Investigating Tesla's Supply Chain and Battery Constraints Alternatives Based on Analytical Hierarchy Process (AHP)

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Abstract: This case study explores the challenges faced by Tesla, a leading electric vehicle (EV) manufacturer, in managing its supply chain and overcoming battery constraints. It provides an overview of Tesla's growth trajectory, the significance of its supply chain, and the critical role of batteries in its operations. The study examines the key challenges Tesla has encountered, the impact on its production and delivery capabilities, and the measures taken by the company to address these constraints.

Keywords: Analytical Hierarchy Process (AHP), Pairwise Comparison, Supply Chain, Supplier Selection.

I. Introduction

Upply chain is a critical process that significantly impacts the performance and Ssuccess of businesses. Choosing the right suppliers can contribute to operational efficiency, product quality, customer satisfaction, and overall profitability.

This paper proposes a decision support system tailored to aid in the optimal selection of supplier companies within this context. The study identifies six main factors, namely effectiveness, feasibility, cost efficiency, risk mitigation, scalability, and stakeholder impact, along with around eighteen sub-factors for supplier selection.

The proposed decision support system leverages the Analytic Hierarchy Process (AHP) algorithm, a widely recognized and effective multi-criteria decision-making method. AHP allows decision-makers to structure and prioritize the identified factors and sub-factors based on their relative importance and impact. By utilizing AHP, the system facilitates a rapid and optimal selection of supply chain partners.

II. Problem Description

Tesla faces significant challenges in managing their supply chain and battery constraints. As production volumes increase and sustainability becomes a key focus, the availability of high-quality batteries and efficient supply chain management are crucial for success. However, these constraints pose several problems such as battery supply shortages, dependence on suppliers, global supply chain complexities, quality control, environmental concerns, cost management, and scalability. Therefore, there is a pressing need to identify strategic measures that can effectively resolve supply chain and battery constraints, allowing companies like Tesla to optimize their production and delivery capabilities while ensuring customer satisfaction and profitability.

III. Methodology

In the project focused on evaluating alternatives for resolving supply chain and battery constraints, a combined methodology utilizing both Analytic Hierarchy Process (AHP) and AHP software was employed.

The methodology began with the establishment of a decision hierarchy, which involved structuring the criteria, sub-criteria, and alternatives in a hierarchical format. This hierarchy provided a clear representation of the decision-making factors and their relationships.

By integrating AHP with the Analytical Hierarchy Process (AHP) software, the methodology ensured a structured and systematic evaluation of the alternatives. It allowed for a comprehensive assessment of the criteria and sub-criteria, capturing the decision-maker's preferences through pairwise comparisons, and deriving priority scores to facilitate quantitative analysis.

IV. Criteria and Sub-Criteria

When evaluating alternatives for resolving supply chain and battery constraints, it is essential to establish a set of criteria and sub-criteria to assess the performance and suitability of each option. These criteria serve as guiding factors that allow for a comprehensive and structured evaluation process. In this project, a total of six criteria and eighteen sub-criteria were utilized to evaluate the alternatives for resolving supply chain and battery constraints. The selection of these criteria and sub-criteria was undertaken through an analysis and careful consideration of multiple factors. Table 1A presents the identified criteria and sub-criteria, and Figure 1C illustrates the proposed AHP model. Table 2A presents Thomas Saaty's nine-point scale (Saaty, 1994), which we utilize to assign scores for criteria, sub-criteria, and alternatives in our evaluation process. The scores assigned to criteria, sub-criteria, and alternatives can be found in Tables 3B to 29B.

V. Risk Management

After choosing criteria and sub-criteria, the potential risks associated with each Tesla's battery supply alternative should be considered using the Analytic Hierarchy Process (AHP) theory. Our evaluation is based on several key criteria and sub-criteria that are vital to ensuring the successful implementation and sustainability of the chosen alternative. The criteria considered include supply chain reliability, cost and financial risks, technological risks, regulatory and environmental risks, scalability and capacity risks, collaborative risks, and geopolitical risks. For each criterion, we have identified relevant sub-criteria to delve deeper into specific risk factors (Figure 2C). By considering these risks, we aim to provide decision-makers with valuable insights into the potential challenges and vulnerabilities associated with outsourcing, vertical integration, gigafactories, advanced robotics and automation, R&D collaboration, and supplier relationships. By understanding and mitigating these risks proactively, stakeholders can make well-informed choices to establish a robust and resilient electric car battery supply chain that meets the industry's growing demands while safeguarding against potential disruptions and uncertainties.

VI. Steps of the AHP Process

The Analytical Hierarchy Process (AHP) proposes several steps for supplier selection. These steps are as follows:

1. Define the overall objective.
2. Establish a structured hierarchy comprising attributes (criteria for supplier selection) and alternatives.
3. Determine the priority weights of the attributes using pair-wise comparison matrices and consistency ratios.
4. Determine the priority weights of alternatives concerning attributes by creating pair-wise comparison matrices for each criterion and calculating their consistency ratios.
5. Calculate the overall priority weights for all elements.

Once the hierarchy is established, the subsequent step involves determining the priorities of elements at each level. To achieve this, comparison matrices are constructed, comparing each element within a level to an element of the immediately higher level. These matrices help prioritize and convert subjective judgments into ratio scale measurements. The preferences are quantified using a nine-point scale, with the meanings of each scale measurement explained in Table 3.

At the subsequent level, we input our criteria, sub-criteria, and alternatives along with their respective scores into the Analytical Hierarchy Process (AHP) software. The outcome of this input can be observed in Table 29B, where the results are presented.

VII. Conclusion

In conclusion, the evaluation of alternatives using the AHP methodology has provided valuable insights into the priorities for resolving supply chain and battery constraints within the context of our study. The analysis involved considering various attributes and assigning weighted values to determine the global priorities of the alternatives. All the tables and values assigned were consistent according to their CR value.

Based on the results, the global priorities of the alternatives are as follows: Outsourcing (0.251), Vertical Integration (0.199), Gigafactories (0.197), Advanced Robotics and Automation (0.147), R&D Collaboration (0.116), and Supplier Relationships (0.091). (See table 28B and table 29B) These priorities reflect the relative importance and impact of each alternative in addressing the identified constraints.

The prioritization of alternatives was determined through a systematic evaluation of the attributes and their weighted values. The attributes considered in the analysis included effectiveness, feasibility, cost efficiency, risk mitigation, scalability, and stakeholder impact. By assigning appropriate weights to these attributes, the relative importance of each attribute was considered during the decision-making process (See figure 3C).

The prioritization of alternatives is visually represented in the priorities chart, where the global priorities are presented in descending order. This chart provides a clear overview of the ranking of alternatives based on their relative importance.

Additionally, the Attributes chart (See figure 4C) illustrates the importance of each attribute in the decision-making process. It showcases the relative weights assigned to each attribute, indicating their significance in the evaluation.

Furthermore, the Weighted Attributes chart (See figure 5C) presents the weighted values

assigned to each attribute for every alternative. This chart offers a comprehensive view of how each alternative performs across the various attributes, allowing decision-makers to identify the strengths and weaknesses of each alternative.

These charts serve as visual aids that facilitate a better understanding of the prioritization process and enable decision-makers to make informed choices based on the relative importance of the attributes and the performance of the alternatives.

In conclusion, the analysis using the AHP methodology, supported by all consistent analysis, the Priorities, Attributes, and Weighted Attributes charts, has provided a comprehensive evaluation of the alternatives and their relative priorities in addressing supply chain and battery constraints. These insights can guide decision-makers in selecting the most suitable strategic measure for optimizing supply chain operations, improving production and delivery capabilities, and enhancing overall performance.

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Appendix A
Information needed for the project

Table 1A: Criteria and sub-criteria of the project

Criteria	Sub-criteria	
Effectiveness	E1	Impact on resolving supply chain and battery constraints
	E2	Improvement in production and delivery capabilities
	E3	Reduction of delays and customer dissatisfaction
Feasibility	F1	Implementation feasibility of the strategic measure
	F2	Availability of necessary resources
	F3	Timeframe for implementation and expected results
Cost Efficiency	C1	Cost-effectiveness of the strategic measure
	C2	Reduction in supply chain costs
	C3	Return on investment and long-term financial benefits
Risk Mitigation	R1	Reduction of risks associated with supply chain and battery constraints
	R2	Minimization of dependence on specific suppliers or external factors
	R3	Enhanced resilience against potential disruptions
Scalability	S1	Potential for scaling up the strategic measure to meet growing demand
	S2	Adaptability to future changes and expansion
	S3	Ability to accommodate increasing production volumes
Stakeholder Impact	SI1	Customer satisfaction and fulfillment of customer expectations
	SI2	Positive impact on shareholders and investors
	SI3	Social and environmental sustainability considerations

Table 2A: Thomas Saaty's nine-point scale

Intensity of importance	Definition	Explanations
1	Equal importance	Two activities contribute equally to the objective
3	Weak importance of one over another	Experience and judgment slightly favor one activity over another
5	Essential or strong important	Experience and judgment strongly favor one activity over another
7	Demonstrated importance	An activity is favored very strongly over another; its dominance demonstrated in practice
9	Absolute importance	The evidence favoring one activity over another is of the highest possible order of affirmation
2,4,6,8	Intermediate values between the two adjacent judgment	When compromise is needed
Reciprocals of above nonzero	If activity I has one of the above non zero numbers assigned to it when compared with activity j, then has the reciprocal value when	A reasonable assumption

Appendix B
Evaluation process

Table 3B: Criteria

Criteria	Effectiveness	Feasibility	Cost efficiency	Risk mitigation	Scalability	Stakeholder impact	Priorities
Effectiveness	1	1	3	5	5	5	0.327731273
Feasibility	1	1	3	3	5	7	0.309974592
Cost efficiency	0.333333333	0.333333333	1	1	3	5	0.133337636
Risk mitigation	0.2	0.333333333	1	1	5	3	0.129114368
Scalability	0.2	0.2	0.333333333	0.2	1	3	0.061568582
Stakeholder impact	0.2	0.142857143	0.2	0.333333333	0.333333333	1	0.038273548
*** Consistency Ratio calculated as**	**0.065**						

Table 4B: Sub-criteria of Effectiveness

Effectiveness 0.327731273202342	E1	E2	E3	Priorities
E1	1	3	4	0.607962213
E2	0.333333333	1	3	0.272098516
E3	0.25	0.333333333	1	0.119939271
*** Consistency Ratio calculated as**	**0.064**			

Table 5B: Sub-criteria of Feasibility

Feasibility 0.309974592470978	F1	F2	F3	Priorities
F1	1	3	7	0.643388869
F2	0.333333333	1	5	0.282839025
F3	0.142857143	0.2	1	0.073772106
*** Consistency Ratio calculated as**	**0.056**			

Table 6B: Sub-criteria of Cost efficiency

Cost efficiency 0.133337635549074	C1	C2	C3	Priorities
C1	1	3	7	0.632473118
C2	0.333333333	1	6	0.29812596
C3	0.142857143	0.166666667	1	0.069400922
*** Consistency Ratio calculated as**	**0.087**			

Table 7B: Sub-criteria of Risk mitigation

Risk mitigation 0.129114368394773	R1	R2	R3	Priorities
R1	1	3	5	0.619352089
R2	0.333333333	1	4	0.284228474
R3	0.2	0.25	1	0.096419437
*** Consistency Ratio calculated as**	**0.075**			

Table 8B: Sub-criteria of Scalability

Scalability 0.0615685823479227	S1	S2	S3	Priorities
S1	1	5	7	0.723506057
S2	0.2	1	3	0.19318606
S3	0.142857143	0.333333333	1	0.083307883
*** Consistency Ratio calculated as**	**0.057**			

Table 9B: Sub-criteria of Stakeholder impact

Stakeholder impact 0.0382735480349104	SI1	SI2	SI3	Priorities
SI1	1	1	1	0.333333333
SI2	1	1	1	0.333333333
SI3	1	1	1	0.333333333
*** Consistency Ratio calculated as**	**0**			

Table 10B: Pairwise Comparisons of Options for Criteria- E1 from all Options

E1 0.607962213225371	Vertical Integration	Gigafactories	Supplier Relationships	Outsourcing	Advanced Robotics and Automation	R&D Collaboration	Priorities
Vertical Integration	1	2	3	2	4	3	0.329761905
Gigafactories	0.5	1	2	1	3	2	0.193187831
Supplier Relationships	0.333333333	0.5	1	0.5	2	0.5	0.097652116
Outsourcing	0.5	1	2	1	3	2	0.193187831
Advanced Robotics and Automation	0.25	0.333333333	0.5	0.333333333	1	0.5	0.063425926
R&D Collaboration	0.333333333	0.5	2	0.5	2	1	0.122784392
*** Consistency Ratio calculated as**	**0.015**						

Table 11B: Pairwise Comparisons of Options for Criteria- E2 from all Options

E2 0.272098515519568	Vertical Integration	Gigafactories	Supplier Relationships	Outsourcing	Advanced Robotics and Automation	R&D Collaboration	Priorities
Vertical Integration	1	1	2	0.5	2	0.5	0.160620017
Gigafactories	1	1	1	0.5	2	1	0.161845507
Supplier Relationships	0.5	1	1	2	0.5	0.5	0.135409933
Outsourcing	2	2	0.5	1	1	0.5	0.172955721
Advanced Robotics and Automation	0.5	0.5	2	1	1	0.5	0.128191661
R&D Collaboration	2	1	2	2	2	1	0.24097716
*** Consistency Ratio calculated as**	**0.096**						

Table 12B: Pairwise Comparisons of Options for Criteria- E3 from all Options

E3 0.119939271255061	Vertical Integration	Gigafactories	Supplier Relationships	Outsourcing	Advanced Robotics and Automation	R&D Collaboration	Priorities
Vertical Integration	1	5	5	2	1	3	0.327634547
Gigafactories	0.2	1	2	1	0.333333333	1	0.107366999
Supplier Relationships	0.2	0.5	1	0.5	1	0.5	0.079163342
Outsourcing	0.5	1	2	1	3	2	0.205415426
Advanced Robotics and Automation	1	3	1	0.333333333	1	2	0.177739795
R&D Collaboration	0.333333333	1	2	0.5	0.5	1	0.102679891
*** Consistency Ratio calculated as**	**0.098**						

Table 13B: Pairwise Comparisons of Options for Criteria- F1 from all Options

F1 0.643388869195321	Vertical Integration	Gigafactories	Supplier Relationships	Outsourcing	Advanced Robotics and Automation	R&D Collaboration	Priorities
Vertical Integration	1	0.333333333	2	0.333333333	0.5	0.333333333	0.092691377
Gigafactories	3	1	3	0.5	2	3	0.246371572
Supplier Relationships	0.5	0.333333333	1	0.5	0.5	2	0.103433429
Outsourcing	3	2	2	1	2	3	0.293851383
Advanced Robotics and Automation	2	0.5	2	0.5	1	2	0.158299797
R&D Collaboration	3	0.333333333	0.5	0.333333333	0.5	1	0.105352442
*** Consistency Ratio calculated as**	**0.081**						

Table 14B: Pairwise Comparisons of Options for Criteria- F2 from all Options

F2 0.282839024774509	Vertical Integration	Gigafactories	Supplier Relationships	Outsourcing	Advanced Robotics and Automation	R&D Collaboration	Priorities
Vertical Integration	1	3	4	0.333333333	0.333333333	3	0.192507083
Gigafactories	0.333333333	1	2	0.333333333	0.5	2	0.111598289
Supplier Relationships	0.25	0.5	1	0.333333333	0.5	0.5	0.067866678
Outsourcing	3	3	3	1	3	3	0.340564727
Advanced Robotics and Automation	3	2	2	0.333333333	1	2	0.198691021
R&D Collaboration	0.333333333	0.5	2	0.333333333	0.5	1	0.088772202
*** Consistency Ratio calculated as**	**0.09**						

Table 15B: Pairwise Comparisons of Options for Criteria- F3 from all Options

F3 0.0737721060301706	Vertical Integration	Gigafactories	Supplier Relationships	Outsourcing	Advanced Robotics and Automation	R&D Collaboration	Priorities
Vertical Integration	1	0.333333333	3	0.333333333	0.5	0.333333333	0.098635511
Gigafactories	3	1	3	2	0.5	0.333333333	0.190186021
Supplier Relationships	0.333333333	0.333333333	1	0.333333333	0.5	0.5	0.072483644
Outsourcing	3	0.5	3	1	1	1	0.194331535
Advanced Robotics and Automation	2	2	2	1	1	1	0.20379698
R&D Collaboration	3	3	2	1	1	1	0.240566308
*** Consistency Ratio calculated as**	**0.089**						

Table 16B: Pairwise Comparisons of Options for Criteria- C1 from all Options

C1 0.63247311827957	Vertical Integration	Gigafactories	Supplier Relationships	Outsourcing	Advanced Robotics and Automation	R&D Collaboration	Priorities
Vertical Integration	1	0.333333333	3	0.333333333	0.333333333	3	0.129239886
Gigafactories	3	1	2	0.333333333	0.5	3	0.171945179
Supplier Relationships	0.333333333	0.5	1	0.333333333	0.5	0.5	0.074965895
Outsourcing	3	3	3	1	0.5	3	0.256918345
Advanced Robotics and Automation	3	2	2	2	1	3	0.285619346
R&D Collaboration	0.333333333	0.333333333	2	0.333333333	0.333333333	1	0.081311348
*** Consistency Ratio calculated as**	**0.097**						

Table 17B: Pairwise Comparisons of Options for Criteria- C2 from all Options

C2 0.298125960061444	Vertical Integration	Gigafactories	Supplier Relationships	Outsourcing	Advanced Robotics and Automation	R&D Collaboration	Priorities
Vertical Integration	1	5	3	0.5	3	3	0.290963403
Gigafactories	0.2	1	4	1	2	3	0.193714294
Supplier Relationships	0.333333333	0.25	1	0.333333333	0.5	1	0.066380555
Outsourcing	2	1	3	1	2	5	0.275460326
Advanced Robotics and Automation	0.333333333	0.5	2	0.5	1	2	0.111671962
R&D Collaboration	0.333333333	0.333333333	1	0.2	0.5	1	0.06180946
*** Consistency Ratio calculated as**	**0.082**						

Table 18B: Pairwise Comparisons of Options for Criteria- C3 from all Options

C3 0.0694009216589862	Vertical Integration	Gigafactories	Supplier Relationships	Outsourcing	Advanced Robotics and Automation	R&D Collaboration	Priorities
Vertical Integration	1	0.333333333	3	1	0.5	0.5	0.123182261
Gigafactories	3	1	3	2	0.333333333	2	0.2258113
Supplier Relationships	0.333333333	0.333333333	1	0.333333333	0.5	0.5	0.071207812
Outsourcing	1	0.5	3	1	0.5	2	0.159334221
Advanced Robotics and Automation	2	3	2	2	1	2	0.288206258
R&D Collaboration	2	0.5	2	0.5	0.5	1	0.132258147
*** Consistency Ratio calculated as**	**0.077**						

Table 19B: Pairwise Comparisons of Options for Criteria-R1 from all Options

R1 0.619352088661552	Vertical Integration	Gigafactories	Supplier Relationships	Outsourcing	Advanced Robotics and Automation	R&D Collaboration	Priorities
Vertical Integration	1	0.333333333	3	0.333333333	2	2	0.152480894
Gigafactories	3	1	3	0.2	3	2	0.217583774
Supplier Relationships	0.333333333	0.333333333	1	0.333333333	0.5	0.5	0.063750735
Outsourcing	3	5	3	1	2	3	0.353209877
Advanced Robotics and Automation	0.5	0.333333333	2	0.5	1	2	0.122345679
R&D Collaboration	0.5	0.5	2	0.333333333	0.5	1	0.090629042
*** Consistency Ratio calculated as**	**0.096**						

Table 20B: Pairwise Comparisons of Options for Criteria-R2 from all Options

R2 0.284228473998295	Vertical Integration	Gigafactories	Supplier Relationships	Outsourcing	Advanced Robotics and Automation	R&D Collaboration	Priorities
Vertical Integration	1	3	3	0.333333333	2	3	0.237102558
Gigafactories	0.333333333	1	2	0.5	3	3	0.180192831
Supplier Relationships	0.333333333	0.5	1	0.333333333	1	1	0.085528679
Outsourcing	3	2	3	1	3	3	0.328820006
Advanced Robotics and Automation	0.5	0.333333333	1	0.333333333	1	1	0.086703215
R&D Collaboration	0.333333333	0.333333333	1	0.333333333	1	1	0.08165271
*** Consistency Ratio calculated as**	**0.051**						

Table 21B: Pairwise Comparisons of Options for Criteria-R3 from all Options

R3 0.0964194373401535	Vertical Integration	Gigafactories	Supplier Relationships	Outsourcing	Advanced Robotics and Automation	R&D Collaboration	Priorities
Vertical Integration	1	0.333333333	3	0.333333333	4	3	0.188340416
Gigafactories	3	1	2	1	3	3	0.267143402
Supplier Relationships	0.333333333	0.5	1	0.333333333	0.5	2	0.092740456
Outsourcing	3	1	3	1	3	3	0.281636156
Advanced Robotics and Automation	0.25	0.333333333	2	0.333333333	1	2	0.10448676
R&D Collaboration	0.333333333	0.333333333	0.5	0.333333333	0.5	1	0.06565281
*** Consistency Ratio calculated as**	**0.076**						

Table 22B: Pairwise Comparisons of Options for Criteria-S1 from all Options

S1 0.723506057212664	Vertical Integration	Gigafactories	Supplier Relationships	Outsourcing	Advanced Robotics and Automation	R&D Collaboration	Priorities
Vertical Integration	1	0.333333333	3	1	3	3	0.217796093
Gigafactories	3	1	3	1	2	3	0.286579162
Supplier Relationships	0.333333333	0.333333333	1	0.333333333	0.5	1	0.073921449
Outsourcing	1	1	3	1	2	2	0.217134717
Advanced Robotics and Automation	0.333333333	0.5	2	0.5	1	2	0.124236874
R&D Collaboration	0.333333333	0.333333333	1	0.5	0.5	1	0.080331705
*** Consistency Ratio calculated as**	**0.039**						

Table 23B: Pairwise Comparisons of Options for Criteria-S2 from all Options

S2 0.193186059927381	Vertical Integration	Gigafactories	Supplier Relationships	Outsourcing	Advanced Robotics and Automation	R&D Collaboration	Priorities
Vertical Integration	1	2	3	1	2	3	0.271998834
Gigafactories	0.5	1	2	1	2	3	0.202870047
Supplier Relationships	0.333333333	0.5	1	0.5	0.5	1	0.088395979
Outsourcing	1	1	2	1	2	3	0.225597319
Advanced Robotics and Automation	0.5	0.5	2	0.5	1	2	0.134360431
R&D Collaboration	0.333333333	0.333333333	1	0.333333333	0.5	1	0.076777389
*** Consistency Ratio calculated as**	**0.015**						

Table 24B: Pairwise Comparisons of Options for Criteria-S3 from all Options

S3 0.0833078828599545	Vertical Integration	Gigafactories	Supplier Relationships	Outsourcing	Advanced Robotics and Automation	R&D Collaboration	Priorities
Vertical Integration	1	2	3	1	2	3	0.270036184
Gigafactories	0.5	1	3	1	2	3	0.215050846
Supplier Relationships	0.333333333	0.333333333	1	0.333333333	0.5	1	0.075787151
Outsourcing	1	1	3	1	2	1	0.207475089
Advanced Robotics and Automation	0.5	0.5	2	0.5	1	2	0.132875074
R&D Collaboration	0.333333333	0.333333333	1	1	0.5	1	0.098775657
*** Consistency Ratio calculated as**	**0.037**						

Table 25B: Pairwise Comparisons of Options for Criteria-SI1 from all Options

SI1 0.333333333333333	Vertical Integration	Gigafactories	Supplier Relationships	Outsourcing	Advanced Robotics and Automation	R&D Collaboration	Priorities
Vertical Integration	1	0.5	2	2	1	2	0.197335194
Gigafactories	2	1	2	2	1	2	0.248471558
Supplier Relationships	0.5	0.5	1	0.5	0.5	1	0.100312334
Outsourcing	0.5	0.5	2	1	0.5	0.5	0.114639819
Advanced Robotics and Automation	1	1	2	2	1	1	0.195946305
R&D Collaboration	0.5	0.5	1	2	1	1	0.14329479
*** Consistency Ratio calculated as**	**0.035**						

Table 26B: Pairwise Comparisons of Options for Criteria-SI2 from all Options

SI2 0.333333333333333	Vertical Integration	Gigafactories	Supplier Relationships	Outsourcing	Advanced Robotics and Automation	R&D Collaboration	Priorities
Vertical Integration	1	0.333333333	2	3	0.333333333	0.5	0.12424239
Gigafactories	3	1	3	3	3	3	0.346049192
Supplier Relationships	0.5	0.333333333	1	1	0.333333333	0.5	0.0762379
Outsourcing	0.333333333	0.333333333	1	1	0.333333333	0.5	0.073413041
Advanced Robotics and Automation	3	0.333333333	3	3	1	3	0.241882526
R&D Collaboration	2	0.333333333	2	2	0.333333333	1	0.138174952
*** Consistency Ratio calculated as**	**0.06**						

Table 27B: Pairwise Comparisons of Options for Criteria-SI3 from all Options

SI3 0.333333333333333	Vertical Integration	Gigafactories	Supplier Relationships	Outsourcing	Advanced Robotics and Automation	R&D Collaboration	Priorities
Vertical Integration	1	3	2	1	2	2	0.251345042
Gigafactories	0.333333333	1	0.5	0.333333333	0.5	0.5	0.071916829
Supplier Relationships	0.5	2	1	0.5	0.5	2	0.130714414
Outsourcing	1	3	2	1	0.333333333	3	0.209746794
Advanced Robotics and Automation	0.5	2	2	3	1	2	0.236356694
R&D Collaboration	0.5	2	0.5	0.333333333	0.5	1	0.099920227
*** Consistency Ratio calculated as**	**0.063**						

Table 28B: Alternative's global Priorities

Option Name	Priorities
Vertical Integration	0.199
Gigafactories	0.197
Supplier Relationships	0.091
Outsourcing	0.251
Advanced Robotics and Automation	0.147
R&D Collaboration	0.116

Table 29B: Alternative's global priorities in detail

	Local weight	Sub criteria	Local weight	Global weight	Local weight						Global weight					
					Vertical Integration	Gigafactories	Supplier Relationships	Outsourcing	Advanced Robotics and Automation	R&D Collaboration	Vertical Integration	Gigafactories	Supplier Relationships	Outsourcing	Advanced Robotics and Automation	R&D Collaboration
Effectiveness	0.3277	E1	0.6080	0.1992	0.3298	0.1932	0.0977	0.1932	0.0634	0.1228	0.0657	0.0385	0.0195	0.0385	0.0126	0.0245
		E2	0.2721	0.0892	0.1606	0.1618	0.1354	0.1730	0.1282	0.2410	0.0143	0.0144	0.0121	0.0154	0.0114	0.0215
		E3	0.1199	0.0393	0.3276	0.1074	0.0792	0.2054	0.1777	0.1027	0.0129	0.0042	0.0031	0.0081	0.0070	0.0040
Feasibility	0.3100	F1	0.6434	0.1994	0.0927	0.2464	0.1034	0.2939	0.1583	0.1054	0.0185	0.0491	0.0206	0.0586	0.0316	0.0210
		F2	0.2828	0.0877	0.1925	0.1116	0.0679	0.3406	0.1987	0.0888	0.0169	0.0098	0.0060	0.0299	0.0174	0.0078
		F3	0.0738	0.0229	0.0986	0.1902	0.0725	0.1943	0.2038	0.2406	0.0023	0.0043	0.0017	0.0044	0.0047	0.0055
Cost efficiency	0.1333	C1	0.6325	0.0843	0.1292	0.1719	0.0750	0.2569	0.2856	0.0813	0.0109	0.0145	0.0063	0.0217	0.0241	0.0069
		C2	0.2981	0.0398	0.2910	0.1937	0.0664	0.2755	0.1117	0.0618	0.0116	0.0077	0.0026	0.0109	0.0044	0.0025
		C3	0.0694	0.0093	0.1232	0.2258	0.0712	0.1593	0.2882	0.1323	0.0011	0.0021	0.0007	0.0015	0.0027	0.0012
Risk mitigation	0.1291	R1	0.6194	0.0800	0.1525	0.2176	0.0638	0.3532	0.1223	0.0906	0.0122	0.0174	0.0051	0.0282	0.0098	0.0072
		R2	0.2842	0.0367	0.2371	0.1802	0.0855	0.3288	0.0867	0.0817	0.0087	0.0066	0.0031	0.0121	0.0032	0.0030
		R3	0.0964	0.0124	0.1883	0.2671	0.0927	0.2816	0.1045	0.0657	0.0023	0.0033	0.0012	0.0035	0.0013	0.0008
Scalability	0.0616	S1	0.7235	0.0445	0.2178	0.2866	0.0739	0.2171	0.1242	0.0803	0.0097	0.0128	0.0033	0.0097	0.0055	0.0036
		S2	0.1932	0.0119	0.2720	0.2029	0.0884	0.2256	0.1344	0.0768	0.0032	0.0024	0.0011	0.0027	0.0016	0.0009
		S3	0.0833	0.0051	0.2700	0.2151	0.0758	0.2075	0.1329	0.0988	0.0014	0.0011	0.0004	0.0011	0.0007	0.0005
Stakeholder impact	0.0383	SI1	0.3333	0.0128	0.1973	0.2485	0.1003	0.1146	0.1959	0.1433	0.0025	0.0032	0.0013	0.0015	0.0025	0.0018
		SI2	0.3333	0.0128	0.1242	0.3460	0.0762	0.0734	0.2419	0.1382	0.0016	0.0044	0.0010	0.0009	0.0031	0.0018
		SI3	0.3333	0.0128	0.2513	0.0719	0.1307	0.2097	0.2364	0.0999	0.0032	0.0009	0.0017	0.0027	0.0030	0.0013
											0.199	**0.197**	**0.091**	**0.251**	**0.147**	**0.116**
										Rank	2	3	6	1	4	5

Appendix C
Charts and Figures

Figure 1C: AHP model

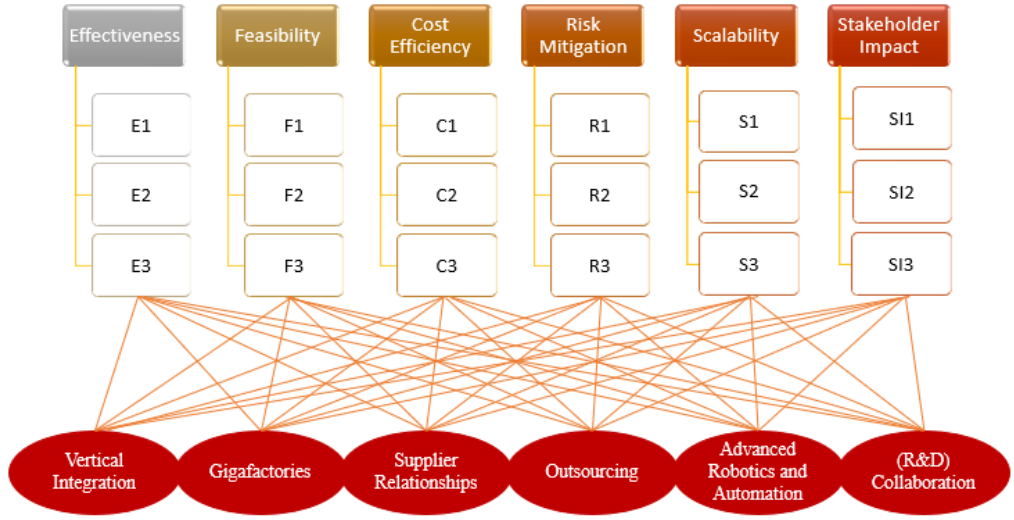

Figure 2C: Risk Assessment Criteria and sub-criteria

Figure 3C: Prioritization of alternatives

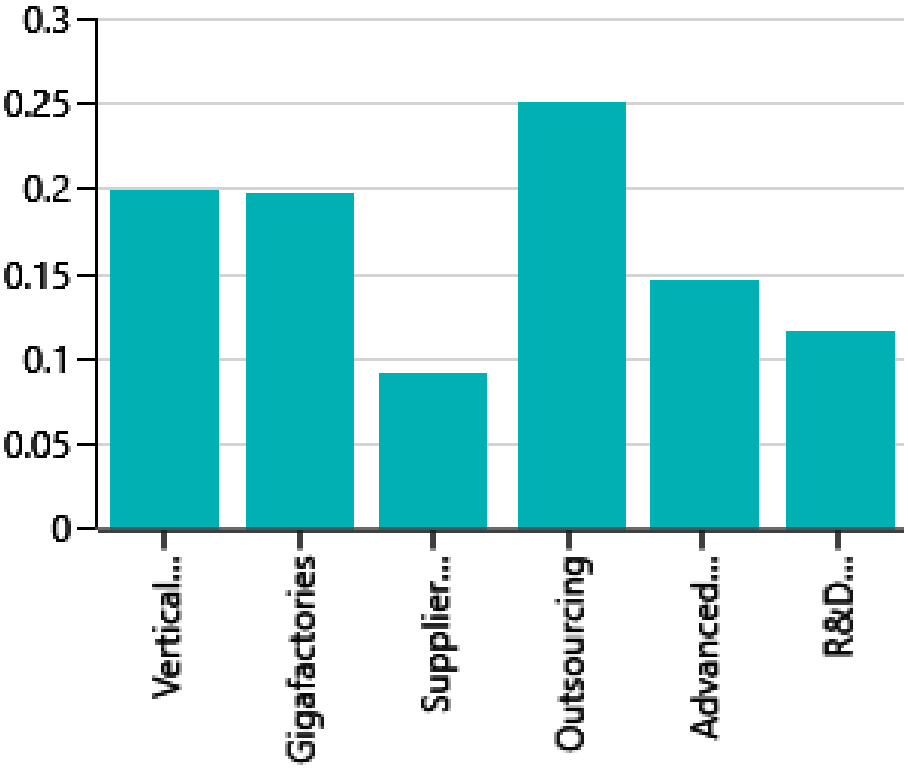

Figure 4C: Attributes chart

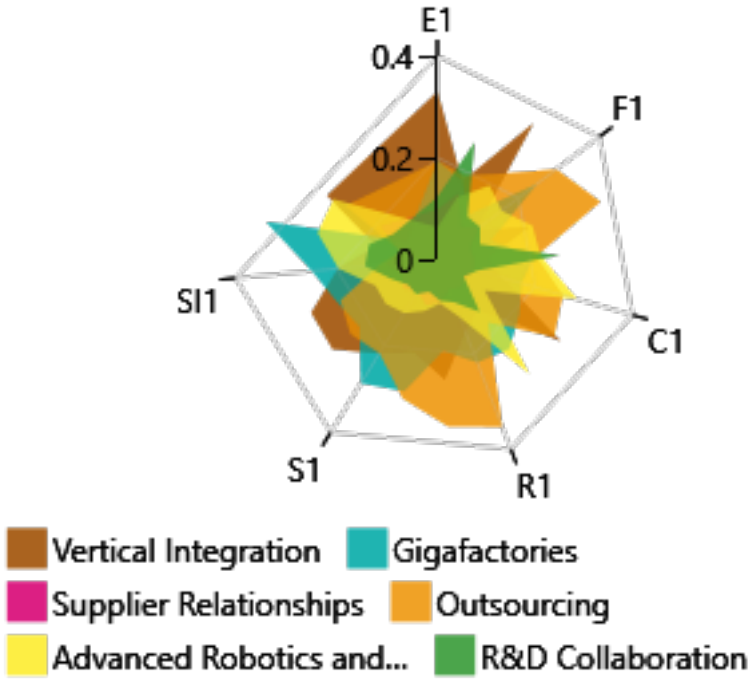

Figure 5C: Weighted Attributes chart