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THE IMPACT OF TEAM FACTORS ON RISK AND DECISION-MAKING PROCESSES IN THE PHASES OF THE INDUSTRIAL PRODUCT LIFE CYCLE

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Good life cycle management (LCM) is key to managing risk and making good decisions throughout the product life cycle. This paper looks at the impact of team dynamics on risk assessment and decision making in the industrial product life cycle. It highlights the importance of a balanced team where younger members bring agility and problem solving skills in the early stages of the product life cycle. Skills retention and development is key to long term adaptability in the life cycle. The developed methodology to integrate modern team factors into LCM will help to improve strategic decision making and resilience in industry.

Keywords: Product Lifecycle Management (PLM), Team Dynamics, Risk Mitigation, Decision-Making Processes, S-Curve Model, BCG Matrix, Analytic Hierarchy Process (AHP), Z-Scaling, Key Performance Indicators (KPIs), Industrial Team Performance.

1. Introduction

Life cycle management

Good life cycle management (LCM) is key to managing risks and making informed decisions across the product life cycle (PL). Established models like Rogers' S-curve which describes the diffusion and growth phases of innovations [1] or the Boston Consulting Group (BCG) matrix which categorizes products by market potential and competitive position [2] provide structured ways to navigate the different phases of the product life cycle. However, these models focus mainly on market and product analysis and often overlook the crucial role of team dynamics and competencies for success in each phase. Recent research shows that team dynamics and composition and interactions, especially experience, flexibility and knowledge transfer are key to agile, risk aware decision making [3]. Age

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specific synergies - combining the problem solving skills of younger team members with the strategic experience of older members - can boost performance across the product life cycle [4]. These findings mean LCM models must include team factors to address the unique demands and risks of each phase and ultimately improve decision quality.

Team Performance Evaluation in Lifecycle Management

LCM provides a structured framework for navigating and optimizing products as they progress from initial design to market exit. Models like Rogers' S-curve, which captures the diffusion and growth phases of innovations, help organizations identify critical points where team interventions can substantially influence product outcomes [1]. Team contributions are especially critical in the growth and maturity phases, where strategic actions can accelerate market adoption or stabilize product relevance (Table 1). The BCG Matrix further complements this approach by categorizing products based on market share and growth potential, which aids in resource allocation across LCM stages [2]. Through this categorization, companies can prioritize their efforts based on market positioning, thus facilitating informed decision-making, especially when team performance evaluations are integrated.

Team Competencies Across Lifecycle Phases

The product life cycle comprises distinct phases, each presenting unique focuses and challenges. An overview of these phases is presented in Table 1 according to different models [5], [6]. This illustrates the structure of the product lifecycle from the introduction phase through to the retire phase.

Table 1

Stages/ Phases of Product Lifecycle

<table>
<tr><td>Stage/ Phase</td><td>I</td><td>II</td><td>III</td><td>IV</td><td>V</td><td>VI</td></tr>
<tr><td>Boronenkova et al. [5]</td><td>Market introduction stage</td><td colspan="2">Growth stage</td><td>Maturity stage</td><td colspan="2">Saturation and decline stage</td></tr>
<tr><td>Terzi et al. [6]</td><td>Design phase</td><td>Manufacturing phase</td><td>Distribution phase</td><td>Use phase</td><td>Support phase</td><td>Retire phase</td></tr>
</table>

In each phase of the product life cycle, distinct competencies are essential for addressing specific demands. Also, it is essential on how team compositions can be optimized by strategically aligning junior and senior members.

Current LCM frameworks often lack mechanisms to assess the impact of team composition and dynamics on project risk and thus on decision-making processes.

Research Purpose

This paper introduces a team-centered assessment framework and an evaluation process modelling to assess the impact of team factors at each Life Cycle (LC) - phase. The aim is to provide a structured approach that aligns team capabilities with the specific requirements and risks of each LC phase, improving strategic decision making and resilience.

3. Methodology

Role of Team Performance in Life Cycle Management

Team performance is a key factor in decision-making and risk management at every stage of the product life cycle and has a direct impact on product success through criteria such as collaboration, adaptability and problem-solving skills.

Effective LCM depends not only on product quality, but also on team cohesion and communication, which improve adaptability and early risk identification [3]. Structured assessment models, such AHP, facilitate the determination of team capabilities with respect to PLC requirements by providing an approach to assess criteria such as team dynamics and their impact on life cycle outcomes [7]–[9]. AHP normalizes the results in the resulting eigenvector [8], but this can be insufficiently differentiated for heterogeneous teams.

Based on AHP approach with Z-scaling [10], we developed an evaluation process modelling. This transforms the eigenvector into a standardized normal distribution, improves comparability between criteria by highlighting the differences in individual weights and increases the robustness of decision-making process. At the same time, it minimizes biases commonly found in traditional AHP applications, allowing for more accurate analysis of team-oriented key performance indicators (KPIs).

This study deals with the investigation of KPIs as essential tools both for the evaluation of performance and for the optimization of strategic management in decision-making processes, In particular, team-oriented KPIs and their central role in the effective management and control of LCM are pointed out. A KPI evaluation framework, that centers on network-based KPIs, enables the analysis of relational dependencies and external influences within business networks [11], [12], which are beneficially for understanding the dynamics and interconnections within small and medium-sized company environments, complementing the team-centric perspective adopted in this study.

Evaluation and Selection of Criteria

The selection of KPIs in this study is based on a comprehensive review and categorization of employee evaluation criteria from existing literature. A consolidated list of criteria from previous research, organized by common characteristics, is presented in Table 2.

Table 2

Consolidated Employee Evaluation Criteria

Criteria	[...]	Description
Problem-solving ability (PS)	[7], [13]	Ability to solve complex problems independently.
Team building & cooperation (TC)	[7], [13]	Social skills combined with technical competence.
Time management (TM)	[9], [13]	Efficient allocation of time across tasks.
Experience/Company affiliation (A2C)	[14]	Specific experience and commitment in the company.
Confidence (CO)	[9], [13]	Confidence level assessed through peer review.
Educational level (EL)	[7]	Formal education and professional knowledge.
Flexibility & versatility (FV)	[7]	Adaptability to changing tasks and roles.
Ethics & integrity (EI)	[7]	Commitment to ethical standards.
Communication skills (CS)	[7]	Effective interpersonal communication.
Innovation & planning (IP)	[7]	Capacity for innovation and strategic planning.

4. Evaluation Process Modelling with Z-Scaling

Let us consider a well defined team, E, of *employees*, E_i, a well defined group, C, of qualitative *criteria*, C_j, that is selected to evaluate the team members/ employees, i.e.,

$$E = \{ E_i \mid i = \overline{1, n} \} \tag{1}$$

$$C = \{ C_j \mid j = \overline{1, m} \} \tag{2}$$

Within the evaluation process associated to a certain product life cycle phase, a set, G, of *evaluation grades*, $G_{hh'}$, is defined so that $G_{hh'}$ can be chosen, as strictly positive rational numbers, for pairwise comparisons of the entities U_h and $U_{h'}$, noted $(U_h\ G_{hh'}\ U_{h'})$, as relative importance of the entity U_h with respect to the entity $U_{h'}$, i.e., about *how equal (a), greater (b)* or *less (c) important* U_h is compared with $U_{h'}$, as follows:

$$G = \{ G_{hh'} \mid h, h' = 1, 2, \dots, \}, G \subset \mathbb{Q}_+^*, U_h \text{ and } U_{h'} \in \text{C or E}, \ (U_h\ G_{hh'}\ U_{h'}),$$
$$G_{hh'} = 1\ (a) \text{ or } G_{hh'} > 1\ (b) \text{ or } 0 < G_{hh'} < 1\ (c) \tag{3}$$

The following properties are true:

$$G_{hh} = G_{h'h'} = 1,\ G_{h'h} = \frac{1}{G_{hh'}}, \text{ for any } h, h' = 1, 2, \dots \tag{4}$$

Let us associate evaluation grades, from the above defined set G, as the proper evaluation grades $D_{jj'}$ for the criteria of the set C, i.e.,

$$G_{hh'} = D_{jj'}, C_j \text{ and } C_{j'} \in \text{C}, (C_j\ D_{jj'}\ C_{j'}), j, j' = \overline{1, m} \tag{5}$$

The effective evaluation grades $D_{jj'}$ are as presented in Table 3.

Let us associate evaluation grades, from the above defined set G, as the proper evaluation grades $F_{ii'j}$ with respect to criterion C_j for the employees of the team E, i.e.,

$$G_{hh'} = F_{ii'j}, E_i \text{ and } E_{i'} \in \text{E}, (E_i\ F_{ii'j}\ E_{i'}), i, i' = \overline{1, n}, j = \overline{1, m} \tag{6}$$

The effective values evaluation grades $F_{ii'}j$ are as presented in Table 4.

Table 3

Effective evaluation grades $D_{jj'}$

	C_1	C_2	…	C_j	…	C_m
C_1	1	D_{12}	…	D_{1j}	…	D_{1m}
C_2	$\frac{1}{D_{12}}$	1	…	D_{2j}	…	D_{2m}
…	…	…	1	…	…	…
C_j	$\frac{1}{D_{1j}}$	$\frac{1}{D_{2j}}$	…	1	…	D_{jm}
…	…	…	…	…	1	…
C_m	$\frac{1}{D_{1m}}$	$\frac{1}{D_{2m}}$	…	$\frac{1}{D_{jm}}$	…	1

Table 4

Effective evaluation grades $F_{ii'j}$

	E_1	E_2	…	E_i	…	E_n
E_1	1	F_{12j}	…	F_{1ij}	…	F_{1nj}
E_2	$\frac{1}{F_{12j}}$	1	…	F_{2ij}	…	F_{2nj}
…	…	…	1	…	…	…
E_i	$\frac{1}{F_{1ij}}$	$\frac{1}{F_{2ij}}$	…	1	…	F_{inj}
…	…	…	…	…	1	…
E_n	$\frac{1}{F_{1nj}}$	$\frac{1}{F_{2nj}}$	…	$\frac{1}{F_{inj}}$	…	1

Let us define the square matrices T_C and T_{Ej} as:

$$T_C = [D_{jj'}],\ j, j' = \overline{1, m} \text{ and } T_{Ej} = [F_{ii'j}], i, i' = \overline{1, n}, j = \overline{1, m} \tag{7}$$

where the elements $D_{jj'}$ and $F_{ii'j}$ are according to eqs. (3) - (6), as the case, i.e., as the correspondent elements of Table 3 and Table 4, respectively.

The *relative weights* of the C and E components are the correspondent elements of the eigenvectors W_C and W_{Ej} associated to matrices T_C and T_{Ej}, respectively.

The eigenvectors W_C and W_{Ej} are determined by the matrix power iteration method [15].

Thus, the iterative computing of the (k) power matrix, $T^{(k)}$, is unrolling, i.e.,

$$T^{(k)} = T^{(k-1)} * T,\ T^{(k)} = [T_{ll'}]_k,\ l, l' = \overline{1,\nu},\ k = 2, 3, ..., T^{(1)} = T,$$
$$T = T_C \text{ for } T_{ll'} = D_{jj'},\nu = m \text{ or } T = T_{Ej} \text{ for } T_{ll'} = F_{ii'j}, \nu = n \quad (8)$$

and, at each iteration (k):

• the rows of the matrix $T^{(k)}$ are normalized to 1, i.e.,

$$S_l = \sum_{l'=1}^{\nu} T_{ll'},\ l = \overline{1,\nu},\ S = \sum_{l=1}^{\nu} S_l,\ w_l = S_l/S,\ l = \overline{1,\nu}\ (\sum_{l=1}^{\nu} w_l = 1) \quad (9)$$

• implicitly, the resulting normalized values w_l represent the elements of the corresponding eigenvector W, W_C or W_{Ej}, as the case, i.e.,

$$W = \begin{bmatrix} w_1 \\ w_2 \\ \ldots \\ w_l \\ \ldots \\ w_\nu \end{bmatrix} \text{ with } \begin{cases} W = W_c \text{, for } l = j, \nu = m \\ W = W_{Ej}, \text{ for } l = i, \nu = n \end{cases} \quad (10)$$

• in relation with iteration (k) and previous iteration $(k-1)$, the relative deviations, $\delta_{l(k),(k-1)}$, of the $W_{(k)}$ eigenvector elements, $w_{l(k)}$, with respect to the $W_{(k-1)}$ eigenvector elements, $w_{l(k-1)}$, are computed, as well in the case of $W_{C(k)}$ eigenvector elements, $w_{j(k)}$, and $W_{Ej(k)}$ eigenvector elements, $w_{ji(k)}$, i.e.,

$$\delta_{l(k),(k-1)} = 100(1 - \frac{w_{l(k)}}{w_{l(k-1)}}), \text{ in \%}, k = 2, 3, ..., l = \overline{1,\nu} \quad (11)$$

$$\delta_{j(k),(k-1)} = 100(1 - \frac{w_{j(k)}}{w_{j(k-1)}}), \text{ in \%}, k = 2, 3, ..., j = \overline{1,m} \quad (12)$$

$$\delta_{ij(k),(k-1)} = 100(1 - \frac{w_{ij(k)}}{w_{ij(k-1)}}), \text{ in \%}, k = 2, 3, ..., i = \overline{1,n}, j = \overline{1,m} \quad (13)$$

• If the relative deviations are within an acceptable range, the corresponding eigenvectors $W_{C(k)}$ and $W_{Ej(k)}$ and their elements are considered acceptable.

• The final values for W_C and W_{Ej} are set to the values of the last iteration *k*, with w_j and w_{ij} corresponding to the values of $w_{j(k)}$ and $w_{ij(k)}$, respectively.

Thus, the eigenvector W_C, as eq. (14) shows, is adequate to be associated to the matrix T_C, so that its elements w_j, $j = \overline{1,m}$, are adequate to represent the *relative weights* of the corresponding components C_j, $j = \overline{1,m}$, from the C criteria set.

$$W_C = \begin{bmatrix} w_1 \\ w_2 \\ \ldots \\ w_j \\ \ldots \\ w_m \end{bmatrix} \quad (14)$$

Also, the eigenvector W_{Ej}, as eq. (15) shows, is adequate to be associated to the matrix T_{Ej}, so that its elements w_{ij}, $i = \overline{1,n}$, are adequate to represent the *relative weights* of the corresponding components, E_i, $i = \overline{1,m}$, from the E team.

$$W_{Ej} = \begin{bmatrix} w_{1j} \\ w_{2j} \\ \cdots \\ w_{ij} \\ \cdots \\ w_{nj} \end{bmatrix}, j = \overline{1,m} \tag{15}$$

Let W_E be the matrix defined so that its columns are equal with the correponding columns of the eigenvectors $W_{Ej}, j = \overline{1,m}$, as eq. (16) shows.

$$W_E = \begin{bmatrix} w_{11} & w_{12} & \dots & w_{1j} & \dots & w_{1m} \\ w_{21} & w_{22} & \dots & w_{2j} & \dots & w_{2m} \\ & & \dots & & & \\ w_{i1} & w_{i2} & \dots & w_{ij} & \dots & w_{im} \\ & & \dots & & & \\ w_{n1} & w_{n2} & \dots & w_{nj} & \dots & w_{nm} \end{bmatrix} \tag{16}$$

It is to highlight that the element w_{ij} of the W_E matrix, represents the relative weight of the corresponding E team component E_i with respect to the criterion C_j, on the E team level.

Let w_{iC} be the *relative weight* of the E team component E_i with respect to all criteria C_j, $j = \overline{1,m}$, on the E team level.

Due to the significance of the relative weight w_{ij}, it results that w_{iC} is the sum of the weighting of w_{ij} by the relative weights associated to the correspondent criteria, $w_j, j = \overline{1,m}$, i,.e,

$$w_{iC} = \frac{1}{m}\sum_{j=1}^{m} w_{ij*}\, w_j,\ i = \overline{1,n} \tag{17}$$

It is to be noted that w_{iC} is the generic element of the matrix W_{EC} defined as product of the matrices W_E and W_C, i.e.,

$$\mathbf{W_E}\ \mathbf{W_C} = \mathbf{W_{EC}},\ \mathrm{W_{EC}} = [w_{iC}],\ i = \overline{1,n} \tag{18}$$

To standardize the resulting vector W_{EC}, a Z-transformation [10, p. 243] is applied, as follows.

Let $\overline{w_C}$ be the mean value, s_{w_C} - the sample standard deviation and z_i - the standardized value (score) of the dedicated vector components w_{iC}, $i = \overline{1,n}$, i.e.,

$$\overline{w_C} = \frac{1}{n}\sum_{i=1}^{n} w_{iC} \tag{19}$$

$$s_{wC} = \sqrt{\frac{1}{n-1}\sum_{i=1}^{n}(w_{iC} - \overline{w_C})^2} \tag{20}$$

$$z_{iC} = \frac{w_{iC} - \overline{w_C}}{s_{wC}},\ i = \overline{1,n} \tag{21}$$

It is to be noted that z_{iC} is the generic element of the matrix Z_{EC},

$$\mathbf{Z_{EC}} = \frac{1}{s_{wC}}(\mathrm{W_{EC}} - \overline{w_C}),\ \mathrm{Z_{EC}} = [z_{iC}],\ i = \overline{1,n} \quad (22)$$

It is to underline that each z_i indicates how many standard deviations s_w the original value w_i is far from the mean value $\overline{w}$.

Also, it is to highlight that the resulting vector, $Z = (z_i)$, $i = \overline{1,n}$, has a mean of 0 and a standard deviation of 1, which enhances the comparability of weights across criteria and team members by standardizing their scales.

5. Case Study

This case study deals with a specialized software development team in an industrial company. The team is characterized by a high degree of specialization and expertise. Many members can be described as experts in their respective fields. The structure of the team is particularly flat, which enables direct communication and fast decision-making processes. However, the team is also characterized by a high average age and a limited influx of new employees. The demographic composition inherent the risk of a loss of knowledge and poses a challenge for adaptability, especially as the product development environment evolves. The case under consideration is transition between phase III and phase IV of its life cycle. In this, around half of the team's activities are dedicated to product maintenance, which emphasizes the relevance of. This phase shift implies the need for a balance between utilizing the expertise of the experienced team members and ensuring an effective transfer of critical knowledge within the team.

This case study examines evaluated KPIs which are critical to maintaining team effectiveness, fostering targeted people development and minimizing risk in the context of knowledge retention and long-term product support. The specific KPIs selected along with the source of each KPI, potential data sources, and the underlying reasons for inclusion, are provided in Table 5. This structure allows for a customized approach to evaluating team performance across the LCM phases, particularly in the development of industrial control systems.

For example, in the design phase, creativity and innovation are essential, making Problem Solving (SP) and Confidence (COPA) key KPIs. As the product enters the introduction and growth phases, adaptability and team cohesion become vital, aligning well with Task Collaboration (ACT4T).

In the maturity phase, priorities shift to cost efficiency and knowledge retention, making Experience Affiliation (A2C) and Average Time per Task (AVGT) critical. Finally, in the decline phase, strategic planning and knowledge transfer take precedence, where A2C supports effective knowledge retention and transition.

Table 5

Selected Team Criteria/ KPI

Criteria	Potential source of information	Authors comments
Solving problems (SP)	Expert/ Team Lead	Ability for solving problems independently
Assuming and completing tasks for a teammate including Team building interventions (ACT4T)	Expert/ Team Lead, Team	Social skill combined with technical competence
Affiliation to the company/ specific experience in the company (A2C)	Human Resources, Employee, Team Lead	Touches several aspects, how long is the employee in the today's setup/ team
Confidence/ passion (COPA)	Employee	Subjective, peer review
Avg. time for each job (AVGT)	PLM System	If measurable, depends also on mode of operation of the team (waterfall, agile, ….)

The shifting competency requirements across the life cycle phases (Table 6) are as follows.

Design Phase: Junior members excel in KPIs like Problem Solving (SP) and Confidence (COPA), fostering the creativity and responsiveness essential for early-stage innovation.

Introduction and Growth Phases: High adaptability is key in these stages as products interact with the market. Junior team members leverage agility and Task Collaboration (ACT4T) by refining product features and mitigating risks through rapid adjustments based on customer feedback.

Maturity Phase: Senior team members bring proficiency in Experience Affiliation (A2C) and Average Time per Task (AVGT), along with cost management skills, which are essential for optimizing processes and reducing costs to maintain product relevance.

Decline Phase: Knowledge transfer and strategic planning become vital, as senior members leverage Experience Affiliation (A2C) to mentor junior colleagues, documenting critical insights and preserving knowledge for future product cycles.

Table 6

Selected Team KPIs per Phase

Stage/ Phase	I	II	III	IV	V	VI
	Market introduction stage	Growth stage		Maturity stage	Saturation and decline stage	
(Team) competence requirements	Creativity, innovation, responsiveness, adaptability	Team cohesion, collaboration		Knowledge, retention, cost management	Strategic, transition	
Derived KPIs	SP, COPA	ACT4T		A2C, AVGT	A2C	

This case study includes the following set of application-specific data:

$E = \{ E_i \mid i = \overline{1,15} \}$;
$C = \{ C_j \mid j = \overline{1,5} \}$, C_1=SP, C_2= ACT4T, C_3=A2C, C_4= COPA, C_5= AVGT (see Table 6);
$D_{jj'} \in \{ 1/4, 1/3, 1/2, 1, 2, 3, 4\}$, $F_{ii'} \in \{1/6, \ldots, 1/2, 1, 2, \ldots, 6\}$;

$$\mathrm{W_C} = \begin{bmatrix} 0.264 \\ 0.381 \\ 0.196 \\ 0.080 \\ 0.080 \end{bmatrix};\ W_E = \begin{bmatrix} 0.195 & \ldots & 0.067 \\ 0.108 & \ldots & 0.067 \\ \vdots & \ddots & \vdots \\ 0.055 & \ldots & 0.067 \\ 0.041 & \ldots & 0.067 \end{bmatrix};\ W_{EC} = \begin{bmatrix} 0.090 \\ 0.074 \\ \vdots \\ 0.063 \\ 0.054 \end{bmatrix};\quad \begin{matrix} \overline{w_C} = 0.067, \\ s_{wC} = 0.018, \end{matrix}\quad Z_{EC} = \begin{bmatrix} 1.322 \\ 0.410 \\ \vdots \\ -0.184 \\ -0.731 \end{bmatrix}.$$

Also, the detailed results which summarize the employee ranking are as presented in Fig. 1.

The integrated assessment highlights the range of performance within the team and supports the identification of performance gaps. This promotes differentiated decision-making and targeted personnel development as part of life cycle management.

It can be seen that there is a discrepancy between the extraordinary, specialized knowledge of individual high performers in the team and the suboptimal use of this knowledge in the team context (e.g. E_1). Although the team has remarkable experience (A2C) and stability (no fluctuations), which are positive in themselves, this could cause future difficulties in the transfer of knowledge within the team.

One part of the team is characterized by outstanding problem-solving skills, which ideally represents a significant enrichment for the entire team. However, the analysis shows that the integration and application of this specialized knowledge is not optimally implemented in the collective work process. This phenomenon could be due to several factors, such as communication barriers, a lack of a common knowledge base or structural and procedural deficits within the team.

Paradoxically, the unusual experience and stability of the team could contribute to making the transfer of know-how more difficult. This situation could be due to a certain persistence in proven methods and processes that hinders innovation and the introduction of new knowledge elements.

The analysis suggests that the team could face serious problems in the long term if there is no strategic intervention to promote knowledge sharing and adapt to changing requirements. These findings highlight the need for action and provide an indicator of risk-based decision making in PLM. This requires further scientific analysis.

Criteria (C_j):	SP	ACT4T	A2C	COPA	AVGT	Resulting vector	Result as Z-Score
eigenvector of criteria (W_C):	0.264	0.381	0.196	0.080	0.080		
	[W_E] -matrix:						
Employee (E_i):	W_{E1}	W_{E2}	W_{E3}	W_{E4}	W_{E5}	W_{EC}	Z_{EC}
Employee E_1	0.195	0.026	0.087	0.080	0.067	0.090	1.322
Employee E_2	0.108	0.048	0.087	0.062	0.067	0.074	0.410
Employee E_3	0.099	0.064	0.087	0.062	0.067	0.078	0.619
Employee E_4	0.025	0.053	0.074	0.053	0.067	0.051	-0.895
Employee E_5	0.095	0.111	0.084	0.080	0.067	0.095	1.604
Employee E_6	0.104	0.104	0.087	0.062	0.067	0.094	1.539
Employee E_7	0.064	0.096	0.078	0.062	0.067	0.079	0.670
Employee E_8	0.034	0.034	0.084	0.048	0.067	0.047	-1.074
Employee E_9	0.029	0.057	0.074	0.066	0.067	0.055	-0.677
Employee E_{10}	0.032	0.060	0.049	0.066	0.067	0.051	-0.852
Employee E_{11}	0.054	0.092	0.065	0.085	0.067	0.074	0.406
Employee E_{12}	0.035	0.057	0.010	0.062	0.067	0.043	-1.314
Employee E_{13}	0.032	0.056	0.049	0.085	0.067	0.052	-0.843
Employee E_{14}	0.055	0.080	0.042	0.060	0.067	0.063	-0.184
Employee E_{15}	0.041	0.063	0.042	0.066	0.067	0.054	-0.731

Fig. 1. Employee evaluation for transition from life cycle phase III to phase IV

Other remarks are the followings: E_1 is an outstanding specialist; E_{11} denotes a high amount of motivation/ confidence/ passion; $E_{1, 2, 3, 5, 6, 7, 11}$ are in the overall result the key employees in the team.

The interpretation of performance data in a team context requires a careful and differentiated approach. Values that are below the average should not be prematurely interpreted as an indicator of lower performance. Often these figures represent newcomers to the team (E_{12}) whose current performance measurement primarily reflects their training phase and not their actual or potential competence. Positioning below the average can reflect a team member's specific role or range of tasks and cast their individual contribution to the overall success of the team in a different light.

The balance of self-confidence and passion within the team indicates a high level of motivation and commitment among team members. A balanced ratio is an indicator that the risk of losing employees is low. This suggests positive team dynamics and a supportive work environment. The condition reinforces the assumption that the majority of team members see a healthy challenge in their work that motivates them and spurs them on to perform.

Team members E_{12}, E_8 and E_4 may need individual attention and support to be fully integrated into the team and optimize their performance. The team leader should take careful action and conduct targeted performance reviews to provide more focused support to E_8 and E_4. Interventions should aim to build confidence, encourage passion for the work and identify and address potential barriers to successful integration and performance.

However, a critical risk identified in the study is that the continuous need for skill development and retention reduces immediate productivity and agility. This represents a "blind spot" in traditional LCM approaches, where management may underestimate the resources needed for effective skill retention, potentially leading to delays and reduced flexibility.

6. Conclusions

A structured approach to LCM has been developed. This integrates team-centered KPIs and the evaluation system, with the aim to optimize team assessment and risk management over the entire product lifecycle.

The traditional LCM models such as the S-curve and the BCG matrix often neglect the importance of team composition, skill diversity and knowledge retention. The results suggest that a balanced team structure, in which younger members with high problem-solving skills and responsiveness are combined with older members who bring stability and expertise, significantly increases performance in all phases of the life cycle.

Targeting team capabilities to the requirements of individual life cycle stages improves both overall performance and risk resilience, supporting the goal of developing an adaptive LCM model that optimally matches team capabilities to life cycle requirements.

A key weakness of traditional practices is that they often overlook the need for continuous skills maintenance and development. Although essential to long-term success, this process can temporarily hinder productivity and agility in the early stages. However, strategic measures such as continuous hiring and fostering a culture of knowledge sharing can help companies to secure their long-term performance.

The introduction of the Z-scaled modelling is a refined approach to standardized team assessment, which enables managers to identify and target performance gaps more precisely. Z-scaling adapts weights to reflect the distribution of each criterion, allowing greater differentiation where criteria dispersion varies. This approach increases decision-making accuracy, especially in contexts with dynamic team contributions across life cycle phases.

In essence, these elements provide a sustainable way for organizations to achieve resilience, innovation and competitive advantage in a changing industrial landscape.

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