/samirsaci/budget-planning.

Githubm, Microsoft Excel file. Web.15 Apr. 2022, https://github.com/samirsaci/budget-planning/blob/main/warehouses.xlsx.