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Ranking of Production Units Using SWOT, AHP and RAPS Techniques

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Abstract
Strategic management is the process by which an organization formulates its objectives and manages to achieve them.
By application of AHP (Analytical Hierarchy Process), RAPS (Ranking Alternatives by Perimeter Similarity) and SWOT (Strengths, Weaknesses, Opportunities and Threats) analysis, the growth of the organization can be achieved smoothly.
By implementing correct methodologies for the analysis, it is possible to ensure that an organization will sustain forever.

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Introduction

Strategic management

Strategic management is the process by which an organization formulates its objectives and manages to achieve them. Strategy is the means to achieve the organizational ends. The interlocking of objectives and strategies characterize the effective management of an organization. The process binds co-ordinates and integrates the parts into a whole. Effective organizations are tied by means-ends chains into purposeful whole. The strategies to achieve corporate goals at higher levels often provide strategies or managers at lower levels.

Strategic management is a stream of decisions and actions which lead to the development of an effective strategy or strategies to help achieve corporate objectives. The strategic management process is the way in which strategists determine objectives and make strategic decisions. Strategic management can be found in various types of organizations, business, service, cooperative, government etc.

With the complexity in environment, predicting the future with accuracy is difficult. The number of variables to be considered in the decision making process are increasing. Production and other management system and related technologies become obsolete within a short span of time. The number of events-both domestic and world affecting the organization is increasing. With all these happening over reliance on experience may prove to be costly. More reliance has to be placed on creativity, innovation, and new ways of looking at the organization in the world in which we exist.

Levels of Strategy

Strategies may exist at three levels in an organization. The levels are corporate level, business level, and operating level.

Corporate level

The Board of Directors and the Chief Executive officers are the primary groups involved in this level of strategy making. Corporate planners and consultants may also be involved. In small and family owned business the entrepreneur is both the general manager and chief strategic manager.

Here the strategy is concerned with what sorts of business should the company as a whole. Decisions like spreading the range of business the company should enter, widening of range of products or service or geographic area to move in are the strategic decisions of the general sort.

Business level
Strategic Business Unit (SBU) managers are involved at this level in taking strategic decisions. Here strategies are about how to complete in particular product-markets. The strategies here are related to a unit within the organization.

Operating level
This third level of strategy is at the operating end of the organization. In this level the strategies are concerned with how the different functions of the enterprise like marketing, finance, manufacturing, etc. contribute to the strategies of other levels. These contributions are important in terms of how can an organization become competitive. Competitive strategy may depend to a large extent on decisions about market entry, price, product offer, financing, manpower, investment in plant, etc. In themselves these are decisions of strategic importance but are made, or at least strongly influenced at operational levels.

Elements of Strategic Management
Strategic Management is concerned with deciding on the strategy and how the strategy is to be put into effect. Strategic management has three main elements: strategic analysis, strategic choice, and strategic implementation.

Strategic analysis
This is concerned with understanding the strategic situation of the organization. This includes the examination of matters like changes in the organizational environment and its effects on the organization, assessment of its resources and strengths in the context of these changes, effect of the changes on people and on their present and future aspirations.

Strategic choice
Strategic analysis provides a basis for strategic choice. This is concerned with the formulation of possible courses of action, their evaluation and the choice between them. This means that the strategic choice has three parts to it. Those are generation of strategic options, evaluation of strategic options and selection of strategy.

Strategic implementation
This is concerned with translation of general directions of strategy into action. This is also as important as strategic analysis and choice. Implementation can be thought of as having several parts. This involves resource planning in which logistics of implementation are examined. It also takes into account the organization structure needed to carry through the strategy and of course the system and people who implement the strategy.

Environmental Analysis
Managers must systematically analyze the environment, since environmental factors are primary influencers of strategy. Environmental analysis gives the strategic manager time to anticipate opportunities and to plan alternative responses to those opportunities. It also helps them to develop an early warning system to prevent threats or develop strategies which can turn a threat to the organization's advantage. Managers need to search the environment to determine the following

- What factors in the environment present threats to the company's present strategy and accomplishment of objectives?
- What factors in the environment present opportunities for a greater accomplishment of objectives through an adjustment in the company's strategy?

Without systematic environmental search and diagnosis, the time pressures of managerial job can lead to inadequately thought out responses to environmental changes. Firms which do environmental analysis are more effective than those which don't successful firms do more and better analysis than the failing firms. The extent and sophistication of the analysis must meet the demands of the environment.
It is important to scan the environment, before the planning exercise is carried out. Environmental scanning is understood in simple words by an example: where a boy has to cross a busy road in a metropolitan city in reaching a goal and he tries to have a visual scan, looks for an opportunity which he may be able to use or not, analyses possible threats due to police, traffic speed or the risk situation in the middle of the road, and only then makes a strategy to cross. In other words, he has to scan his entire environment, be it in terms of analyzing the traffic density and speed, signal enforcement rules, and then do a kind of SWOT analysis including his own capacity before planning to cross. Even during implementation of his strategy to cross the road by going to the zebra line and then crossing. To cross wherever he is standing or else to cross blindly in one shot he monitors the situation around and if necessary, reviews the strategy.

Types of Environments
Environment can be classified as internal i.e., within the organization and external i.e., environment in general. General environment can be viewed from different dimensions like socio-economic, cultural, technological, political and legal. The environmental analysis includes the study of all these dimensions and their interplay as well as impacts. Organizational environment includes dimensions relating to customers, suppliers, labors, competitors, and community.

General environment
The general environment can be viewed from different angles. Some of these are socio-economic, cultural, technological and legal and regulatory environments.

Economic environment
There are a variety of economic factors which affect demand and supply for products and services and their prices. The state of the economy at present and in the future can affect the fortunes and strategies of the firm. The specific factors that a firm would be interested to analyze are the stage of the business cycle, inflationary or deflationary situation, monetary policies, fiscal policies, balance of payments, structure of industry, global competition etc. Each of these factors of the economy can help or hinder the achievement of a firm's objectives and lead to success or failure of the strategy.

Social environment
The values and attitudes of people affect strategy. The following example would illustrate the importance of social factors.
Example: In nuclear power plants, because of radioactive elements present, guidelines and procedures for decommissioning are stipulated, much in advance of actual decommissioning, resulting in national and international criteria for radiation protection, transport and waste disposal and environment al safety during various stages of decommissioning.

Technology environment
Strategy managers also search for new and better technology that would increase the sales, reduce costs and improve the product. Changing technology can offer major opportunities for improvement and can eliminate major threats. Some examples of products which came into limelight because of technological developments are: "Word processors and electronic type writers" in place of "manual and electric type writers" Technological advancement will affect the product life cycle also. Decrease in product life cycle results in increased profits. Technological change may also affect distribution methods, quality and types of raw materials, and the skills of the work force. Whether technological change comes fast or slow is a function of the creativity of people and entrepreneurs, receptivity of the industry, availability of finance for R&D activity and global changes

Legal/Regulatory environment
This can also be called as political environment. Presently, the central, the state and local governments of many countries are increasingly affecting the operations of almost all business. The governments may legislate on matters like wage and price control, safety and health at work, location of the plants, waste treatment, etc. Government policies about its relationship with business can change over time. With the change in government the policies of the firms, the complexion of threats and opportunities may also change. Hence, a strategic manager should also examine the legal and regulatory environment.

Table 1

Social	Political	Economic	Technological
Poverty	Stability	Agricultural production	Rural technology
Inequality	Centre state relations	Industrial production	Agriculture technology
Social Structure	International relations	Energy	Manufacturing technology
Education	Type of politics	Inflation	Communication technology
Literacy	Ideology	Ideology	Information technology
Population	Law and order	Balance of payments	Transport technology
Labor Movement		Saving Rule	Biotechnology
Health/Media-care		Infrastructure	Management technology
Media		GNP	Transfer of technology
Caste/Creed		Monetary & Fiscal policy	
Values		Government borrowings	
Language		Deficit financing	

Organizational environment
Organizational environment covers major groups or stake holders who can influence the firm. A Stake holder is any individual or organization whose behavior can directly affect the firm's future but is not under the firm's control. These are suppliers, customers, competitors, and community. These groups have a stake in the firm, relationship with it, and interests in its operations.

SWOT Analysis
SWOT analysis for project management is a simple, yet effective process. It allows the project manager to identify areas that needs improvement. By implementing the correct methodologies for the analysis, it is possible to ensure that a project will be completed on time and within budget. SWOT stands for Strengths, Weaknesses, Opportunities and Threats.
The use of SWOT analysis lets the project manager to improve the whole project or individual tasks where better efficiency can be gained. It also mitigates risks associated with the tasks and optimizes the whole process. The team members get to do more with less. Because of the nature of the analysis, it is important to conduct the SWOT analysis during the startup phase. It can provide a solid backbone to the project plan.

Conducting SWOT analysis
It is important to have a clear objective during SWOT analysis sessions. That way, each stakeholder understands what is expected

of him/her. If the analysis is done during the initial startup phase, key members must come together and identify all required tasks and the potential risks to each step of the project. On the other hand, it is also possible to have a SWOT analysis session in the middle of the project. If this is the case, the main focus is usually to reassess the schedule, the budget, or to conduct a cost/benefit analysis of certain processes.

While the purpose of the SWOT analysis may be clear on paper, its actual implementation can vary. In addition, it is common for the discussion among stakeholders to go off-topic during the session itself. For this reason, it is important to create a set of pre-defined questions. This will serve as the guide for the SWOT analysis session. The project manager may also present his initial set of findings for discussion. Any relevant information will give attendees an opportunity to clear things up. The process results to improved productivity.

Strengths (*internal, positive factors*)

Strengths describe the positive attributes, tangible and intangible, internal to your organization. They are within your control.

- What do you do well?
- What internal resources do you have? Think about the following:
- What advantages do you have over your competition?
- Do you have strong research and development capabilities? Manufacturing facilities?
- What other positive aspects, internal to your business, add value or offer you a competitive advantage.

Weaknesses (*internal, negative factors*)

Weaknesses are aspects of your business that detract from the value you offer or place you at a competitive disadvantage. You need to enhance these areas in order to compete with your best competitor.

- What factors that are within your control detract from your ability to obtain or maintain a competitive edge?
- What areas need improvement to accomplish your objectives or compete with your strongest competitor?
- What does your business lack (for example, expertise or access to skills or technology)?
- Does your business have limited resources?
- Is your business in a poor location?

Opportunities (*external, positive factors*)

Opportunities are external attractive factors that represent reasons your business is likely to prosper.

- What opportunities exist in your market or the environment that you can benefit from?
- Is the perception of your business positive?
- Has there been recent market growth or have there been other changes in the market that create an opportunity?

Threats (*external, negative factors*)

Threats include external factors beyond your control that could place your strategy, or the business itself, at risk. You have no control over these**,** but you may benefit by having contingency plans to address them if they should occur.

- Who are your existing or potential competitors?
- What factors beyond your control could place your business at risk?
- Are there challenges created by an unfavorable trend or development that may lead to deteriorating revenues or profits?
- What situations might threaten your marketing efforts?
- Has there been a significant change in supplier prices or the availability of raw materials?
- What about shifts in consumer behavior, the economy, or government regulations that could reduce your sales?
- Has a new product or technology been introduced that makes your products, equipment, or services obsolete?

TOWS Analysis

A TOWS analysis is a strategic planning tool that considers your company's threats, opportunities, weaknesses, and strengths. It's a variation on a SWOT analysis. Businesses use a TOWS matrix when they want to take full advantage of opportunities in the external landscape–for example, to increase market share and profits for employees and stockholders. TOWS analysis is a business strategy that uses the principles of a traditional SWOT analysis in a reverse-engineered approach. The letters in TOWS (and in SWOT) correspond to threats, opportunities, weaknesses, and strengths.

Since a TOWS analysis fits into the SWOT framework, knowing how a SWOT analysis works can help you compare the two. Using a conventional SWOT matrix, a company looks internally to identify its strengths and weaknesses before considering how those factors drive or give way to opportunities and threats.

In contrast, a TOWS analysis (or TOWS matrix) starts with identifying external threats and opportunities and works backward. Taking the external factors into consideration, decision-makers can strategize how the organization's internal strengths and weaknesses might be useful for addressing challenges and capitalizing on external opportunities.

TOWS analysis strategies

A TOWS analysis is a planning tool that examines your company's threats, opportunities, weaknesses, and strengths. Companies use this type of analysis to strategize for future challenges and initiatives. Here are four variations of a TOWS analysis you might consider using:

1. **Strengths-opportunities (SO):** This TOWS strategy, also known as the maxi-maxi strategy, is a business plan that pursues opportunities through the sheer force of an organization's strengths. It places less emphasis on a company's weaknesses. As an example, imagine a company with more robust customer service than its competitors. Using an SO strategy, this

company's marketing campaigns would tirelessly market their customer service to increase brand awareness among individuals who feel unhappy with a competitor's subpar customer service.

2. **Strengths-threats (ST):** Also known as the maxi-mini strategy, the ST strategy places a company's strengths on the front lines of any organizational decisions. Like a sports team with exceptional scoring skills but a weak defense, this strategy forces a company to lean into its strengths to overcome competitors and future obstacles.
3. **Weaknesses-opportunities (WO):** After a company has identified its weaknesses, it can use the WO strategy, also known as the mini-maxi strategy, to establish initiatives or plans to minimize these target weaknesses. In reducing vulnerabilities in marketing strategy or business processes, the company better enables itself to chase new opportunities, push into fresh markets, and create brand recognition among new demographics.
4. **Weaknesses-threats (WT):** The WT strategy, or mini-mini strategy, aims to predict external threats before they appear and minimize any internal weaknesses that might leave the company vulnerable. Using this strategy, a company can start brainstorming strategic options for overcoming future hurdles.
5. **Multi criteria technique:** Multiple criteria decision analysis, or MCDA, is a structured process for evaluating options with conflicting criteria and choosing the best solution. MCDA is similar to a cost-benefit analysis but evaluates numerous criteria, rather than just cost.

As a practice, MCDA has applications in a number of fields, including business, government and everyday life. For example, if you're responsible for procurement at a company, you can use MCDA to decide between vendors or to select equipment that meets all of the company's needs.

Benefits of a multiple criteria decision analysis:

Conducting an MCDA aims to help you determine which options are most effective, increasing the efficiency of the decision-making process. In addition to providing, you with an ordered list of alternatives, it addresses the social aspects of decision-making to encourage discussion between different decision-makers. Here are some additional benefits of this analysis:

- Acts as a means of communication: A MCDA can help further communication between different stakeholders, ensuring that everyone involved in the decision gets the opportunity to address the issue.
- Provides useful insights: By visualizing the values of your alternatives using an MCDA, you can discover useful insights that you might otherwise miss, allowing you to make the most informed decision possible.
- Uses a systematic approach: All MCDAs use a systematic approach to identifying and comparing different options by assessing their impacts, performances, advantages and disadvantages, which can help you ensure your decision-making is consistent, regardless of the issue

Analytical Hierarchy Process (AHP)

AHP was initially developed by T.L. Saaty in the 1970s to deal with multiple criteria in decision making processes and after his first book in 1980 the method was extended by several scholars and because of its ease of use and simplicity applied in a wide range of fields. AHP structures the complex decision making problems in a hierarchic manner, perform measurement on a ratio scale for all components of the hierarchic structure and synthesis the results

Numerous applications have been made in areas such as credit evaluation and various investment decisions, customer's product selection decisions, education, facility location decisions, hardware and software selection, healthcare, performance evaluation, personnel selection (as mentioned above), portfolio selection, new product development, product mix decisions, production/ inventory planning and control, project and contractor selection decisions in project management, public policy decisions, reengineering and QFD, resource allocation and assignment, supplier/vendor selection, technology selection etc.

Objective of Study

- Study of steel industry for conducting SWOT analysis.
- Conducting SWOT analysis for steel rolling mills.
- Based on SWOT analysis, TOWS study for formulating strategies.
- Computing the prioritized weights among different strategies by MCDM technique.
- Ranking of the units where strategies are implemented by scoring approach.
- Ranking of the units where strategies are implemented by RAPS approach.

Literature Review

The mechanism of MCDM emerged as a set of novel techniques for facilitating and improving decision-making in situations where the consideration of multiple criteria is required [1]. One of the advantages of using MCDM is that it can generate consistent, structured, rational, robust, and transparent information in complex situations [2]. The academic literature defines MCDM as an approach that involves the analysis of various available choices in a particular situation [3]. MCDM is successfully utilized in numerous areas, including business, medicine, engineering, government, and even daily life [4-9]. There are many customized MCDM tools that were specifically designed for use in particular areas. The paradigm of MCDM implies following a series of steps. The Analytic Hierarchy Process (AHP) is a relatively old MCDM technique that still remains popular. It was developed in the 1980s by L.Saaty [12] and has been enhanced since then. previous MCDM techniques that were used in the educational sector are covered. Note that the RAPS technique has not been used in any studies so far except for the original research conducted by Uroševi´c, *et al*. [10]. Multi-criteria decision-making (MCDM) approach integrates alternative performance measures in conflicting options and results to generate a feasible solution [11]. The RAPS technique assisted in ranking the Engineering departments using weights derived from the AHP technique. For the first time, the use of RAPS in the educational

sector is presented in this paper, Omer [13].
Strategic management is a collection of actions and decisions taken in order to achieve organization's goals and objectives. Decision making process is greatly affected by internal and external factors. Systematic identification and analysis of the effects of such factors on organization success has received significant research attention [14-21]. The Strengths-Weakness-Opportunities-Threats (SWOT) technique is frequently used to analyse internal and external factors, assess the feasible alternative strategies, and then to determine the best one that helps an organization in achieving its desired objectives and goals. Nevertheless, the SWOT analysis as a qualitative tool does not numerically evaluate the effect of each factor on selected strategies [22-24].

Literature Gap
Application of integration of SWOT, TOWS analysis is not found, so far in the literature, industrial application. A gap is also observed in applying RAPS and AHP technique in such application.

Methodology
The methodology proposed:
1. Performing SWOT analysis
2. Determination of AHP weights and prioritizing
3. Identification of strategies
4. Ranking of production units by scoring method
5. Ranking of production units by scoring method

The proposed project is carried out in steel industry. The various factors that are considered in steel industry are;

- **Strengths**

1) Technology
Technological innovation provides many new market opportunities. Success in capturing new, emerging markets will depend on the industry's ability to compete in different environments.

2) Managerial and workers experience
Experienced managers having an advantage in anticipating future business opportunities, threats, competitive pressure and changes in technology and customer demand generate innovative ideas in the organizational development.

3) Design:/product mix/brand name/customer faith
The influence of sustainable development on the chemical industry increases the complexity of all its subsystems. In plant design less than 1 percent of ideas for new designs ever become commercialized. During this solution process, typically, cost studies are used as an initial screening to eliminate unprofitable designs. If a process appears profitable, then other factors are considered, such as safety, environmental constraints, controllability, etc. The general goal in plant design is to construct or synthesize "optimum designs" in the design of the desired constraints.

4) Construction of plant:/infrastructure connectivity to port
Construction of plant is one of the niche segments from the specialty chemical segment of chemical industry. Building structures requires protection from natural hazards and industrial corrosives and regular maintenance to sustain for a longer duration of time. Chemicals used in construction impart these qualities to structures.

5) Operation easiness
In close coordination with the owner and engineering, procurement, and construction, the project team identifies organizational tasks, roles and responsibilities, assists with start-up, ramp-up, and operations and maintenance, focuses on high priority risks, and analyzes opportunities created by activities ahead of schedule. Proper maintenance strategy ensures maximum safety, reliability, and availability of the equipment and systems at a minimal overall cost.

- **Weakness**

1) Raw material availability due to rise in input cost
Availability of raw materials plays a crucial role in the industry by minimizing the transportation costs in its procurement, its handling and the qualitative and quantitative issues. Resource efficiency involves the optimal use of materials across the product life cycle and value chain, from raw material extraction and conversion, product design and manufacture, transportation, consumption and re-use, to recovery, disposal or recycling.
The opportunities to improve the resource efficiency of a product are not limited to a specific stage of the life cycle, and improvements at one stage can have a profound impact on another. By usage of less material resources and optimizing their use, business and societies can reduce the risks linked with resource depletion, materials security and environmental impact.

2) Long products exposed to cyclical markets
Manufacture of SMO requires skilled and well trained technical manpower. The main promoter having over 25 years in the field has a strong technical team already identified for production.

3) High interest and finance charges is a concern

- **Opportunities**

6) Product diversification

The demand is growing at about 10 – 12% per annum which will enable future expansion.

7) Continued emphasis on infrastructure building & several Greenfield projects under execution will boost growth.

8) Export potential

At present, the export control system is governed by a complex set of laws, regulations, and processes involving multiple agencies.

- **Threats**

1) Rising in inflation rate and increase in interest rates by RBI etc. impacts the rate of growth

The product is flammable and dangerous, a risk of accident will exist. The management has to take adequate precautions and also ensure insurance cover of the assets and also manpower. It is necessary to manage the risk of fires and explosion process. The properties that characterize flammable materials and the procedures used to reduce fire and explosion hazards.

2) The debt crisis in Europe & the political turbulence in the middle east

Most of the statutory and regulatory approvals are yet to be obtained. This could potentially cause a delay in the entire procedure.

3) Competitors entry:/global competition

Table 2: AHP scale

Scale of preference	Definition
1	Equally preferred
3	Moderately preferred
5	Strongly preferred
7	Very strongly preferred
9	Extremely preferred
2,4,6,8	Intermediate preferences between the two adjacent judgements
Reciprocal of the above non-zero numbers	If criteria C_i is assigned to one of the above non zero numbers when it is compared with criteria C_j, C_i has compared with criteria C_j, C_j has the reciprocal value when it is compared with C_i.

Future new companies may come up locally or new sources of imports may increase competition. As the manufacturing technology is closely held by promoter and is proprietary this will act as barrier against this threat.

4) Increase cost of production due to volatility in supply prices

Key employees are yet to be recruited. This poses a threat in the delay of commercial production if they are not on boarded on time.

Brief on AHP

AHP has five main steps as: defining the problem, decomposition of the problem in order to obtain a hierarchic structure (goal-criteria-sub criteria), construct pair wise comparison matrices for each element in the hierarchy comparing with respect to the upper level element, measuring the consistency of those matrices and calculating the weights of all elements of the hierarchy, and finally synthesizing the results in order to obtain overall score or global weight of the elements named as alternatives appearing in the bottom of the hierarchy.

The AHP is based on four axioms

1. Reciprocal judgments,
2. Homogeneous elements,
3. Hierarchic or feedback dependent structure, and
4. Rank order expectations.

The synthesis of the AHP combines multidimensional scales of measurement into a single "one-dimensional" scale of priorities. Decisions are determined by a single number for the best outcome or by a vector of priorities that gives a proportionate ordering of the different possible outcomes to which one can then allocate resources in an optimal way subject to both tangible and intangible constraints.

The general structure of the AHP approach that can provide decision support can be understood with the help of the following sequential procedure:

1. List the set of different alternatives (a_i $1 \leq i \leq n$)
2. Identify the factors which may be intrinsic as well as extrinsic, which may have impact on the selection of an alternative for an organization. For each of these impacts, identify the criteria (C_i, $1 \leq i \leq m$) and the quantifiable indicators to the criteria for a possible measure.
3. Develop a graphical representation of the problem in terms of the overall goal, the factors, the criteria and the decision alternatives. Such a graph depicts the hierarchy for the problem.
4. Assign weights to each alternative on the basis of its relative importance of its contribution to each decision criterion. This is carried out through a pair-wise comparison of the alternatives based on the decision criterion. Table shows a typical scale

for pair-wise comparison matrix elements M_{kij} for each criterion C_k, where M_{kij} is evaluated when A_i is compared with A_j, and Table-1 also shows the general format of a pair-wise comparison matrix.

5. Once the pair-wise comparison matrix has been formed for a criterion C_k, the normalized priority of each alternative is synthesized. This is done as follows:

- Sum up the values in each column of M_k
- Divide each element in the column by its column total, which results in a normalized pair-wise comparison matrix.
- Compute the average of the elements in each row of the normalized comparison matrix, thus providing an estimate of the relative priorities of the n alternatives. This results in a priority vector, PM_{ki} denotes the priority for alternative A_c with respect to criterion C_k.

6. In addition to the pair-wise comparisons of the n alternative, use the same pair-wise comparison procedure to set priorities for all the criteria in terms of the importance of each in contributing towards the overall goals of the organization. Let L_{ij} denote each element of the resulting pair wise comparison matrix, when C_i is compared with C_j.
7. The priority vector P_{Li} is synthesized similar to step 5 (P_{Li} denotes the priority for criterion C_i).
8. Calculate the overall priority for alternative A_i denote by P_{Ai}, as follows:

$$P_{Ai} = \sum_{k=1}^{m} PM_{ki} \times P_i$$

Table 3: Comparison of relative weights

Evaluation criteria	C_1	C_2	C_3	C_4	C_m
C_1	1	Reciprocal of entries below the diagonal	Reciprocal of entries below the diagonal	Reciprocal of entries below the diagonal	Reciprocal of entries below the diagonal
C_2	Degree of preference of C_2 versus C_1	1			
C_3	Degree of preference of C_3 versus C_1	Degree of preference of C_3 versus C_2	1		
C_4	Degree of preference of C_4 versus C_1	Degree of preference of C_4 versus C_2	Degree of preference of C_4 versus C_3	1	
C_m	Degree of preference of C_m versus C_1	Degree of preference of C_m versus C_2	Degree of preference of C_m versus C_1	Degree of preference of C_m versus C_4	1

9. Choose the alternative, which has the highest priority.
10. According to Satty (1980), a key step in AHP is the establishment of priorities through the use of the pair-wise comparison procedure, and the quality of the ultimate decision relates to the consistency of judgments that the decision maker demonstrates during the process of pair-wise comparisons.

Table 4: Consistency table

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0.00	0.00	0.58	0.9	1.12	1.24	1.32	1.41	1.45	1.49	1.51	1.48	1.56	1.57	1.59

$$CR = \frac{CI}{RI}$$

Consistency Ratio (CR) → < 0.1; trustworthy
→ > ≈ 0.1; just accepted
→ ≈0.8-0.9 completely untrustworthy

The Consistency Index for a matrix is calculated from $(\lambda_{max} - n)/(n - 1)$. The last step is to calculate the Consistency Ratio for the set of judgements using the CI for the corresponding value from large samples of matrices of purely random judgments using the table given above. The upper row is the order of the random matrix, and the lower is the corresponding index of consistency for random judgements.

Ranking Alternatives by Perimeter Similarity (RAPS)

The methodology of the RAPS technique can be explained in the following steps:

Step-1: In this step, the input data are normalized, which is necessary to convert from a multidimensional into a non dimensional decision space. Eq.(1) is used to perform normalization for max criteria, and for the min criteria Eq.(2) is used to perform normalization:

$$r_{ij} = \frac{x_{ij}}{\max_i(x_{ij})}, \forall_i, \forall i \in [1,2,\ldots,m] \wedge j \in S_{max} \quad (1)$$

$$r_{ij} = \frac{\min_i(x_{ij})}{x_{ij}}, \forall I \in [1,2,\ldots,m] \wedge j \in S_{min} \quad (2)$$

Where x_{ij} is the decision-making matrix of m alternatives and n criteria, i = 1,...,m and j = 1,...,n; S_{max} is the maximization criteria set; S_{min} is the minimization criteria set.
x_{ij} = pairwise comparison between i and j.
r_{ij} = normalization value of x_{ij}.

Step-2: The process of normalization yields the normalized decision matrix as shown in Eq.(3).

$$R = [r_{ij}]_{m\times n} = \begin{array}{c} \\ A_1 \\ A_2 \\ \vdots \\ A_m \end{array} \begin{array}{c} \begin{array}{cccc} C_1 & C_2 & \cdots & C_n \end{array} \\ \begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1j} \\ r_{21} & r_{22} & \cdots & r_{2j} \\ \vdots & \vdots & \ddots & \vdots \\ r_{m1} & r_{m2} & \cdots & r_{mn} \end{bmatrix} \end{array} \quad (3)$$

Step-3: Weighted normalization. For each normalized assessment r_{ij}, weighted normalization in Eq.(4) is used. The result value of the normalized weight is the weighted normalized matrix, and its shown in Eq.(5).

$$u_{ij} = w_j r_{ij}, \forall i \in [1,2,\ldots,m], \forall j \in [1,2,\ldots,n] \quad (4)$$

$$u = [u_{ij}]_{m\times n} = \begin{array}{c} \\ A_1 \\ A_2 \\ \vdots \\ A_m \end{array} \begin{array}{c} \begin{array}{cccc} C_1 & C_2 & \cdots & C_n \end{array} \\ \begin{bmatrix} u_{11} & u_{12} & \cdots & u_{1j} \\ u_{21} & u_{22} & \cdots & u_{2j} \\ \vdots & \vdots & \ddots & \vdots \\ u_{m1} & u_{m2} & \cdots & u_{mn} \end{bmatrix} \end{array} \quad (5)$$

u_{ij} = weighted normalized value of r_{ij}.
Step-4: Determine the optimal alternative by identifying each element of the optimal alternative using Eq.(6) which leads to the optimal alternative set in Eq.(7).

$$q_j = \max(u_{ij} \mid 1 \le j \le n), \forall i \in [1,2,\ldots,m] \quad (6)$$

$$Q = \{q_1, q_2, \ldots, q_j\}\ j = 1,2,\ldots,n \quad (7)$$

Step-5: Decomposition of the optimal alternative implies the decomposition of the optimal alternative in the two subsets or two components. The set Q can be represented as the union of the two subsets, as shown in Eq.(8). If k represents the total number of criteria that should be maximized, then h = n – k represents the total number of criteria that should be minimized. Hence, the optimal alternative is shown in Eq.(9).

$$Q = Q^{max} \bigcup Q^{min} \quad (8)$$

$$Q = \{q_1, q_2, \ldots, q_k\} \bigcup \{q_1, q_2, \ldots, q_h\}\ k+h=n \quad (9)$$

Step-6: The decomposition of the alternative is similar to step-5. This step is the decomposition of each alternative, as shown in Eqs.(10) and (11).

$$u_i = u_i^{max} \bigcup u_i^{min}\ \forall i \in [1,2,\ldots,m] \quad (10)$$

$$u_i = \{u_{i1}, u_{i2}, \ldots, u_{ik}\} \bigcup \{u_{i1}, u_{i1}, \ldots, u_{ih}\}\ \forall i \in [1,2,\ldots,m] \quad (11)$$

Step-7: This step is related to the magnitude of the component, which needs to calculate each component of the optimal alternative. Thus, calculate the magnitude using Eqs.(12) and (13) and for each alternative using Eqs.(14) and (15).

$$Q_k = \sqrt{q_1^2 + q_2^3 + ... + q_k^2} \quad (12)$$

$$Q_h = \sqrt{q_1^2 + q_2^3 + ... + q_h^2} \quad (13)$$

$$u_{ij} = \sqrt{u_{i1}^2 + u_{i2}^2 + ... + u_{ik}^2} \ \forall i \in [1,2,\ldots,m] \quad (14)$$

$$u_{ih} = \sqrt{u_{i1}^2 + u_{i2}^2 + ... + u_{ih}^2} \ \forall i \in [1,2,\ldots,m] \quad (15)$$

Step-8: Ranking the Alternatives by Perimeter Similarity (RAPS). The optimal alternative perimeter is represented as the right-angle triangle perimeter. Components Q_k and Q_h are the base and perpendicular sides of this triangle, respectively, are expressed in Eq.(16). For each alternative, using Eq.(17), calculate the perimeter. The ratio between the perimeter of each alternative and the optimal alternative is expressed in Eq.(18). Arrange and rank alternatives according to the descending order of PS_i values of each alternative.

$$P = Q_k + Q_h + \sqrt{Q_k^2 + Q_k^2} \quad (16)$$

$$P_i = u_{ik} + u_{ih} + \sqrt{u_{ik}^2 + u_{ih}^2} \quad (17)$$

$$PS_i = \frac{P_i}{P}, \forall i \in [1,2,\ldots,m] \quad (18)$$

PS_i = weightage of alternative.

Case Study

Undoubtedly, steel is the most widely used input material in manufacturing sector due to its excellent mechanical properties, resistance to corrosion and low cost. Steel industry contributes about 2% to the GDP of India. Apart from this direct contribution, the effect on Indian economy is 1.4 times with an employee multiplier of 6.8X. It is understood from World Steel Association that for every two jobs created globally in steel industry, ancillary industries create 13 more jobs across the supply chain. (https://pib.gov.in/newsite/PrintRelease.aspx?relid=153661 and https://steel.gov.in/ make-india#skipCont)

The demand for steel is cyclic in nature. When the economy is in upward trend, steel demand increases and drops down during economic down turn. Towards the end of 2014, China started oversupply of steel which caused the steel price drop to the bottom most. National Steel Policy introduced by Indian Government in 2017, envisions the growth trajectory of the Indian steel industry till 2030-31, some of the policies are

- Enhancement of Steel-making capacity to 300 million tonnes per annum by 2030-31.
- Finished steel production to reach 230 million tonnes, assuming a yield loss of 10% for conversion of crude steel to finished steel – that is, a conversion ratio of 90%.
- Steel consumption to reach 206 million tonnes by 2030–31 and net exports are expected at 24 million tonnes.

With this steel production levels, the per capita steel consumption is expected to increase to 160 kg by 2030-31 from the present level of 74.3 in 2019-20.

India's total investment in construction sector is likely to grow by 50% over the next 5 years. The urbanization rate in India is expected to increase to 40% by 2030-31 from current level 33%.

The Indian steel industry: Growth, challenges and digital disruption, Indian Steel Association, PWC, November, 2019.

The Indian automotive industry is the fourth largest in the world and presently contributing around 9% of steel demand [13]. This sector, including component parts, is expected to cross USD 250 billion by 2026. India's auto and auto component export markets are also expected to grow at a CAGR of 3% until 2026 [13]. http://www.cmie.com.

Mills of RINL

RINL Visakhapatnam Steel Plant is the only shore based Integrated Steel Plant in the country. It is well connected with Port and Railways for transportation of Raw Materials and Finished Goods. The Plant has a rated capacity of 7.3 million tons per annum Liquid Steel production. It has huge land bank for expansion of its capacity up to 20 million tons. Keeping in this view a SWOT analysis of RINL is conducted on finished steel producing units of WRM1, WRM2, STM, MMSM, LMMM, SBM. For improving the strategic action to be taken on this and ranked using AHP method, ranked the units for observing their performances and for suitable action

STM (Structural Mill)
700,000 tpy of structural sections in straight length within 3,733 rolling hours and 850,000 tpy of sections in straight length within 4,533 rolling hours.

Starting material
Continuously cast cold bloom 200×200×12,000 mm, weight 3,670 kg.

Final Products
Beams:
ISMB 100, 125, 150 mm
ISJB 150, 175 mm
ISLB 100, 125, 150 mm

Channels:
ISMC 75, 100, 125, 150, 175 mm
ISJC100, 125, 150, 175 mm
ISLC 100, 125, 150 mm

Equal Angles:
55 to 100 mm (thickness 5 to 12mm)

Flats:
70 to 180 mm (thickness 8 to 30 mm)

Special sections like:
Rounds: 45 to 95mm
Squares: 45 to 80mm

HE columns with parallel flanges:
100 to 120mm (DIN 1025-5 standard)

IPN Beams with tapered flanges:
100 to 180 mm (DIN 1025 - 1 standard)

IPE Beams with parallel flanges:
100 to 180 mm (DIN 1025 - 5 standard)

Tee:
60 × 60 × 7mm (Indian Standard: IS 1173) (EN standard: 10055)

Unequal angle:
80 × 50, 90 × 60, 125 × 75mm (Indian Standard: IS 808) (EN standard:10056)

Plant Operation Data
Annual Production

Total Production	700,000-850,000(TPY)
Calendar days	365
Weekly shutdown days	52
Capital Shutdown days	13
Operating days	300
No. of operating shifts/day	3
Total operating hours/year	7200

Wire rod mill-2
Technical data
Billet specifications
Billet length: (Nominal)
150 × 150 mm: 12000 mm
125 × 125 mm: 9,920 to 10,400 mm

Weight

Billet section	Billet length	Nominal	Maximum
150 × 150 mm	12,000 mm	2,120 kg	2,273 kg
125 × 125 mm	10,000 mm	1,152kg	1,255 kg

Tolerance

Rhomboidity	:	<2.0%
Length Tolerance	:	0 mm / + 80 mm
Curvature	:	< 6 mm in 1,000 mm
Cross section	:	± 1.7%
Twist	:	< 0.8°/m
Bulging	:	< 1.65%
Corner Radius	:	150 × 150 mm: 8 mm (Cast billet) 125 × 125 mm: 25 mm (Rolled billet)

Special bar mill

Special Bar Mill is a new mill under 6.3 mtpa expansion of VSP in Phase-2 which is designed to produce 7.5 lakh tons per annum of value added rounds. It is designed to produce different types of steel from low, medium and high carbon steel up to low alloy steel grades such as spring steel and bearing steel. Around 100 grades of steel can be produced in SBM.

The mill is capable to roll the following special steels,

- Case hardening steel
- Cold heading quality steel
- Electrode steel
- Spring steel
- Bearing steel
- Free cutting steel
- Medium and high carbon steel

The Mill is supplied by M/s. SIEMENS VAI with a Reheating furnace supplied by M/s. Italimpiantti. Both the Mill & Furnace are designed with Level-2 automation systems. The Rolling mill is capable of rolling the products with a Tolerance level of 1/4th of DIN 10060. The mill has the feature of free size rolling which facilitates rolling of intermediate product sizes with a Tolerance level of 1/4th of DIN 10060. The mill is equipped with a billet Re-heating furnace of 200 ton/Hr capacity. The Reheating furnace is capable of heating the billets in the range of 1050 ℃ to 1200 ℃. The mill is designed for Low temperature rolling which will add value to the products by imparting fine grain structure. This will avoid conventional heat treatment at customer end.

The input Blooms are of size 150 × 150 × 12,000 mm with a weight of 2150 Kg; however, it is also possible to roll 125 × 125 × 9.800 - 10.400 mm with limited rolling rates.

The product mix for the mill is from 20mm to 45mm rounds with a provision to roll 16mm and 18mm round. The final product can be produced in both straight form and coil form. The average bundle weight in straight form is around 3.5 - 4.5 Ton & the weight of the coil is around 2 ton. In straight form the cut length can be varied from 6m to 12m as per customer requirement.

The mill is at +5 m level. The rolling mill is supplied with Red Ring Housing less stands, which ensure symmetrical gap adjustment. The rated capacity of the mill is 7,50,000 Tons per annum, however with changes in rolling rates and product mix, it is possible to roll 9,00,00 Tons per annum.

Light and medium merchant mill

1. Mill availability (%) (Calendar hours):

Net availability	81.91

2. Mill utilisation (% available rolling time)

Billet Mill	89.7
Bar Mill	92.5

3. Mill productivity (T/Utilised hrs)

Bar Mill 157.2

a) Sections rollings: (in terms of finished product)

i) Rounds 12-16 mm	134	
18 mm and above	192	
ii) Reinforcing bars 10 mm	74.5	
12 to 16 mm	134	
18 to 25 mm	192	
iii) Squares	170	
iv) Flats	173 & 192	
v) Equal angles	192	
vi) Unequal angles:	45 × 30 × 5-6 mm	192
75 × 50 × 6-10 mm	192	

vii) T-bars	192
viii) Channels	192
ix) Average for all sections	157.2
4. Yield from blooms (%)	
i) Saleable billets	96
ii) Billets for wire rod mill	97
iii) Billets for Sections rolling	97
5. Yield of LMMM products from Billets	97
6. Average productivity of billet mill	331
7. Arisings (% to input)	
a) Mill scale	1.5
b) Scrap	1.5

Medium merchant and structural mill

The Medium Merchant and Structural Mill (MMSM) is one of the modern rolling mills of Visakhapatnam Steel Plant. It is the third and last rolling mill as per the rationalized concept. This is a single strand continuous mill having production capacity of 8,50,000 T/year. The product mix of MMSM is shown in Table-4 and the product mix rolled and Stabilized in MMSM is shown in Table-5.

Table 5: MMSM product mix

Products	Size (mm)
Rounds	40-75
Squares	40-75
Flats	100 × 10-20 to 150 × 10-20
Equal angles	75 × 75 × 6-10 to 110 × 110 × 6-12
Unequal angles	80 × 60 × 6-10 to 100 × 75 × 6-12
Channels	100 × 50 to 180 × 90
T ñ bars	100 × 100
Beams HE type	96 × 100 to 114 × 120
Beams IPE type	100 × 55 to 180 × 91

Table 6: MMSM product mix rolled and stabilized

Products	Size (mm)
Rounds	40-80
Squares	65-90
Flats	150 × 10-12
Equal Angles	75 × 75 × 6-8 to 100 × 100 × 8-10
Channels	100 × 50 to 150 × 75
Beams HE type	114 × 120
Beams IPE type	180 × 91
Beams ISMB type	125 × 70 to 175 × 85

1.	Mill availability (% calendar hours)			
	a)	Net availability		81.92
2.	Mill utilisation (% net available hours)			82.00
3.	Mill productivity (per utilised hours) in terms of finished product (Tonnes)			
	i)	Rounds: 42-45 mm	168	
		50-75 mm		213
	ii)	Squares:	40-65 mm	213
	iii)	Equal angles:	75 × 75 × 6-10 mm	208
			80 × 80 × 6-10 mm	210
			90 × 90 × 6-12 mm	221
			100 × 100 × 6-12 mm	234
	110 × 110 × 6-12 mm		235	
	iv)	Unequal angles:		208
	vi	Flats :	100 × 10-20 mm	155
			150 × 10-20 mm	211
	vi)	IPE beams	100 mm × 55 mm	219
			120 mm × 64	232
			140 mm × 73	235

		160 mm × 82	231
		180 mm × 91	235
vii)	HE beams		235
viii)	T Bars		190
ix)	Channels:	100 × 50 mm	229
		125 × 65 mm	229
		150 × 75 mm, 175x75mm and	
		180 × 90 mm	235
x)	Average for all sections		222.2

Wire rod mill

The Wire Rod Mill of VSP is high speed 4 strand No-Twist continuous mill designed to produce 8,50,000 T of wire rod coils. The mill is designed to produce plain wire rods from 5.5 mm to 12.7 mm dia and Rebar in 8mm, 10mm and 12mm diameter in coil form. However, sizes up to 14mm are being rolled presently. The mill is constructed at an elevated level of +5350mm. Rolled billets of 125 mm × 125 mm square cross section, length ranging from 9.8 m to 10.4 m and weighing approx. 1250 kgs are used as input material. The mill is designed to roll steel stock of 0.9% max. Carbon content.

Yield	97% min
Rolling rate	190 T/hr max
Sp. Gas consumption	260 Mcal/T (max.) of billet rolled
Sp. Power consumption	125 KWH/T of billet rolled
Mill utilization	67% minimum

SWOT Analysis is Performed on Steel Mills with AHP Weights

Table 7: SWOT analysis

	S	W	O	T
S	1	6	4	3
W	0.17	1	0.33	0.5
O	0.25	3	1	2
T	0.33	2	0.5	1
Total	1.75	12	5.8333	6.5

Table 8: SWOT analysis after normalization with column wise total

	S (1)	W (2)	O (3)	T (4)	Total (5) = (1+2+3+4)	Weightage Col. (5)/4
S	0.571429	0.5	0.685718	0.461538	2.21868524	0.5546713
W	0.095238	0.083333	0.057143	0.076923	0.31263782	0.0781595
O	0.142857	0.25	0.17143	0.307692	0.871979	0.2179948
T	0.190476	0.166667	0.085715	0.153846	0.5967036	0.1491759
Sum					4	

Model calculation

λ_{max} = Summation of (weightage of Table-7 cell wise*total of cell wise in Table-6)

= (0.5546713*1.75) + (0.0781595*12) + (0.2179948*5.833) + (0.1491759*6.5) = 4.149

$$CI = \frac{\lambda_{max} - n}{n - 1}$$

CI = (4.149 – 4)/(4 – 1) = 0.049

$$CR = \frac{CI}{RI}$$

CR = 0.049/0.9 = 0.05

CR is less than 10 % hence the data is considered consistent.

Strengths of the organisation

S1) Brand name: reputation of quality products and brand name in the market.
S2) Shore base plant: it is a locational advantage for export of products and import of critical spares
S3) Highly skilled and dynamic human resources: Knowledgeable and skilled workforce availability
S4) Environmental and social commitments: non-polluting and iso company. adherence to social commitment through corporate responsibility
S5) Enriched product mix: the product mix of long products serves the need of infrastructure, railways, automobile, etc.

Table 9: AHP analysis of strengths

Criteria	S1	S2	S3	S4	S5	Weights	
S1	1	0.5	0.3	2	2	0.168571	CR = 0.07
S2	2	1	0.3	2	0.5	0.16	
S3	3	3	1	6	2	0.411429	
S4	0.5	0.5	0.2	1	0.333	0.068571	
S5	0.5	2	0.5	3	1	0.191429	

Weakness

W1)Cyclic products: demand fluctuates
W2)High finance charges: due to high equity base, higher rates on loans obtained
W3)Only long products: long products such as, rounds, rebar's angles, channels, other structural.
W4)Production cost increase: continuous increase in raw material cost, lesser yield etc.

Table 10: AHP analysis of weakness

Criteria	W1	W2	W3	W4	Weights	
W1	1	0.2	0.2	0.3	0.07	CR = 0.098
W2	5	1	3	3	0.5	
W3	5	0.33	1	0.5	0.19	
W4	4	0.33	2	1	0.24	

Opportunities

O1) Focus on expansion: ample availability of space for upgrading product value in terms of packaging, branding, customer reach, augmenting new facilities etc.
O2) Good roll pass design: potential to product diversification is available.
O3) Flexible in future: upgradation to the latest technology for quality improvement, productivity improvement is always possible.
O4) Good internal market: continuous growth of Indian economy propels internal market, high demand is available.

Table 11: AHP analysis of opportunities

Criteria	O1	O2	O3	O4	Weights	
O1	1	0.17	3	0.5	0.14	CR = 0.07
O2	6	1	5	2	0.52	
O3	0.333	0.2	1	0.3	0.08	
O4	2	0.5	4	1	0.26	

Threats

T1) Competition: higher competition from secondary steel marketers.
T2) Dumping: competition from China and over supplying from other countries due to their economies melting.
T3) Demand not expected lines in domestic market; market instability due to inflation and uncertainty.
T4) Debt crisis: higher production costs due to fluctuations in market and increase in interest rates on working capital.

Table 12: AHP analysis of threats

Criteria	T1	T2	T3	T4	Weight	
T1	1	3	7	9	0.57	CR = 0.09
T2	0.33	1	5	7	0.29	
T3	0.14	0.2	1	3	0.09	
T4	0.11	0.14	0.33	1	0.05	

Table 13: Global scoring of SWOT sub factors (AHP technique)

		Level 1 weights (A)	Level 2 weights (B)	Global weights (A*B)	Ranking
S	S1	0.55	0.17	0.0935	4
	S2	0.55	0.16	0.088	5
	S3	0.55	0.41	0.2255	1
	S4	0.55	0.07	0.0385	10
	S5	0.55	0.19	0.1045	3
W	W1	0.08	0.07	0.0056	17
	W2	0.08	0.5	0.04	9
	W3	0.08	0.19	0.0152	14
	W4	0.08	0.24	0.0192	12
O	O1	0.22	0.14	0.0308	11
	O2	0.22	0.52	0.1144	2
	O3	0.22	0.08	0.0176	13

	O4	0.22	0.26	0.0572	7
T	T1	0.15	0.57	0.0855	6
	T2	0.15	0.29	0.0435	8
	T3	0.15	0.09	0.0135	15
	T4	0.15	0.05	0.0075	16

After conducting SWOT analysis, the weights are ranked as per the Table-12 strengths S3, S5, S1, S2, S4 are in descending order, which shows the company is having suitable strengths to face the threats and for overcoming the weakness.

TOWS Analysis (Different Groupings)

Table 14: Grouping of strengths and threats

Strengths	Threats
Shore base plant	Demand
Brand name	Debt crisis
Enriched product mix	Competition
Highly skilled and dynamic human resources environmental and social commitments	Dumping

Based on Table-13, the strategies that are adapted for sustainability.
Strategy-1: STR 1 product mix improvements.
Strategy-2: STR 2 export enhancement.

Table 15: Grouping of strengths and opportunities

Strengths	Opportunities
Shore base plant Brand name Enriched product mix Highly skilled and dynamic human resources Environmental and social commitments	Focus on expansion/flexible in future good internal market ROLL PASS DESIGN

Strategy-3: STR 3 New products design strength and opportunity
Strategy-4: STR 4 Quality improvement programs strength and opportunity

Table 16: Grouping of opportunities and weakness

Opportunities	Weakness
Focus on expansion/flexible in future good internal market	Production cost increase
ROLL PASS DESIGN	High finance charges
	Only long products
	CYCLIC PRODUCTS

Strategy-5: STR 5 Yield improvement, Branding and Better Packaging weakness and opportunities.
Strategy-6: STR 6 Production cost decrease weakness and opportunities.

Table 17: Grouping of threats and weakness

Opportunities	Weakness
Demand	Production cost increase
Debt crisis	High finance charges
Competition	Only long products
Dumping	Cyclic product

Strategy-7: STR 7 Production rate improvement for reduction in fixed costs weakness and threats.
Strategy-8: STR 8 Customer base improvement by reducing defectives and discount weaknesses and threats.
Total eight strategies are adoptable for improvement.

Table 18: Normalised weight table - strategy wise (AHP technique)

Strategies	Effecting factors	Global weights				Total weights (1+2+3+4)	Normalized weights
		1	2	3	4		
STR1	S5, S3, T1, T3	0.1045	0.2255	0.0855	0.0135	0.429	0.215577889
STR2	S1,S2, T2	0.0935	0.088	0.0435		0.225	0.113065327
STR3	S3,02,O4	0.2255	0.1144	0.0572		0.3971	0.199547739
STR4	S3,S1, O1, O3	0.2255	0.0935	0.0308	0.0176	0.3674	0.184623116
STR5	W4,W3, O1,O4	0.0192	0.0152	0.0308	0.0572	0.1224	0.061507538
STR6	W4,W2, O4,O1	0.0192	0.04	0.0572	0.0308	0.1472	0.073969849
STR7	T4,T1, W2,W4	0.0075	0.0855	0.04	0.0192	0.1522	0.076482412

STR8	T1,T2, W1,W3	0.0855	0.0435	0.0056	0.0152	0.1498	0.075276382
Total						1.9901	

Normalised weights of each strategy are mention in the Table-17.
Total 6 rolling mills are existing in VSP, each mill is visited and are asked scoring on 1 to 5 scale against the implementation of strategies, this is done to check the ranking of departments in order to pull the low ranked departments and to keep sustained efforts in high ranked departments, this is done after taking scores from 3 people and averaging.

Table 19: Ranking of departments by scoring approach (using AHP)

Strategies	**Weight (1)**	**dep1 (2)**	**Weight (1*2)**	**dep2 (3)**	**Weight (1*3)**	**dep3 (4)**	**Weight (l*4)**	**dep4 (4)**	**Weight (4*1)**	**dep5 (5)**	**Weight (5*1)**	**dep6 (6)**	**Weight (6*1)**
STR 1	0.22	4	0.86231	4	0.8623	3	0.6467	2	0.43116	4	0.8623	3	0.6467
STR 2	0.11	3	0.3392	4	0.4523	4	0.4523	3	0.3392	3	0.3392	3	0.3392
STR 3	0.20	4	0.79819	3	0.5986	3	0.5986	4	0.79819	4	0.7982	2	0.3991
STR 4	0.18	3	0.55387	4	0.7385	2	0.3692	2	0.36925	3	0.5539	3	0.5539
STR 5	0.06	5	0.30754	3	0.1845	3	0.1845	3	0.18452	3	0.1845	3	0.1845
STR 6	0.07	2	0.14794	3	0.2219	3	0.2219	2	0.14794	2	0.1479	3	0.2219
STR 7	0.08	3	0.22945	2	0.153	2	0.153	3	0.22945	3	0.2294	3	0.2294
STR 8	0.08	3	0.22583	3	0.2258	3	0.2258	3	0.22583	4	0.3011	3	0.2258
	Sum		3.46432		3.4369		2.8521		2.72553		3.4166		2.8006
	Rank		1		2		4		6		3		5

Note: In the above Table-18, dep1-wrm2, dep2-sbm, dep3-stm, dep4-wrm, dep5-mmsm, dep6-lmmm

RAPS techniques

Table 20: Scoring as per RAPS scale

	min	**max**	**max**	**max**	**min**	**max**	**min**	**min**
Weights	0.22	0.11	0.2	0.18	0.06	0.07	0.08	0.08
Department	**str1**	**str2**	**str3**	**str4**	**str5**	**str6**	**str7**	**str8**
dep1	4	3	4	3	5	2	3	3
dep2	4	4	3	4	3	3	2	3
dep3	3	4	3	2	3	3	2	3
dep4	2	3	4	2	3	2	3	3
dep5	4	3	4	3	3	2	3	4
dep6	3	3	2	3	3	3	3	3
max	4	4	4	4	5	3	3	4
min	2	2	1	1	3	2	2	3

Each value is x_{ij} in this table

Table 21: Normalizing of department score

	min	**max**	**max**	**max**	**min**	**max**	**min**	**min**
Weights	0.22	0.11	0.2	0.18	0.06	0.07	0.08	0.08
	str1	**str2**	**str3**	**str4**	**str5**	**str6**	**str7**	**str8**
dep1	0.5	0.75	1	0.75	0.6	0.67	0.67	1
dep2	0.5	1	0.75	1	1	1	1	1
dep3	0.67	1	0.75	0.5	1	1	1	1
dep4	1	0.75	1	0.5	1	0.67	0.67	1
dep5	0.5	0.75	1	0.75	1	0.67	0.67	0.75
dep6	0.67	0.75	0.5	0.75	1	1	0.67	1

Each value is r_{ij} in this table

Table 22: Weighted normalizing department score

	min	**max**	**max**	**max**	**min**	**max**	**min**	**min**
Weighed	0.22	0.11	0.2	0.18	0.06	0.07	0.08	0.08
	str1	**str2**	**str3**	**str4**	**str5**	**str6**	**str7**	**str8**
a	0.11	0.0825	0.2	0.135	0.04	0.046667	0.05	0.08
b	0.11	0.11	0.15	0.18	0.06	0.07	0.08	0.08
c	0.14	0.11	0.15	0.09	0.06	0.07	0.08	0.08
d	0.22	0.0825	0.2	0.09	0.06	0.047	0.053	0.08
e	0.11	0.0825	0.2	0.135	0.06	0.047	0.053	0.06
f	0.147	0.0825	0.1	0.135	0.06	0.07	0.053	0.08
min	0.22				0.06		0.08	0.08
max		0.11	0.2	0.18		0.07		

Table 23: Ranking of department as per RAPS technique

	Qmax	Qmin	Optimal perimeter	Perimeter ratio (PS_i)	Rank
	0.298998	0.254558	0.94624		
	Magnitude of alternative (max)	**Magnitude of alternative (min)**	**Perimeter of each alternative**		
dep1	0.25925	0.1504	0.7094	0.749783124	4
dep2	0.2681	0.16881	0.7538	0.796648732	2
dep3	0.2181	0.194707	0.7053	0.745376378	5
dep4	0.2389	0.24747	0.8303	0.877577589	1
dep5	0.2592	0.1730	0.7439	0.786195257	3
dep6	0.1998	0.1853	0.6577	0.695105611	6

dep1-wrm2, dep2-sbm, dep3-stm, dep4-wrm, dep5-mmsm, dep6-lmmm

Results

Thus, from SWOT analysis and AHP criterion method, the projects are prioritized with ranking. As per swot analysis,
Highly skilled and dynamic human resources: Knowledgeable and skilled workforce availability S3, Enriched product mix: the product mix of long products serves the need of infrastructure, railways, automobile etc. S5, Brand name: reputation of quality products and brand name in the market, S1, Shore base plant: it is a locational advantage for export of products and import of critical spares, S2, Environmental and social commitments: non-polluting and ISO company, S4.
Shore base plant: it is a locational advantage for export of products and import of critical spares the least rated are, W3, T3, T4, W1.

W3) Only long products: long products such as rounds, rebar's angles, channels, other structural.
T3) Demand not expected lines in domestic market; market instability due to inflation and uncertainty.
T4) Debt crisis: higher production costs due to fluctuations in market and increase in interest rates on working capital.
W1) Cyclic products: demand fluctuates.

The weakness and threats which can be addressed by utilising the opportunities.
The tows analysis is conducted total eight strategies are formulated. They are applied in respective departments of finishing mills of Visakhapatnam steel plant, STR1, STR2, STR3, STR4 are ranked high.
STR1: Product mix improvements: because of scope availability in rolling mills, better roll pass design facilities are available, product mix can help the unit for market sustainability.
STR2: Export enhancement: shore and brand image helps to improve market potential.
STR3: New products design: market diversification will help to face competition.
STR4: Quality improvement programs: quality improvement programmes will help to improve brand image and market penetration.

The implementation status review is taken among 6 departments and are ranked based AHP and RAPS analysis, the departments are listed as follows,

Table 24: Comparison between normal and RAPS

Departments	Normal	RAPS
1	1	4
2	2	2
3	4	5
4	6	1
5	3	3
6	5	6

dep1-wrm2, dep2-sbm, dep3-stm, dep4-wrm, dep5-mmsm, dep6-lmmm

As per the weights of AHP strategies implements in different department is considered. the ranks of departments are mentioned in the above table.
But in reality the strategies can be minimization or maximization types, which is not addressed in simple AHP model. It is addressed in RAPS technique. Hence the ranking is changed.as per this all latest departments commissioned are appearing in the top of list.
Observations as per RAPS:
Rank-1: wrm1: High quality and better market demand.
Rank-2: sbm: New unit, new market is available particularly for railways.
Rank-3: stm: New unit, new market is available. Input is from new steel melting shop. Quality is good.
Rank-4: wrm2: Further to be explored. Still some problems exist due to stabilization of new unit.
Rank-5 and 6 being old units, needed upgradation
Ranking is influenced by quality, better product mix and better yield. It plays a role this clearly shows RAPS is the best technique.

Conclusion

A well-known technique in strategic planning is to gather and organize information regarding the strengths, weaknesses, opportunities and threats facing the immediate and near future of an organization. This technique is usually called SWOT. Based

on this information the organization must develop alternative plans and select the most convenient to its interests. It is assumed that previously to this process, for the appropriate evaluations of the plans, the organizations should have reviewed (and restate if needed) its mission, vision and values. The objectives of these plans should be to take most advantage of the strengths and opportunities, as well as to reinforce most the weaknesses and develop the best defense to the threats. As we can expect neither of the plans could be considered as dominant in the sense that it would be the best one with respect to all of the objectives.

Future Scope of Study

- Based on SWOT analysis, TOWS analysis is done to formulate different strategies. Consequently, we will be faced to the classical problem of relative preference between them. In this work, we proposed to solve the problem by combining this technique with AHP in order to compare the alternatives.
- The implementation of strategies in various units of organization may vary depending on the conditions prevalent in those units. Hence the departments have to be ranked based on the implementation levels. Departments have to be ranked accordingly, which is done in this work. So that low ranked department can be pulled up and high ranked department can be made to sustain its position. Ranking according to conventional techniques and RAPS technique is demonstrated here.
- Both techniques (AHP & RAPS) have found small changes in intermediate rankings. However, RAPS being new technique, it is suggested for implementing these techniques are to be applied in other units of organization. Application in other units such as Mining, Textiles and Pharmaceuticals to be explored. Other MCDM techniques such as VIKOR, MOORA, etc. can be applied to find the best technique.
- In future fuzzy AHP can be applied as the strategic management decisions for forecasting purpose.

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