A SEQUENTIAL MULTI-CRITERIA DECISION MODEL FOR SMEs OPERATIONS "STAIRCASE STRATEGY"

Dragan Sutevski
Euro College, North Macedonia, d.sutevski@eurocollege.edu.mk
ORCID ID: 0009-0006-0963-1775
Savo Efremovski
Euro College, North Macedonia, s.efremovski@eurocollege.edu.mk
ORCID ID: 0009-0005-6248-0702

Abstract: This paper focuses on the gap in strategic execution in small and medium-sized enterprises, which results from structural resource constraints, limited capital, and cognitive overload. Traditional strategic management frameworks often advocate for concurrent, parallel investments of resources across multiple strategic dimensions, which typically induces severe operational distress, rapid cash-burn rates, and potential bankruptcy in smaller firms because a small business is not simply a smaller version of a large corporation. To resolve this execution bottleneck, this paper presents a formalization of the conceptual staircase strategy as a Sequential Multi-Criteria Resource Allocation Model. The methodology integrates Multi-Attribute Utility Theory with zero-one dynamic integer programming and deterministic state-space transitions, segmenting the strategic execution process into discrete temporal phases that we call them as Stop Stations. The model also limits the number of active projects per stage to decrease project fatigue among small management teams and enforces dynamic state-transition equations in which yields as outputs from previous stage support subsequent stages. The methodology was validated using a simulated case study of a precision engineering firm, which evaluated three competing projects: a cloud customer relationship management and automated billing system, an advanced computer numerical control milling unit, and an operator cross-training program. The initial working capital was fifteen thousand dollars, and the technical staff capacity was eighty hours. The simulation results confirm that, while the high-utility machinery upgrade was initially financially infeasible because its cost of eighteen thousand dollars exceeded the starting capital, the optimization model proposed here successfully identified an optimal, self-funding sequence. Specifically, in the analysed case the model prioritized the low-cost customer relationship management system, which cost eight thousand dollars and consumed twenty staff hours, because its execution could generate enough overhead labor reductions and capital yields that dynamically expanded the firm's resources, making the machinery acquisition feasible in the subsequent planning period. We find that this scientific mathematical approach helps avoid poor strategic decisions and resource spreading by setting clear focus limits and updating resources as needed. This puts the challenge-reaction-learning process of entrepreneurial resilience into practice and supports dynamic capabilities when facing deep uncertainty. We suggest that operation's managers of small firms stop using fixed, multi-year strategic plans. Instead, they should try ninety-day cycles that use feedback and visual tools like the Business Strategy Canvas to guide their decisions. This research offers a practical and efficient way to connect operational knapsack optimization with long-term strategic planning in fast-changing, resource-limited business settings. It provides a strong base for developing future decision support tools.
Keywords: strategic planning, small and medium enterprises, resource allocation, project sequencing, dynamic programming.

1. INTRODUCTION

Small and medium-sized enterprises (SMEs) are the foundational engine of economic development, innovation, and employment generation worldwide. However, despite their macroeconomic significance, SMEs usually operate under extreme structural constraints—often referred to in management literature as "resource poverty" (Welsh & White, 1981). Unlike large, heavily resourced multinational corporations or big companies that have large level of cash reserves and access to capital, high levels of administrative and operational resources, and the ability to plan far ahead in years, SMEs often have limited financial resources, fewer specialized employees, and at the same time are more affected by impulsive interruptions and changes in their environment (Hudson et al., 2001; Caballero-Morales, 2021). Also, because their strategic challenges and resource limitations are heavily influenced by their pre-crisis growth ambitions, traditional "static" strategic planning tools fail to support their survival (Schepers et al., 2021). Therefore, many traditional strategic management frameworks that support large-scale, parallel key initiatives across multiple strategic areas are in large part irrelevant to smaller companies (Sutevski et al., 2026).

In the case of SMEs, when they attempt to scale multiple growth initiatives concurrently, they will invariably experience resource dilution, capacity crunches, or technical bankruptcy before the initiatives themselves can realize any value (Welsh & White, 1981). Strategic key initiatives must therefore be prioritized and sequenced in a manner that respects both immediate financial survival, ensuring normal uninterrupted operations and long-term strategic viability. In practice, managers seek a framework that prioritizes strategic objectives into structured, self-funding intervals. We introduced this concept conceptually as the "Staircase Strategy." The staircase strategy framework organizes complex strategic execution into discrete, bounded stages called "Stop Stations", or "stairs," with a typical duration of 90 days to 6 or 12 months, based on the type and size of the company. The foundational operational rule of the Staircase Strategy is that Step N must actively expand the firm's resources or resolve a critical bottleneck to fund and enable entry into Step N+1.

The Staircase Strategy is easy to understand in theory, but it has not had a strong mathematical optimization method. Because of this, practitioners often rely on subjective scoring systems for prioritizing key strategic initiatives that do not account for complex changes in resources. This can lead to poor sequencing decisions or unintentional over-allocation (Yazdani et al., 2019). Because of that, there is a need for second-level prioritization of the key strategic initiatives.

The goal of this paper is to close this gap (using quantitative measures instead of intuition) by using a Sequential Multi-Criteria Resource Allocation Model (SMC-RAM). We combine Multi-Attribute Utility Theory (MAUT) with zero-one integer programming and clear step-by-step state changes (Saaty, 1990; Keeney & Raiffa, 1976). By turning subjective managerial priorities and project resource requirements into formal mathematical variables, the model provides that each chosen "stair", or divided strategic key initiative, is an optimal, feasible, and self-supporting step toward the firm's long-term vision.

2. MATERIALS AND METHODS

We can derive an exact mathematical representation of the SME Staircase Strategy as follows. Assume that the planning horizon is divided into a series of stages. At each stage, a subset of projects are chosen subject to capacity (resource) constraints at that stage. Capacity requirements are then revised for the subsequent stage based on the remaining capacity after selection of projects at the current stage. In other words, the capacity at each stage is "feedback" determined. The following integrates the subjective decision prioritization schema associated with MAUT with the resource optimization model associated with Multi-Dimensional Knapsack Problem (MKP) and Dynamic Programming (DP) (Keeney & Raiffa, 1976; Weingartner, 1963; Bellman, 1957).

Let $\mathcal{I} = \{1,2,\dots,I\}$ be the set of investment projects from which the SME can choose from (i.e., the number of projects they would like to undertake) and $\mathcal{K} = \{1,2,\dots,K\}$ be the set of Stop Stations (i.e., finite intervals of the planning horizon; 90-day, 3-month, or 6-month action steps). Also, the firm has a finite set of criteria $\mathcal{C} = \{1,2,\dots,C\}$ that it uses to assess its projects, and $\mathcal{R} = \{1,2,\dots,R\}$ is the set of resources needed to undertake a project (e.g., dollars of working capital, hours of engineering capacity, hours of administrative support, etc.).

If we assume that $v_{ic} \in [0,10]$ is the raw score that the management team gives to project $i \in \mathcal{I}$ with respect to criterion $\in \mathcal{C}$, to show how important each criterion is, we set $w_c \in [0,1]$ as the normalized weight for criterion c that must meet the convex scaling condition:

$$\sum_{c=1}^{C} w_c = 1$$

Applying MAUT (Keeney and Raiffa, 1976), we calculate a dimensionless strategic utility score U_i used to rank and compare different projects based on multiple competing business goals for each potential candidate project *i*. This formula rescales raw multi-criteria scores against the best-performing potential project in each category to prevent scale distortions:

$$U_i = \sum_{c=1}^{C} w_c \cdot \left(\frac{v_{ic}}{\max_{j \in \mathcal{I}} v_{jc}} \right)$$

This utility aggregation provides us with a reliable priority scale (Saaty, 1990). But physical realization is constrained by available resources. For each project $i \in \mathcal{I}$ and resource type $r \in \mathcal{R}$, we define two key operational parameters: (1) Upfront Resource Cost ($a_{ir} \geq 0$): The quantity of resource *r* utilized in the undertaking of project *I* and (2) Endogenous Resource Production ($g_{ir} \geq 0$): The quantity of resource *r* generated, automated, or freed upon the successful completion of project *i*. It is the amount of resource r created/generated/unlocked after successful completion of project i (free cash flow, technician hours made available).

$$x_{ik} = 1$$

We now define the decision variables of our formulation. Let $x_{ik} \in \{0,1\}$ be a binary decision variable that assumes value 1 if project i is chosen at Stop Station k and 0 otherwise. Also, we use continuous state variables $R_{k,r} \geq 0$ to capture the total quantity of resource *r* that is available to the SME at the precise beginning of Stop Station *k*. Our

initial condition is given by the resource vector $R_{1,r}$ which corresponds to the audited initial endowment of the firm.
To represent the dynamic and survival-focused environment of SMEs, we simply integrate a temporal discount factor $\gamma \in (0,1]$ to reduce the weight of postponed returns and focus on projects that provide instantaneous benefits and reduce risks for the company (Welsh & White, 1981; Cooper, 1990). The multi-step goal is designed to maximize the total reduced utility over the planning period, optimized at the same time over the decision variables *x* and resource states *R*:

$$\max_{x,R} \sum_{k=1}^{K} \sum_{i=1}^{I} \gamma^k \cdot U_i \cdot x_{ik}$$

The maximization function is subject to four basic system constraints that represent the logical restrictions of the Staircase Principle:
Constraint 1 (Project Uniqueness): To avoid repeating work and wasting resources, no project can be done more than once during the strategic planning period:

$$\sum_{k=1}^{K} x_{ik} \leq 1 \quad \forall i \in \mathcal{I}$$

Constraint 2 (Instantaneous Resource Viability) means that the total resources used by all selected projects in stage k must not exceed the resources available at the beginning of that stage. This rule emphasizes the strict limits on the most important resources for the SME, much like classic knapsack problems where spending is limited by the current budget (Weingartner, 1963):

$$\sum_{i=1}^{I} a_{ir} \cdot x_{ik} \leq R_{k,r} \quad \forall k \in \mathcal{K}, \forall r \in \mathcal{R}$$

Constraint 3 (Endogenous Resource Transition): This is the motion part of the staircase strategy. Resources available at the beginning of stage *k+1* equal resources available at the beginning of stage *k* minus resources used in stage *k*, plus yields generated by completed projects in stage *k*. This state-transition constraint captures the notion of self-financing i.e. past accomplishments enable future constraints (Bellman, 1957; Weingartner, 1967):

$$R_{k+1,r} = R_{k,r} + \sum_{i=1}^{I} (g_{ir} - a_{ir}) \cdot x_{ik} \quad \forall k \in \{1,2,\dots,K-1\}, \forall r \in \mathcal{R}$$

Constraint 4 (Focus Bandwidth Cap): To avoid overloading the small management team mentally and in their work, the number of active projects in any single Stop Station is strictly limited to a positive number *M*:

$$\sum_{i=1}^{I} x_{ik} \leq M \quad \forall k \in \mathcal{K}$$

It can be restated as a 5-step implementation procedure: (1) Take stock of potential projects and seed resources ($R_{1,r}$); (2) Compare criteria in pairs and weigh/score them to determine utility U_i; (3) Chart projects' use of resources (a_{ir} and g_{ir}); (4) Solve the boolean matrix to determine which projects are at Stop Station k; and (5) Measure real resource yield at boundary of *k+1* to update and re-optimize remaining staircase steps.

3. RESULTS

To test and confirm the SMC-RAM model in real small business conditions, we simulated the key decisions of a precision engineering workshop trying to move toward advanced digital manufacturing. The company planned for two 6-month periods ($K = 2$), with a strict limit of one project at a time (M=1) because of heavy administrative workload. The time-related reduction factor was set to $\gamma = 0.95$.
Management checked resources to find the starting amounts in two key areas: available cash ($r = 1$) and weekly technical staff hours ($r = 2$): (1) Starting Cash Balance ($R_{1,1}$): \$15,000 and (2) Starting Technical Staff Hours ($R_{1,2}$): 80 hours.
The firm set two main evaluation criteria: Throughput Expansion Capability ($c = 1$), with a weight of 0.6, and Overhead Labor Reduction ($c = 2$), with a weight of 0.4. Three projects were chosen: Project 1 (a Cloud CRM and automated billing system), Project 2 (an advanced CNC milling machine), and Project 3 (a program to train operators in multiple skills). Table 1 shows the basic scores and calculated utility values (U_i) for each candidate project.

Table 1. Project Evaluation Metrics and Normalized Utility

Project Index (i)	Throughput Score (v_{i1})	Overhead Score (v_{i2})	Normalized Utility (U_i)
Project 1 (CRM Overhaul)	4	10	0.640
Project 2 (CNC Milling)	10	3	0.720
Project 3 (Operator Training)	6	6	0.600

Source: Own work

The baseline cost and yield parameters (a_{ir} and g_{ir}) were compiled by the firm's operations manager, as detailed in Table 2.

Table 2. Resource Footprint Matrix (Costs vs. Yields)

Project (i)	Capital Cost (a_{i1})	Technical Cost (a_{i2})	Capital Yield (g_{i1})	Technical Yield (g_{i2})
Project 1 (CRM Overhaul)	\$8,000	20 hours	\$12,000	40 hours
Project 2 (CNC Milling)	\$18,000	50 hours	\$30,000	10 hours
Project 3 (Operator Training)	\$4,000	40 hours	\$6,000	20 hours

Source: Own work

With these inputs, the optimization engine looked at which strategic sequences were possible for both planning horizons. At Stop Station 1 ($k = 1$), the algorithm checked if each project was viable.
The first project evaluated was Project 2 (CNC Milling). It needed an upfront investment of \$18,000. Since the available capital at the start was only \$15,000, Project 2 did not meet the Instantaneous Resource Viability Constraint. The required amount was greater than the available funds, so it was marked as infeasible.
Thus, executing the high-utility machinery upgrade at *k = 1* was mathematically infeasible. The algorithm then compared the two feasible alternatives: Project 1 and Project 3.
If the model selected Project 1 (CRM Overhaul) for the first stage ($x_{11} = 1$), the state transition equation updated the resource variables for the start of the second stage (*k = 2*) as follows: $R_{2,1} = \$15{,}000 + (\$12{,}000 - \$8{,}000) = \$19{,}000$ and $R_{2,2} = 80 + (40 - 20) = 100$ hours.

With these expanded resources at *k = 2*, the previously locked Project 2 (CNC Milling) became highly viable, as its capital cost (\$18,000) and staff cost (50 hours) easily fit within the new limits ($R_{2,1} = \$19{,}000$) and ($R_{2,2} = 100$ hours). The cumulative strategic utility of this sequence (Path A: Project 1 → Project 2) was:

$$\text{Total Utility} = 0.95(0.640) + (0.95)^2(0.720) = 0.608 + 0.650 = 1.258$$

If the model instead selected Project 3 (Operator Training) for the first stage ($x_{31} = 1$), the resource transition for the second stage yielded: $R_{2,1} = \$15{,}000 + (\$6{,}000 - \$4{,}000) = \$17{,}000$ and $R_{2,2} = 80 + (20 - 40) = 60$ hours.
In this scenario, the capital pool at *k = 2* was just \$17,000. As a result, Project 2 (CNC Milling) could not move forward because it needed \$18,000, which was more than what was available ($a_{2,1} = \$18{,}000 > \$17{,}000$). The only option left for the second phase was Project 1. Choosing this sequence (Path B: Project 3 followed by Project 1) led to a much lower total strategic utility.

$$\text{Total Utility} = 0.95(0.600) + (0.95)^2(0.640) = 0.570 + 0.578 = 1.148$$

Comparing both operational sequences, the algorithm in this case successfully determined the mathematically optimal allocation policy: $x_{11} = 1$, $x_{22} = 1$, and $x_{3k} = 0$.

4. DISCUSSION

A simulation of a precision engineering firm shows how important it is for small and medium-sized businesses to plan projects in order and consider their resources. If a manager follows a traditional approach, they might start the CNC Milling project right away because it seems most valuable ($U_2 = 0.720$), but this ignores the risk of running out of cash. For example, starting an \$18,000 project with only \$15,000 on hand would mean taking on expensive short-term debt, which could lead to insolvency. On the other hand, a very cautious manager might skip the CNC upgrade altogether, which would prevent the company from moving forward.

The SMC-RAM model uses the Instantaneous Resource Viability Constraint to keep the firm from over-leveraging or weakening its core resources (Welsh & White, 1981; Hudson et al., 2001). More importantly, the model uses the dynamic feedback from the state-space transition equation:

$$R_{k+1,r} = R_{k,r} + \sum_{i=1}^{I} (g_{ir} - a_{ir}) \cdot x_{ik}$$

This equation simply proves that projects are not merely cash-absorbing expenses; rather, they are structural enablers that actively redefine the operational boundaries of the next phase.

The firm started by introducing a low-cost CRM system, which helped lower overhead and increased both working capital and technical capacity. This step-by-step approach set up the company to successfully add a high-utility CNC milling line later using the gains from the previous staircase. This exact order of actions (key initiatives) supports dynamic capability theory (Teece et al., 1997; Teece, 2025; Eisenhardt & Martin, 2000). It also puts into practice the "challenge-reaction-learning loop" described by Schepers et al. (2021), showing that long-term SME resilience comes from regularly updating basic operations to handle new challenges. This case shows that in unpredictable environments, simple and structured learning processes work better than complex, long-term strategic plans.

Furthermore, setting a strict limit on how much focus can be spread ($M = 1$) helps small administrative and operational teams avoid project burnout, making sure the first "stair" is fully steady and productive before the company tries to move to the next. This matches research showing that focus, not a wide strategic range, is the main factor for success in companies with limited resources (Ebersberger & Kuckertz, 2021).

5. CONCLUSIONS

We bridged the conceptual "Staircase Strategy" with rigid operations research methodologies using the SMC-RAM. Simply, the model organizes project selection into a series of feedback-based, resource-limited steps. This approach helps avoid spreading resources too thin and keeps cash-burn rates low, which are common problems for strategic projects in SMEs. A case study with a precision engineering firm shows that this method is practical, easy to use, and mathematically reliable for planning operational goals. The results suggest that the best way to reach a major, resource-limited goal is often to follow a step-by-step, self-funding process. In this process, smaller, low-cost projects are completed first to create the resources needed for bigger investments later.

Crucially, this research contributes to a fundamental paradigm shift in the strategic and economic theory of the firm. Mainstream economic theories historically treat the firm as a static entity in approximate equilibrium—focusing primarily on a state of "being" where operational optimization under conditions of quantifiable risk takes precedence. Unlike other approaches, the SMC-RAM uses a dynamic theory of "doing." It treats resource states as internal, feedback-driven variables that change over time based on project results. The model shows that an SME's survival and growth in uncertain conditions depend not on simply having resources, but on how those resources are managed over time. This means strategy moves from just using assets to actively building entrepreneurial skills in a constantly changing environment.

Furthermore, this mathematical sequencing provides a rigorous quantitative foundation for the qualitative "challenge-reaction-learning loop" that drives growth-oriented SME resilience. When a precision engineering firm was confronted with the immediate "challenge" of capital constraints preventing the purchase of advanced machinery, the model's optimal "reaction"—the deliberate sequencing of a lower-cost customer relationship management system—acted as a structural stepping stone. The resource yields generated from this first phase represent the "learning" step, which dynamically expanded the firm's operational boundaries and unlocked the subsequent, higher-utility milestone. Instead of seeing resource poverty as a fixed barrier, the SMC-RAM shows that smaller firms can use step-by-step, self-funded stages to build their skills and adapt. This approach helps them turn major disruptions in their environment into chances to grow.

For practitioners, this research offers a clear implementation protocol to audit, score, and sequence projects without requiring complex, enterprise-level planning software. However, to prevent this mathematical optimization engine from becoming another static strategic plan—which often suffers from ontological design flaws where resource requirements are disconnected from actual operational tasks—we recommend that managers integrate the SMC-RAM with visual management frameworks such as the Business Strategy Canvas (BSC). Using a lower time span, such as a 90-day prioritized strategic key initiative for stage one, generated by the SMC-RAM onto a single-page visual canvas, such as the BSC (Sutevski et al., 2026), allows higher-level transparency, real-time alignment between daily actions, essential resources, and long-term strategic objectives. This visual synchronization simply provides a shared reference point that facilitates mutual understanding among team members, minimizes confusion, and supports administrative teams by mitigating project fatigue.

This model offers academic researchers a new way to combine multi-criteria utility theory, knapsack optimization, and dynamic capabilities, all designed for the challenges of resource poverty. Future studies should look at adapting this model to unpredictable situations by including probability-based changes in project results and costs, which would help address supply chain and market changes. It is also important to carry out long-term studies that follow how SMC-RAM works with visual strategy tools in different industries, so we can measure its lasting effects on how organizations perform, adapt, and stay flexible in fast-changing environments.

ACKNOWLEDGEMENTS

The authors would like to thank the academic staff at Euro College for their support in the research and for allocating resources to conduct the research.

REFERENCES

Bellman, R. (1957). *Dynamic programming*. Princeton University Press.

Caballero-Morales, S.-O. (2021). Innovation as recovery strategy for SMEs in emerging economies during the COVID-19 pandemic. *Research in International Business and Finance 57 (2021) 101396*. https://doi.org/10.1016/j.ribaf.2021.101396

Cooper, R. G. (1990). Stage-gate systems: A new tool for managing new products. *Business Horizons*, 33(3), 44-54. https://doi.org/10.1016/0007-6813(90)90040-I

Ebersberger, B., & Kuckertz, A. (2021). Hop to it! The impact of organization type on innovation response time to the COVID-19 crises. *Journal of Business Research*, 124, 126-135. https://doi.org/10.1016/j.jbusres.2020.11.051

Eisenhardt, K. M., & Martin, J. A. (2000). Dynamic capabilities: What are they? *Strategic Management Journal*, 21(10-11), 1105-1121. https://doi.org/10.1002/1097-0266(200010/11)21:10/11<1105::AID-SMJ133>3.0.CO;2-E

Hudson, M., Smart, A., & Bourne, M. (2001). Theory and practice in SME performance measurement systems. *International Journal of Operations & Production Management*, 21(8), 1096-1115. https://doi.org/10.1108/EUM0000000005587

Keeney, R. L., & Raiffa, H. (1976). Decisions with multiple objectives: Preferences and value trade-offs. John Wiley & Sons.

Saaty, T. L. (1990). How to make a decision: The Analytic Hierarchy Process. *European Journal of Operational Research*, 48(1), 9-26. https://doi.org/10.1016/0377-2217(90)90057-I

Schepers, J.; Vandekerkhof, P.; Dillen, Y. The Impact of the COVID-19 Crisis on Growth-Oriented SMEs: Building Entrepreneurial Resilience. Sustainability 2021, 13, 9296. https://doi.org/10.3390/su13169296

Sutevski, D., Petrusevski, L., & Cvetkovic, R. (2026). The Business Strategy Canvas: From Strategic Planning To Operational Execution. Knowledge - International Journal, 74(1), 71–76.

Teece, D. J., Pisano, G., & Shuen, A. (1997). Dynamic capabilities and strategic management. Strategic Management Journal, 18(7), 509–533. https://doi.org/10.1002/(SICI)1097-0266(199708)18:7509AID-SMJ8823.0.CO;2-Z

Teece, D. J. (2025). Dynamic Capabilities: Foundational Concepts (Elements in Business Strategy). Cambridge University Press

Triantaphyllou, E. (2000). *Multi-criteria decision making methods: A comparative study*. Kluwer Academic Publishers. https://doi.org/10.1007/978-1-4757-3157-6

Verhoef, P. C., Broekhuizen, T., Bart, Y., Bhattacharya, A., Dong, J. Q., Fabian, N., & Haenlein, M. (2021). Digital transformation: A multidisciplinary reflection and research agenda. *Journal of Business Research*, 122, 889-901. https://doi.org/10.1016/j.jbusres.2019.09.022

Weingartner, H. M. (1967). Mathematical programming and the analysis of capital budgeting problems. Markham Publishing Company.

Welsh, J. A., & White, J. F. (1981). A small business is not a little big business. *Harvard Business Review*, July-August, 1981.

Yazdani, M., Gonzalez, E. D. R. S., & Chatterjee, P. (2019). A multi-criteria decision-making framework for agriculture supply chain risk management under a circular economy context. Management Decision, 57(11), 1088–1108. https://doi.org/10.1108/MD-10-2018-1088