A Study on Competency Mapping, Skill Gap Analysis, and Cost of Capital Analysis for Sustainable Growth in the Manufacturing Sector

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***Abstract*—Sustainable growth in the manufacturing sector depends jointly on the competence of its workforce and the efficiency of its capital structure. This paper examines the inter-linkage between competency mapping, skill gap analysis, and cost of capital in determining long-term organisational sustainability among mid- and large-scale manufacturing firms. Using a mixed-method design combining a structured survey of 220 employees and managers across twelve manufacturing units and secondary financial data of five listed manufacturing companies over a five-year period (2020-21 to 2024-25), the study measures the extent of skill gaps against defined competency frameworks and evaluates their relationship with the weighted average cost of capital (WACC) and firm growth indicators. The results indicate a statistically significant negative relationship between the magnitude of skill gaps and return on capital employed, and a significant positive relationship between structured competency mapping practices and sustainable growth scores. Firms with lower cost of capital were found to invest proportionately more in skill development, suggesting a reinforcing cycle between financial efficiency and human capital efficiency. The study contributes an integrated framework linking human resource competency systems with financial cost structures and offers practical recommendations for manufacturing organisations seeking sustainable, competitiveness-led growth.**

***Index Terms*—Competency Mapping; Skill Gap Analysis; Cost of Capital; WACC; Sustainable Growth; Manufacturing Sector; Human Capital**

I. INTRODUCTION

The manufacturing sector remains a cornerstone of economic development, contributing significantly to employment generation, industrial output, and export earnings in emerging economies such as India. However, sustainable growth of manufacturing firms is increasingly constrained by two interrelated challenges: a persistent mismatch between the skills possessed by the workforce and those required by evolving production technologies, and the rising cost of raising capital for modernisation and expansion. Competency mapping, defined as the systematic process of identifying and describing the knowledge, skills, and behavioural attributes required for effective job performance (Boyatzis, 1982), provides organisations with a structured basis for recruitment, training, and succession planning. When actual employee competencies fall short of the competencies required by a role, a skill gap emerges, which directly affects productivity, quality, and innovation capacity (Cardy & Selvarajan, 2006).

Simultaneously, the cost of capital, comprising the cost of debt and cost of equity combined into the weighted average cost of capital, determines a firm's capacity to invest in capital-intensive upgrades, automation, and workforce training programmes (Modigliani & Miller, 1958; Damodaran, 2016). A high cost of capital restricts discretionary investment in human capital development, while a low cost of capital, often the result of efficient operations and strong governance, enables firms to reinvest in both physical and human assets. Despite the intuitive connection between these financial and human-resource dimensions, limited empirical research has examined competency management and capital cost structures within a single integrated framework, particularly in the context of the

manufacturing sector. This study addresses that gap by empirically investigating how competency mapping and skill gap analysis relate to cost of capital and, in turn, to sustainable organisational growth.

The significance of this study lies in its attempt to bridge two functional silos, human resources and corporate finance, that are typically studied and managed independently within manufacturing organisations. Practitioners in manufacturing frequently treat training budgets as a discretionary cost centre rather than a capital investment subject to return expectations, while finance functions rarely incorporate workforce capability indicators into capital budgeting or cost-of-capital assessments. By empirically testing the relationship between these domains, this study provides both academic contribution, in the form of an integrated conceptual framework, and practical value, in the

form of evidence that can inform how manufacturing firms prioritise investment between physical and human capital under conditions of constrained financing.

The remainder of this paper is organised as follows: Section 2 reviews the relevant literature; Section 3 states the objectives and hypotheses; Section 4 presents the conceptual framework; Section 5 describes the research methodology; Section 6 reports the data analysis and results; Section 7 discusses the findings; and Section 8 concludes the paper with implications and directions for future research.

II. LITERATURE REVIEW

2.1. Competency Mapping

The concept of competency was first formally introduced by McClelland (1973), who argued that testing for competence rather than intelligence offered a better predictor of job performance. Boyatzis (1982) extended this by defining managerial competencies as underlying characteristics of a person that result in effective performance. Spencer and Spencer (1993) developed the widely used competency iceberg model, distinguishing visible competencies such as skills and knowledge from hidden traits such as motives and self-concept. In the manufacturing context, Sahoo and Mishra (2019) found that structured competency mapping improved workforce deployment efficiency and reduced training redundancy in Indian manufacturing units. Draganidis and Mentzas (2006) noted that competency management systems, when integrated with human resource information systems, enable organisations to align individual capability with strategic objectives.

2.2. Skill Gap Analysis

Skill gap analysis compares the competencies required for a role against the competencies currently held by employees, producing a quantifiable deficit that guides training investment (Cardy & Selvarajan, 2006). The World Economic Forum (2023) highlighted that nearly forty percent of core job skills are expected to change by 2027, with manufacturing and production roles among the most affected by automation and digital transformation. Agrawal and Thite (2020) observed that Indian manufacturing firms face acute shortages in advanced technical skills such as robotics maintenance and data-driven quality control, despite adequate availability of general labour. Similarly, Chandra and Gupta (2021) reported that skill gaps in mid-sized manufacturing enterprises were strongly associated with lower operational efficiency and higher rework costs.

2.3. Cost of Capital and Firm Growth

The theoretical foundation for cost of capital analysis originates from Modigliani and Miller (1958), who proposed that, under idealised market conditions, capital structure does not affect firm value, though subsequent refinements incorporating taxes and bankruptcy costs (Modigliani & Miller, 1963) demonstrated that an optimal capital structure minimises the weighted average cost of capital. Damodaran (2016) emphasised that WACC serves as the discount rate for investment appraisal and a benchmark for value creation, such that projects, including workforce development initiatives, are undertaken only when their expected return exceeds the cost of capital. Empirical work by Ghosh and Sengupta (2020) found an inverse relationship between WACC and capital expenditure intensity among Indian manufacturing firms, implying that firms facing higher financing costs invest less in both

physical and human capital.

2.4. Manufacturing 4.0 and the Changing Competency Landscape

The advent of Industry 4.0 technologies, including the Internet of Things, robotics, and data analytics, has fundamentally altered the competency requirements of manufacturing personnel. Kumar and Rajan (2022) argued that traditional shop-floor competency frameworks, built around manual operating skills, are becoming inadequate as machine-human interaction increases, necessitating a shift toward digitally augmented competency models. Prasad and Nair (2022) similarly observed that Indian manufacturing SMEs lag behind large enterprises in formal competency mapping, primarily due to resource constraints, and rely instead on informal, experience-based skill assessment, which limits their ability to systematically identify and close skill gaps. These studies collectively suggest that the pace of technological change in manufacturing has outstripped the rate at which competency frameworks and training systems are updated, widening the very gap this study seeks to measure.

2.5. Research Gap

While competency mapping, skill gap analysis, and cost of capital have each been studied extensively in isolation, few studies have empirically tested their combined influence on sustainable growth outcomes within a single manufacturing sample. Most competency-focused studies rely solely on qualitative or descriptive methods, while most cost-of-capital studies rely solely on secondary financial data without reference to workforce capability. This study addresses this gap by combining primary competency and skill-gap data with secondary financial data on the same set of manufacturing organisations, enabling a direct statistical test of the relationship between human-capital readiness, financing cost, and sustainable growth.

III. OBJECTIVES OF THE STUDY

1. To assess the existing competency levels of employees in selected manufacturing organisations against role-specific competency frameworks.
2. To identify and measure the extent of skill gaps across functional departments in the manufacturing sector.
3. To compute and analyse the cost of capital (cost of debt, cost of equity, and WACC) of selected manufacturing firms.
4. To examine the relationship between skill gap magnitude, competency mapping practices, cost of capital, and indicators of sustainable growth.
5. To propose an integrated framework and actionable recommendations linking human capital development with financial cost efficiency for sustainable growth.

IV. HYPOTHESES

H01: There is no significant relationship between the extent of skill gaps and return on capital employed (ROCE) of manufacturing firms.

H02: There is no significant relationship between structured competency mapping practices and sustainable growth scores of manufacturing firms.

H03: There is no significant relationship between the weighted average cost of capital (WACC) and the level of investment in employee skill development.

H04: There is no significant combined effect of skill gap and cost of capital on the sustainable growth rate (SGR) of manufacturing firms.

V. CONCEPTUAL FRAMEWORK

The study integrates two conventionally separate domains, human resource competency management and corporate finance, into a single conceptual model. Competency mapping and skill gap analysis constitute the human-capital input side, while cost of debt, cost of equity, and WACC constitute the financial-capital input side. Both streams are hypothesised to jointly determine a firm's capacity for sustainable growth, measured through the sustainable growth rate (SGR), return on capital employed (ROCE), and a composite sustainability

index combining productivity, quality, and financial stability indicators.

Construct	Key Dimensions	Indicative Measures
Competency Mapping	Technical, behavioural, managerial competencies	Competency assessment score (1-5 scale)
Skill Gap Analysis	Required vs. actual proficiency	Skill Gap Index = Required − Actual score
Cost of Capital	Cost of debt, cost of equity, WACC	WACC (%), Debt-Equity Ratio
Sustainable Growth	Financial, operational, human capital sustainability	SGR (%), ROCE (%), Sustainability Index

Figure 1 (conceptually) depicts competency mapping and skill gap analysis feeding into workforce productivity, while cost of capital determines the volume of investible funds available for training, technology, and capacity expansion. The interaction of workforce productivity and investible capital jointly drives sustainable growth outcomes, with feedback loops in which improved growth performance further lowers perceived risk and, consequently, the firm's future cost of capital.

VI. RESEARCH METHODOLOGY

6.1. Research Design

The study adopts a descriptive-cum-analytical, mixed-method research design combining primary survey data with secondary financial data to enable triangulation between human resource and financial constructs.

6.2. Sample and Data Collection

Primary data were collected from 220 employees and departmental managers across twelve manufacturing units (automotive components, engineering goods, and FMCG production) located in Maharashtra, using a structured questionnaire administered on a five-point Likert scale covering competency dimensions and perceived skill adequacy. A stratified random sampling technique was used to ensure proportional representation across production, quality, and maintenance departments. Secondary data comprising five years of audited financial statements (FY 2020-21 to FY 2024-25) of five listed manufacturing companies were sourced from company annual reports and the CMIE Prowess database to compute cost of capital and growth indicators.

6.3. Tools and Techniques

- Competency Gap Score: Difference between required and actual competency ratings, department-wise.
- Cost of Equity: Estimated using the Capital Asset Pricing Model (CAPM).
- Cost of Debt: Post-tax effective interest rate on borrowed funds.
- WACC: Weighted average of cost of equity and cost of debt using market value weights.
- Statistical Tools: Descriptive statistics, Pearson correlation, and multiple regression analysis using SPSS (v.26).

6.4. Variables

The independent variables are the Skill Gap Index and Competency Mapping Score (primary data) and WACC (secondary data); the dependent variable is the Sustainable Growth Rate, supported by ROCE as a secondary outcome measure.

6.5. Sample Profile

Category	Classification	Frequency (n=220)	Percentage
Department	Production	88	40.0%
	Quality Assurance	56	25.5%
	Maintenance/Engineering	50	22.7%
	Others (HR, Planning)	26	11.8%

Experience	Below 5 years	74	33.6%
	5-10 years	89	40.5%
	Above 10 years	57	25.9%

The sample was predominantly drawn from production and quality-assurance functions, reflecting the departments most directly exposed to technology-driven skill change, and included a balanced mix of early-career and experienced employees, allowing comparison of competency perceptions across tenure levels.

VII. DATA ANALYTICS AND RESULTS

7.1. Descriptive Statistics

Variable	Mean	Std. Deviation	Minimum	Maximum
Competency Mapping Score (1-5)	3.42	0.61	2.10	4.70
Skill Gap Index (0-5)	1.38	0.54	0.30	2.60
WACC (%)	11.6	1.9	8.4	15.2
Sustainable Growth Rate (%)	9.3	2.7	4.1	14.8
Return on Capital Employed (%)	13.7	3.2	6.5	19.4

On average, respondents rated organisational competency mapping practices as moderate (mean = 3.42 on a 5-point scale), while the mean Skill Gap Index of 1.38 indicates a moderate shortfall between required and actual proficiency, most pronounced in advanced technical and digital-manufacturing skills.

7.2. Correlation Analysis

Variable Pair	Pearson r	p-value	Result
Skill Gap Index & ROCE	-0.512	0.000	Significant negative
Competency Mapping Score & SGR	0.487	0.001	Significant positive
WACC & Skill Development Investment	-0.463	0.002	Significant negative
Competency Mapping Score & WACC	-0.298	0.021	Significant negative

The correlation results show a moderately strong negative relationship between the Skill Gap Index and ROCE ($r = -0.512$, $p < 0.01$), and a moderately strong positive relationship between Competency Mapping Score and Sustainable Growth Rate ($r = 0.487$, $p < 0.01$). WACC is negatively correlated with the proportion of revenue invested in skill development ($r = -0.463$, $p < 0.01$), supporting the premise that a higher cost of capital constrains discretionary human-capital investment.

7.3. Regression Analysis

A multiple regression was run with Sustainable Growth Rate as the dependent variable and Skill Gap Index, Competency Mapping Score, and WACC as predictors.

Predictor	Unstandardised β	Standard Error	t-value	Sig.
(Constant)	8.914	1.204	7.403	0.000
Skill Gap Index	-2.107	0.512	-4.115	0.000
Competency Mapping Score	1.842	0.486	3.790	0.001
WACC (%)	-0.396	0.147	-2.694	0.009

The regression model was statistically significant, $F(3, 211) = 26.84$, $p < 0.001$, explaining approximately 46

percent of the variance in Sustainable Growth Rate ($R^2 = 0.462$, Adjusted $R^2 = 0.454$). All three predictors were statistically significant, confirming that lower skill gaps, stronger competency mapping, and lower cost of capital jointly and independently predict higher sustainable growth.

7.4. Hypothesis Testing Summary

Hypothesis	Statistical Result	Decision
H01: Skill gap and ROCE unrelated	$r = -0.512$, $p < 0.01$	Rejected
H02: Competency mapping and SGR unrelated	$r = 0.487$, $p < 0.01$	Rejected
H03: WACC and skill investment unrelated	$r = -0.463$, $p < 0.01$	Rejected
H04: No combined effect on SGR	$F = 26.84$, $p < 0.001$	Rejected

VIII. FINDINGS AND DISCUSSION

The findings confirm that competency mapping and skill gap magnitude are significantly associated with financial performance and growth sustainability in manufacturing firms. Departments with wider skill gaps, particularly in automation, robotics maintenance, and digital quality-control systems, reported comparatively lower ROCE, consistent with the observations of Agrawal and Thite (2020) regarding technical skill shortages in Indian manufacturing. The significant positive relationship between competency mapping and sustainable growth rate corroborates Draganidis and Mentzas (2006) and Sahoo and Mishra (2019), reinforcing that structured, role-based competency frameworks translate into measurable growth outcomes rather than remaining a purely administrative HR exercise.

The negative relationship between WACC and skill-development investment aligns with Ghosh and Sengupta (2020), extending their capital-expenditure findings specifically to human-capital expenditure. This suggests that finance and human resource functions in manufacturing firms are not independent; firms that manage their capital structure efficiently and maintain a lower cost of capital appear to channel the resulting financial flexibility into workforce upskilling, which in turn improves productivity and reinforces future financial performance, an interaction broadly consistent with Rastogi and Dave (2021). The regression results further indicate that competency mapping exerts a comparatively larger standardised effect on sustainable growth than WACC alone, suggesting that, while capital cost is an important enabling condition, the presence of a structured competency system is the more proximate driver of sustainable growth.

Collectively, these findings support an integrated view in which human capital systems and financial cost structures should be managed jointly rather than in functional silos. Manufacturing firms seeking sustainable growth would benefit from periodic, role-specific skill audits linked explicitly to capital budgeting decisions, ensuring that investment in training is prioritised using the same rigour applied to physical capital expenditure decisions.

8.1. Managerial Implications

- Institutionalise annual, role-specific competency audits linked directly to production technology roadmaps rather than generic annual appraisals.
- Treat workforce upskilling budgets as capital allocation decisions, evaluated against the same hurdle rate used for physical capital investment.
- Prioritise closing skill gaps in digitally intensive functions such as automation, robotics maintenance, and data-driven quality control, where gaps showed the strongest negative association with ROCE.
- Pursue capital structure optimisation, such as improved working-capital management and credit ratings, as an indirect but effective lever for expanding the resource envelope available for training investment.

8.2. Scope and Limitations

The study is confined to twelve manufacturing units and five listed companies within a single state, which may limit the generalisability of findings to manufacturing firms operating in different regulatory or technological contexts. The competency and skill-gap measures rely on self-

reported and supervisor-rated perceptions rather than objective skill-testing instruments, which may introduce a degree of response bias. Additionally, the five-year financial window, while adequate for computing average cost-of-capital trends, may not fully capture longer-term capital-structure cycles. These limitations suggest caution in generalising the specific coefficient magnitudes, though the directional relationships are consistent with the broader literature reviewed in Section 2.

IX. CONCLUSION

This study establishes an empirically grounded link between competency mapping, skill gap analysis, and cost of capital as joint determinants of sustainable growth in the manufacturing sector. The results demonstrate that narrower skill gaps and stronger competency mapping practices are associated with higher returns on capital employed and higher sustainable growth rates, while a higher cost of capital constrains investment in workforce development, creating a compounding disadvantage for financially inefficient firms. The study contributes an integrated conceptual framework and empirical evidence supporting the proposition that human capital management and corporate financial strategy are interdependent levers of sustainable competitiveness. Manufacturing organisations are advised to institutionalise continuous competency mapping, align skill-development budgets with capital-cost considerations, and treat workforce investment as a value-creating capital allocation decision rather than a discretionary overhead. Future research could extend this framework longitudinally across a larger multi-state sample and incorporate sector-specific automation intensity as a moderating variable.

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