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A systematic approach to corporate innovation excellence

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Abstract

While international standards on innovation management have gained interest, "excellence" in innovation management has not been thoroughly studied in the literature. To address this gap, this study proposes the "Innovation Excellence Model" for corporate innovation. This approach aims to provide a concise way of excellence in corporate innovation system design. This model focuses on three important components of the system: innovation execution system, innovation organization, and innovation engine. This model is based on three different innovation engines (idea-driven, analysis-driven, and research-driven) and proposes a card-based control system to balance workload and project flows. The integration of card-based control and its simulated case provides a tangible and effective means of translating theoretical concepts into practical execution. A novel key performance indicator, "CIP – Corporate Innovation Performance" is also introduced for monitoring the excellence degree. By fostering a holistic understanding of excellence in corporate innovation, the model enables organizations to navigate the design of innovation management system, propelling them toward excellence and growth.

Keywords: Corporate Innovation, Excellence Model, Innovation Management

1. Introduction

Excellence models and standards are two different approaches that organizations can use to improve their performance and achieve their goals. An "excellence model" can be considered a framework used to assess and improve organizational performance. It is typically a systematic approach that defines key areas of focus and outlines specific practices and behaviors that are associated with high levels of organizational performance (Mann and Grigg, 2004; Mohammad et al., 2011). Organizations that use an excellence model typically strive for "excellence" and seek to exceed minimum requirements.

On the other hand, "standards" focus on meeting minimum requirements. Excellence models are typically more comprehensive than standards, covering a wider range of performance areas and providing more detailed guidance on best practices.

In recent years, there has been a growing emphasis on the importance of adhering to international standards on innovation management (Hyland & Karlsson, 2021). However, despite this trend, the topic of achieving excellence in innovation management has not been explored with the same level of rigor and comprehensiveness in academic literature.

Although there have been some initial efforts to tackle this issue, the field remains relatively new and uncharted in academic literature. In light of this gap, and with the aim of surpassing existing standards, this study puts forward a novel approach to corporate innovation: the "Innovation Excellence Model (IEM)."

IEM aims to provide a more comprehensive and systematic guide for organizations seeking to achieve excellence in their innovation practices. It aims to be a groundbreaking framework to achieve innovation excellence in corporate settings, which centers around three crucial components: the innovation execution system, innovation organization, and innovation engine.

IEM is anchored on three distinct innovation engines: idea-driven, analysis-driven, and research-driven, each emphasizing different approaches to innovation. It further puts forth a card-based control system that promotes a balanced distribution of workloads and project flows, fostering seamless collaboration and efficient resource allocation.

In addition, the Corporate Innovation Performance (CIP) is proposed as a novel key performance indicator (KPI) enabling organizations to monitor their progress and level of excellence. This approach aims to simplify the process of achieving innovation excellence by providing a clear and visually appealing roadmap, facilitating organizations' ability to cultivate a culture of innovation and generate meaningful outcomes.

The remainder of this study is structured as follows. Section 2 presents an in-depth literature review on the concept of "excellence" in the context of innovation management, examining existing research and identifying gaps in the literature. In Section 3, the IEM is introduced, providing a comprehensive overview of the framework and outlining its key dimensions and components. Section 4 highlights a novel KPI specifically designed for corporate innovation, offering a reliable and effective means of monitoring and assessing an organization's innovation excellence level. Section 5 discusses how to balance the innovation engines. Finally, concluding remarks are presented in the final section.

2. Literature Review

To gather information on previous attempts to explore the concept of excellence in innovation, a thorough search of the Thomson Reuters' Web of Science/Knowledge database was conducted. Specifically, papers containing the terms "excellence in innovation" or "innovation excellence" in their titles, abstracts, or keywords were retrieved from the database.

A total of 47 publications were identified, with an h-index of 9 and a cumulative number of times cited reaching 364. Fig. 1 depicts the sum of times cited per year, revealing a steady increase in interest in this area over time.

Prior work on this topic remains relatively limited. This suggests that although interest in the topic has fluctuated over time, there is still a need for further research and development in the field.

Table 1 offers a list of the most frequently cited papers on this subject, providing a valuable resource for researchers seeking to delve deeper into this field of inquiry.

Dervitsiotis (2010) explored the potential of an "innovation excellence model" to enhance innovation performance in organizations, emphasizing the importance of leadership and culture in driving innovation.

Table 1. A summary table of the literature

Year	Authors	Total citations
2010	Dervitsiotis, Kostas N.	46
2006	Mele, Cristina; Colurcio, Maria	44
2007	Martensen, Anne; Dahlgaard, Jens J.; Park-Dahlgaard, Su Mi; et al.	43
2016	Lee, Youngsu; Rim Suk-Chul	32
2009	Kimiloglu, Hande; Zarali, Hulya	25
2008	Dahlgaard-Park, Su Mi; Dahlgaard, Jens, J.	17

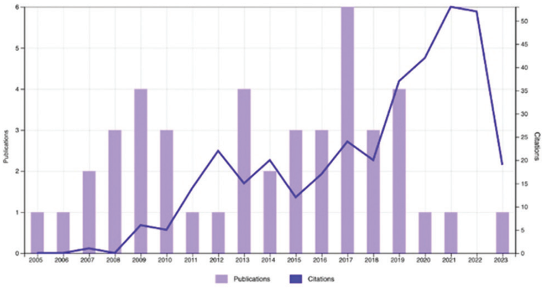


Fig. 1. Times cited and publication over time

Mele and Colurcio (2006) proposed a framework for measuring innovation excellence in the service sector, focusing on the integration of customer feedback and employee involvement in the innovation process.

Martensen et al. (2007) investigated the impact of ISO 9000 certification on innovation performance in small- and medium-sized enterprises (SMEs), highlighting the positive influence of ISO 9000 on innovation capacity and organizational learning.

Lee and Rim (2016) explored the effect of government funding on innovation excellence in South Korean SMEs, emphasizing the importance of strategic planning and risk management in leveraging public funds for innovation.

Kimiloglu and Zarali (2009) examined the role of leadership and organizational culture in fostering innovation excellence in Turkish companies, identifying a strong positive correlation between leadership style, organizational culture, and innovation performance.

Upon reviewing the retrieved papers, it becomes evident that there is only one existing model for innovation excellence in the literature, which is the "4P model" proposed by Dahlgaard-Park and Dahlgaard (2008).

The 4P model is a customized version of the EFQM Excellence Model, which is widely used in business excellence frameworks. While the EFQM model has four result factors, including Customer Results, Employee Results, Society Results, and Key Performance Results, the 4P model has only one result factor, which is Innovation Results. In addition, the 4P model has two additional enablers' factors, which are Customer Orientation and Innovativeness.

The authors of the 4P model emphasize the importance of leadership, people, and partnerships as the key areas that companies should improve before focusing on process improvement (Dahlgaard-Park and Dahlgaard, 2008).

Dahlgaard et al. (2013) conducted a study where they reviewed various business excellence models and discussed their limitations, implications, and further development. They also considered the 4P excellence model as a simplified version of business excellence model. Although the 4P model was initially introduced as an IEM, it has undergone significant development and transformation. As a result of this evolution, the BEF: Business Excellence Framework has emerged as a new and advanced version of the 4P model. However, it is worth noting that the BEF is no longer an IEM but rather a comprehensive business excellence model.

Overall, the literature review suggests that research in this area remains relatively limited. Further exploration of this topic could help organizations develop more effective innovation management systems and enhance their overall innovation performance.

3. Proposed Approach

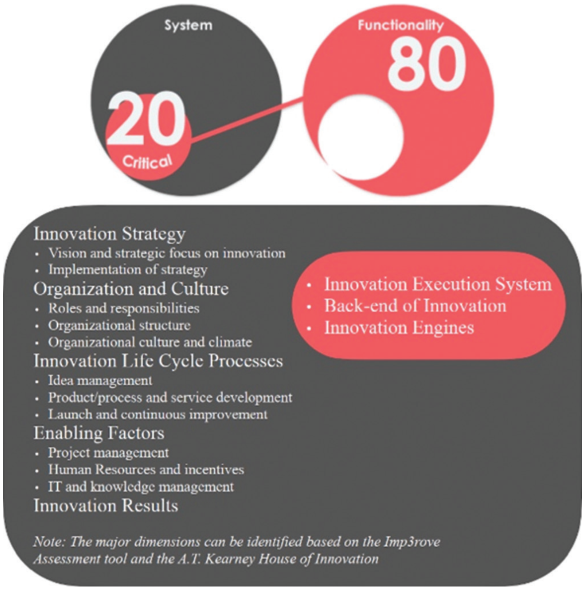
A robust innovation management system incorporates various components and processes to facilitate innovation throughout the organization. However, not all components of an innovation management system are equally important, and some are more critical than others in contributing to the functionality of the overall system. As such, it is essential to identify and prioritize these critical components during the setup phase of the innovation management system.

The IMP³ROVE – European Innovation Management Academy has developed an online benchmarking tool. It is based on A.T. Kearney's House of Innovation model (Diedrichs et al., 2006). A well-structured and reasonable list of innovation management components can be derived from this tool (Fig. 2).

The "IEM – Innovation Excellence Model" proposed in this study places emphasis on the most crucial components of a typical corporate innovation system during its "implementation/setup" phase. These components contribute significantly to the overall functionality of the system.

The model prioritizes three key components that work together synergistically:

(i) Innovation execution system
(ii) Back-end of innovation
(iii) Innovation engines.



Note: The major dimensions can be identified based on the Imp3rove Assessment tool and the A.T. Kearney House of Innovation

Fig. 2. Critical components of corporate innovation

Lercher (2020) brings attention to a central concern; existing innovation models fall short in adequately addressing innovation management within companies and its integration with corporate strategy to the extent required for effective entrepreneurial action and the comprehensive exploration of all innovative opportunities. In addition, these models often lack a practical orientation, encompassing only select aspects of the innovation process. It is important to underscore the particular emphasis on the deficiency of real-world orientation within this discourse.

The "Big Picture" model (Lercher, 2020) stands out as a distinctive example among rare frameworks, having been developed with a deliberate focus on real-world applicability. Similarly, the Arthur D. Little's IEM (Kirchgeorg et al., 2010) is another paradigm that has been meticulously crafted with a strong emphasis on real-world orientation.

Drawing inspiration from these perspectives, the model proposed in this paper is uniquely shaped by incorporating these valuable contributions. The resulting model represents a synthesis of these insights, underscoring its holistic approach that takes into account both theoretical constructs and pragmatic considerations. Fig. 3 provides an overview of the IEM, showcasing its key components and functionalities. The practical experience distinctly underscores the significance of these specific components as well.

3.1. Harmony of the Critical Components

The IEM perceives "corporate innovation" as a comprehensive approach encompassing management activities dedicated to fostering "innovation projects." Through this perspective, it delineates three fundamental cycles of innovation processes tailored

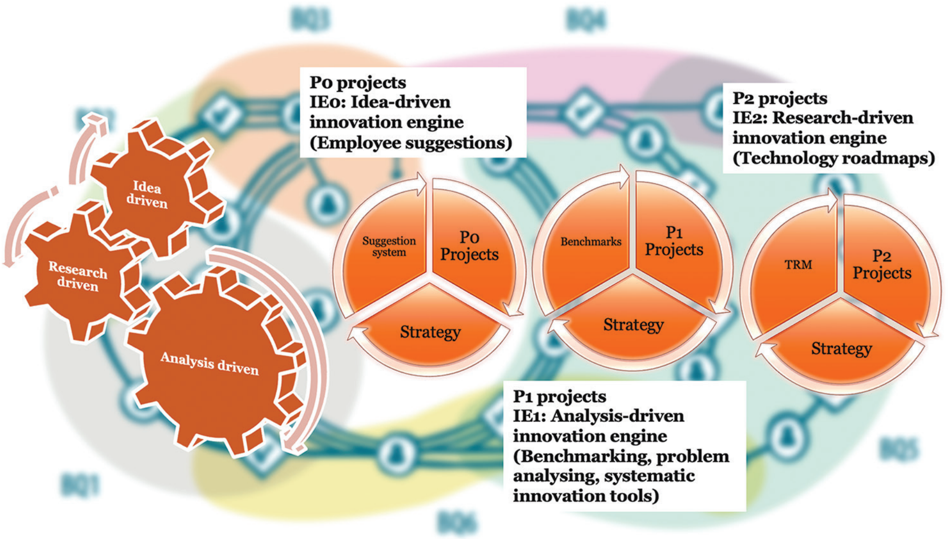


Fig. 3. An overview of the proposed model

for the primary project types which can be found in typical corporate innovation scenarios.

These cycles, namely *P0*, *P1*, and *P2*, serve as essential frameworks for effectively navigating and orchestrating innovation initiatives within organizations. Project cycles are set in motion by three distinct engines: the idea-driven engine, the analyses-driven engine, and the research-driven engine. The prominence of each engine's role can vary based on the competitive environment and strategic priorities of the organization.

The structuring of the innovation management system through project-based cycles draws inspiration from the Big Picture model. This model has been adapted to accommodate different types of projects, resulting in a differentiated approach that offers a fresh perspective.

The core of this approach is the differentiation among project categories, which leads to the emergence of a nuanced model. Furthermore, the innovation engines that propel these project cycles have been formulated by drawing insights from the descriptions of Kirchgeorg et al. (2010).

Table 2 provides a comprehensive comparison of the corresponding project types. This comprehensive comparison highlights the distinct characteristics and dimensions of each project type within the IEM.

Each project type serves specific objectives, faces varying levels of risk, and requires unique management approaches. The comparison table serves as a guide to understand the diversity of projects and their respective contributions to organizational innovation efforts.

3.2. Cycle of the *P0* Projects

"*P0* projects" are dedicated to continuous innovation. These projects are aimed at fostering ongoing improvement and advancement within an organization. In general, the responsibility for *P0* projects can be distributed among various departments depending on the organization's structure and industry, those are more frequently handled by world-class manufacturing offices or total quality management offices in automotive industry.

Within the context of an automotive manufacturing company, an example could be the implementation of Lean Manufacturing principles on the assembly line to reduce waste, increase efficiency, and improve overall production quality. These projects prioritize incremental enhancements and align with the company's ongoing commitment to operational excellence.

"Corporate suggestion systems" can indeed be one of the main drivers of the *P0* projects. These systems provide a platform for employees to contribute their ideas and suggestions for improving processes, products, or services within the organization. Indeed, *P0* projects are typically grounded in the idea-driven innovation engine. This engine emphasizes the generation and exploration of new ideas as the primary driver for initiating projects. Emphasizing the idea-driven engine for *P0* projects can foster a culture of innovation within the organization. It encourages employees to actively contribute ideas, engage in problem-solving, and collaborate to drive impactful initiatives.

3.3. Cycle of the *P1* Projects

"*P1* projects" are structured around the "analysis-driven engine," characterized by distinct driving forces such as benchmark studies and systematic innovation tools. These projects predominantly revolve around the development of novel products or processes.

Table 2. Comprehensive comparison of the project types

Criteria	***P0* projects**	***P1* projects**	***P2* projects**	***P3* projects**	***P(−1)* projects**
Primary objective	Continuous improvement	Enhancing existing products/processes	Research and development of new technologies/products	Radical innovation and breakthrough ideas	Reverse innovation from emerging markets
Risk level	Low	Moderate	High	Very high	High
Innovation type	Incremental innovation	Product/process innovation	Research-driven innovation	Radical innovation	Adaptation and innovation for new markets
Implementation area	Across departments or functions	Mainly within specific departments	Research and development departments	Cross-functional teams or innovation laboratories	Emerging markets and global adaptation
Key drivers	Employee suggestions, process optimization	Benchmark studies, systematic innovation tools	Strategic technology roadmaps, emerging technologies	Disruptive ideas, breakthrough innovations	Adaptation to local needs and contexts
Data and metrics	Process metrics, employee participation	Performance metrics, market analysis	Technological feasibility, innovation metrics	Market impact, transformation metrics	Market fit, local impact
Resource allocation	Distributed within organization	Dedicated teams and resources	R&D departments, specialized experts	Cross-functional teams, innovation laboratories	Local teams, market-oriented resources
Time horizon	Short-term, ongoing	Medium-term, project-based	Long-term research and development cycle	Long-term, high-risk	Market adaptation over the long term
Management approach	Continuous improvement mindset	Analysis-driven decision-making	Research and development process	Disruptive thinking, risk management	Market adaptation, flexible strategies
Innovation culture emphasis	Encouraging ideas, incremental gains	Analytical decision-making, efficiency	Technical expertise, research excellence	Radical thinking, experimentation	Adaptation, market responsiveness
Global versus local focus	Often internal, some external engagement	Mainly internal, some external engagement	Internal focus, technological exploration	Internal and external, disruptive potential	Local focus, market-specific innovation
Outcome expectation	Continuous enhancement of processes	Improved products or processes	Novel technologies, patentable inventions	Breakthrough products or services	Adapted products for new markets
Performance measurement	Process efficiency, employee involvement	Product performance, market share	Technological feasibility, innovation impact	Market disruption, transformative change	Market penetration, competitive success

Effective management of *P1* projects necessitates the establishment of a dedicated unit within the organization, one equipped with full-time resources and competencies. Given their intensity, *P1* projects require a specialized focus on innovation engineering.

An example in the automotive industry might involve the creation of a more fuel-efficient engine for a specific vehicle model. The analysis-driven engine could be employed to assess market demands, analyze competitive benchmarks, and formulate a precise strategy for integrating new technologies. This project would emphasize the optimization of current product offerings while staying aligned with the company's overall innovation strategy.

Much like "*P0* projects," the inception of "*P1* projects" is rooted in a purpose-driven approach. While "*P0* projects" are directed toward continuous innovation and sustained enhancement, "*P1* projects" take on a more targeted orientation, with a focus on optimizing existing processes and products. In this sense, the innovation strategy for "*P1* projects" centers on meticulous analysis and strategic alignment. The engagement of specialized units, equipped with the necessary expertise, underscores the commitment to precision and effectiveness.

The organizational structure for *P1* projects may vary based on the industry and context. However, the presence of a dedicated department specifically focused on managing "*P1* projects" is pivotal. This unit is entrusted with orchestrating the intricate facets of analysis, benchmarking, and innovation strategy. A team well-versed in innovation engineering is crucial for driving "*P1* projects" toward successful outcomes.

By highlighting the analysis-driven engine and strategic alignment, "*P1* projects" emphasize a deliberate and calculated approach to innovation. This methodology facilitates the integration of data-driven insights, benchmarking data, and systematic innovation tools into the project's fabric. It underscores the importance of informed decision-making and precise execution, ultimately leading to the creation of impactful innovations within the organization.

3.4. Cycle of the *P2* Projects

"*P2* projects," on the other hand, operate within the framework of the research-driven engine. These projects, exemplified by initiatives like New Technology Exploitation (NTE) projects (Bigwood, 2004), place a heightened emphasis on research. They encompass projects that delve deeply into research-driven exploration and technology development. Typically, these projects are overseen by organizations' Research and Development (R&D) departments, given their research-intensive nature. An illustrative example could be the development of autonomous driving capabilities for a fleet of vehicles. This project could utilize the research-driven engine to explore emerging technologies, conduct in-depth research on self-driving systems, and develop cutting-edge algorithms. The project's success hinges on staying at the forefront of technological advancements while aligning with the company's long-term strategic technology roadmap.

NTE projects, falling under the umbrella of "*P2* projects," embody a research-centric focus. These projects are marked by their dedication to leveraging available and emerging technologies. Their main driving force lies in strategic technology roadmaps. These roadmaps guide the direction of NTE projects by aligning them with the overarching technological strategy of the organization. This alignment ensures that innovation efforts are purposeful, directed, and in line with the long-term technological vision.

To effectively manage the portfolio of "*P2* projects," technology roadmaps aligned with this strategic objective can be utilized. These roadmaps take into account the organization's technological aspirations and capabilities, offering a roadmap for the successful execution of "*P2* projects." This approach enhances decision-making, resource allocation, and overall project management, ensuring that each project contributes meaningfully to the organization's technological advancement.

Within organizations, the R&D departments play a pivotal role in steering the course of "*P2* projects." These departments are equipped with the expertise needed to oversee the intricate research processes, technology assessments, and innovation strategies that underpin these projects. The collaboration of multidisciplinary teams within R&D departments is a key to driving the successful realization of "*P2* projects."

3.5. Cycle of the *P3* Projects

P3 projects carry higher risk, are more innovative, and typically target more radical innovations compared to other projects. On the other hand, *P0*, *P1*, and *P2* projects tend to concentrate on improving existing processes, products, and available technologies, with lower risk associated.

P3 projects are all about innovation and creating something entirely new. For instance, consider a project where the goal is to develop a flying car. This type of endeavor goes beyond refining existing concepts; it is about embracing radical ideas and pushing boundaries. In this case, engineers and designers are inventing a completely novel mode of transportation, exploring uncharted territories of technology. *P3* projects are where ground-breaking ideas take shape and bring transformative change.

3.6. Cycle of the *P(−1)* Projects

For multinational corporations, a distinct cycle, denoted as "*P(−1)* projects," might be required. These projects fall within the scope of "reverse" innovation, where solutions are developed in emerging markets and later adapted globally (von Zedtwitz et al., 2015), and they may necessitate the application of both analysis-driven and research-driven engines based on project specifics.

For an automotive company, this might involve creating an affordable and durable vehicle tailored to the needs of developing countries. The analysis-driven engine could be used to identify market gaps, while the research-driven engine could explore innovative manufacturing processes that suit the local context. This project highlights the unique challenges and opportunities of reverse innovation, aiming to address specific market demands.

The model proposed in this study does not incorporate this project type. Global innovation projects encompass various unique circumstances that multinational companies need to consider. Factors such as communication and information flow (von Zedtwitz and Joachim, 2020), as well as organizational structures (von Zedtwitz et al., 2004), require specific configurations for these projects. Therefore, attempting to overly simplify them to fit within a generic innovation management system could be misleading for corporations.

4. Measuring the Performance

After the innovation system is planned, careful attention is given to evaluating its performance. This assessment is made using "CIP - Corporate Innovation Performance," a comprehensive measure that shows how effective the system is. The CIP is calculated using Equation 1, which highlights a quantitative method for gauging the success and influence of the innovation structure.

$$CIP = \sum_{i=0}^{2} MP_i \times IE_i \times ((EnP_i) \times (ExP_i) \times (SP_i)) \qquad (1)$$

CIP: Corporate innovation performance
MP_i: Maturity degree
EnP_i: Engine performance
ExP_i: Project execution performance
SP_i: Strategy performance
IE_i: Importance degree of the innovation engine

In this equation, *CIP* stands for Corporate Innovation Performance, which is the ultimate result of this calculation. It serves as a quantified measure of how well the innovation system is performing within the organization.

MP_i refers to the Maturity Degree, which gauges how developed or advanced a particular aspect of the organization's innovation framework is. This value captures the level of sophistication in terms of innovation practices.

IE_i signifies the importance degree of the innovation engine. This factor quantifies the significance of each innovation engine (idea-driven, analysis-driven, and research-driven) within the overall innovation process.

EnP_i represents Engine Performance, which evaluates how well each innovation engine operates in practice. It measures the efficiency and effectiveness of the engines' functionalities.

ExP_i relates to Project Execution Performance, assessing how efficiently and successfully projects (*P0*, *P1*, *P2*) are executed within the organization. This component encapsulates the project management capabilities of the innovation system.

SP_i stands for Strategy Performance, which evaluates how well the organization's innovation strategy aligns with its overall corporate objectives. It measures the strategic coherence between innovation endeavors and business goals.

The calculation involves multiplying these various factors together and then aggregating the results for each "*i*" value from *0* to *2*, representing the three different project cycles. This holistic approach provides a holistic view of the organization's innovation performance, considering multiple dimensions that contribute to the overall effectiveness of the innovation management system.

Consider the following hypothetical example to demonstrate the calculation of the *CIP* using the provided formula. Assume we have an automotive manufacturing company that is evaluating its CIP. The company employs three different project cycles: *P0*, *P1*, and *P2*. Each of these cycles operates at different levels of maturity, has varying importance degrees, and demonstrates diverse performance levels.

Let's assign some arbitrary values to these parameters for the purpose of illustration:

For the P0 projects cycle (i = 0):
Maturity degree (MP_0) = 0.7
Importance degree (IE_0) = 0.4
Engine performance (EnP_0) = 0.8
Project execution performance (ExP_0) = 0.6
Strategy performance (SP_0) = 0.9

For the P1 projects cycle (i = 1):
Maturity degree (MP_1) = 0.6
Importance degree (IE_1) = 0.3
Engine performance (EnP_1) = 0.7
Project execution performance (ExP_1) = 0.5
Strategy performance (SP_1) = 0.8

For the P2 projects cycle (i = 2):
Maturity degree (MP_2) = 0.8
Importance degree (IE_2) = 0.3
Engine performance (EnP_2) = 0.9
Project execution performance (ExP_2) = 0.7
Strategy performance (SP_2) = 0.85

Plugging these values into the formula:
$CIP = 0.12096 + 0.0504 + 0.1638 = 0.33516$

The derived CIP value serves as a pivotal metric indicative of the organization's ongoing need for continuous improvement. It stands as a dynamic gauge of the innovation system's effectiveness, highlighting the extent to which the various dimensions of the innovation ecosystem are aligned and contributing to the company's innovative prowess.

CIP is a measurement framework of the IEM. Its sub-level performance factors and indicators need consideration of detailed company-specific dimensions. Dziallas and Blind (2019) provide an extensive literature analysis on innovation indicators throughout the innovation process. A comprehensive list of the corresponding factors and indicators can be found in Dziallas and Blind (2019).

In its essence, CIP reflects not only the present state of the innovation management system but also serve as a harbinger of future endeavors. Much like the Overall Equipment Effectiveness (OEE) metric that underscores manufacturing performance, CIP serves as a tailored, innovation-specific integrated KPI for the organization. Just as OEE provides insights into the efficiency of manufacturing processes, CIP offers a comprehensive view of the innovation landscape, encompassing engine maturity, project execution, strategy alignment, and more.

4.1. Determining the Maturity Degree

The IEM defines three distinctive maturity levels within the realm of corporate innovation. Each level is characterized by unique attributes, corresponding to specific coefficients that contribute to the overall CIP calculation.

1. *Level-1: Transparent Management* (MP_i*: 0.33)*

At this level, the innovation execution processes are clearly defined, fostering transparency in management practices. KPIs are established, providing a transparent framework for evaluating innovation endeavors.

2. *Level-2: Systematic Management* (MP_i*: 0.66)*

As innovation progresses to this level, a systematic approach prevails. System behavior becomes predictable, and data-driven management practices come to the fore. Decisions are guided by empirical insights, enhancing the efficiency and effectiveness of the innovation ecosystem.

3. *Level-3: Intelligent Management* (MP_i*: 1)*

At the pinnacle of the innovation hierarchy, intelligent management takes center stage. Real-time data become the cornerstone of decision-making, enabling the system to function optimally. Continuous adaptation and refinement are inherent, ensuring that the organization operates under optimal conditions.

These maturity levels underscore the evolution of the innovation framework, each contributing to the holistic calculation of CIP. The model not only provides a quantified measure of innovation performance but also delineates the path to advancing corporate innovation, from transparent management to intelligent, data-driven optimization.

4.2. Determining the Importance Degree

Determining the importance degree is a context-specific task, influenced by a variety of factors. These include the company's goals, the market landscape, available resources, and industry alignment. In essence, it is a tailored evaluation, reflecting the strategic choices that align with the company's vision.

A prominent consultancy company contributes to this discussion through insightful reports (Kirchgeorg et al., 2010). These reports offer guidance to companies seeking direction in setting their importance degree levels. This external perspective acts as a compass, providing a wider view and potential benchmarks for organizations navigating this decision-making process. For instance, in the case of an automotive manufacturer, based on the report, importance degree levels might be aligned as follows, as depicted in Fig. 4.

It is important to note that while external references provide insight, the final determination of importance degree remains an internal endeavor. By blending internal assessment with external insights, companies create an importance degree framework that resonates with their unique goals.

4.3. Performance Metrics and Assessment

In this section, we discuss the performance metrics; EnP_i – Engine Performance, ExP_i – Project Execution Performance, and SP_i – Strategy Performance.

4.3.1. $\mathbf{EnP_i}$ – engine performance

EnP_i measures how efficiently and effectively each innovation engine operates. In the IEM, innovation engines include the idea-driven, analysis-driven, and research-driven engines, each supporting different types of innovation projects.

Key elements to assess:

- Efficiency rate: How quickly does each engine process ideas, analyses, or research? For example, the idea-driven engine should move ideas from conception to action quickly, showing high efficiency.
- Success rate of outputs: What percentage of ideas or research findings lead to meaningful projects? A high success rate indicates that the engine consistently produces valuable outputs.
- Adaptability to market changes: How well does the engine respond to changes in technology and market demand? For instance, an analysis-driven engine should quickly integrate market shifts and competitor insights.

Assessment scale (*0* to *1*):

- Low: The engine operates slowly, rarely produces successful outputs, and is not responsive to market changes.

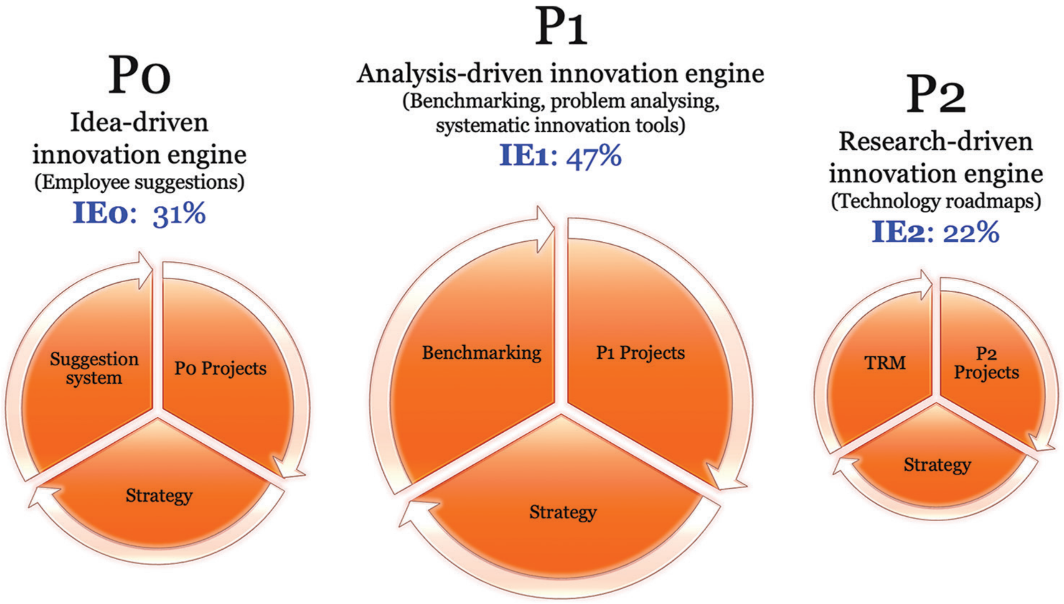


Fig. 4. Importance degree of innovation engines: Automotive industry rates

- Moderate: The engine functions with average speed and output success, with basic responsiveness to change.
- High: The engine is highly efficient, with a high output success rate and excellent adaptability.

4.3.2. ExP_i – project execution performance

ExP_i evaluates how well innovation projects (*P0*, *P1*, *P2*) are executed. This metric looks at timelines, resource usage, and achievement of project goals.

Key elements to assess:

- Timeliness: Are projects completed on schedule? This factor measures whether projects meet their deadlines, essential for maintaining momentum in innovation.
- Resource utilization: Is the organization using resources efficiently? This includes staying within budget and maximizing manpower without waste.
- Goal achievement rate: Are the project objectives being met? For instance, if a project aims to improve product efficiency by 10%, this metric evaluates whether that goal is achieved.

Assessment scale (*0* to *1*):

- Low: Projects are often delayed, over budget, and few goals are met.
- Moderate: Projects usually meet deadlines and budgets but may achieve only some of their goals.
- High: Projects consistently stay on time, within budget, and meet or exceed their goals.

4.3.3. SP_i – strategy performance

SP_i assesses how well the innovation strategy aligns with broader organizational goals, such as market expansion or sustainability. It measures strategic alignment, market impact, and risk management.

Key elements to assess:

- Strategic alignment: Are innovation projects aligned with the company's strategic goals? This includes ensuring projects contribute to long-term objectives.
- Market impact: Do the innovations positively impact the market, improve customer satisfaction, or provide a competitive edge? High market impact shows that the organization's innovations are valued externally.
- Risk management: How effectively does the organization manage risks in its innovation activities? Effective risk management reduces the chance of project failures due to unforeseen challenges.

Assessment scale (*0* to *1*):

- Low: Projects rarely align with strategic goals, have minimal market impact, and risk management is poor.
- Moderate: Projects sometimes align with strategy, make a moderate market impact, and have basic risk management.
- High: Projects align closely with goals, have a significant market impact, and provide risk management in place.

These metrics, assessed on a *0* to *1* scale, provide a structured approach to evaluating innovation performance. By regularly assessing EnP_i, ExP_i, and SP_i, organizations gain insights into their innovation system's strengths and areas for improvement, supporting a continuous journey toward excellence in innovation management.

5. Keeping the Innovation Engines Synchronized

The IEM takes into account corporate innovation as management actions for innovation projects. Following this perspective, it outlines three fundamental cycles of innovation processes that correspond to the primary project types found in typical corporate innovation scenarios. These cycles are known as *P0*, *P1*, and *P2* project cycles. Each of these project cycles is set into motion by one of three distinct engines: the idea-driven engine, analysis-driven engine, and research-driven engine, respectively.

The choice of which engine to prioritize can vary based on the corporate's competitive landscape and strategic direction. This determination of engine balance constitutes a strategic choice. Deciding on these equilibrium rates is a pivotal step in the strategic journey. Equally crucial is the question of how to ensure the entire system operates in accordance with these designated rates.

Determining the right balance and maintaining the synchronization of these engines within the innovation management system is a strategic imperative. In this context, it becomes a pivotal issue to ensure that the selected engine's prominence aligns with the corporate strategy. This strategic alignment forms the bedrock for achieving innovation success. The selected engine dictates the rhythm and emphasis of the innovation process, steering it toward optimal results in line with the overarching strategic goals.

This scenario highlights an environment with multiple projects in play. Successfully managing such an array of endeavors requires considering critical elements simultaneously. These encompass portfolio management, project cycle planning, and the equitable allocation of shared resources.

What amplifies the complexity of this landscape is the intrinsic nature of these projects, which revolve around innovation. This, in turn, introduces an element of uncertainty, underscoring the imperative of adept real-time decision-making as a pivotal driver of success.

5.1. Card-based Navigation

Due to its computational advantages and decreased vulnerability to uncertainty, a preference often emerges for card-based control approaches in real-world contexts. Card-based systems rely on the inherent signals of the existing system to authorize releases (Riezebos, 2006).

Among the card-based control systems documented in existing literature, COBACABANA – Control of Balance by Card-Based Navigation, as elaborated by Land (2009), shines as one of the most intricate and sophisticated.

Its operational mechanism seamlessly aligns with the intricate task of managing multiple projects within the IEM. This mechanism facilitates the execution of project releases from the portfolio, with the optimized allocation of cards ensuring the model's effective implementation.

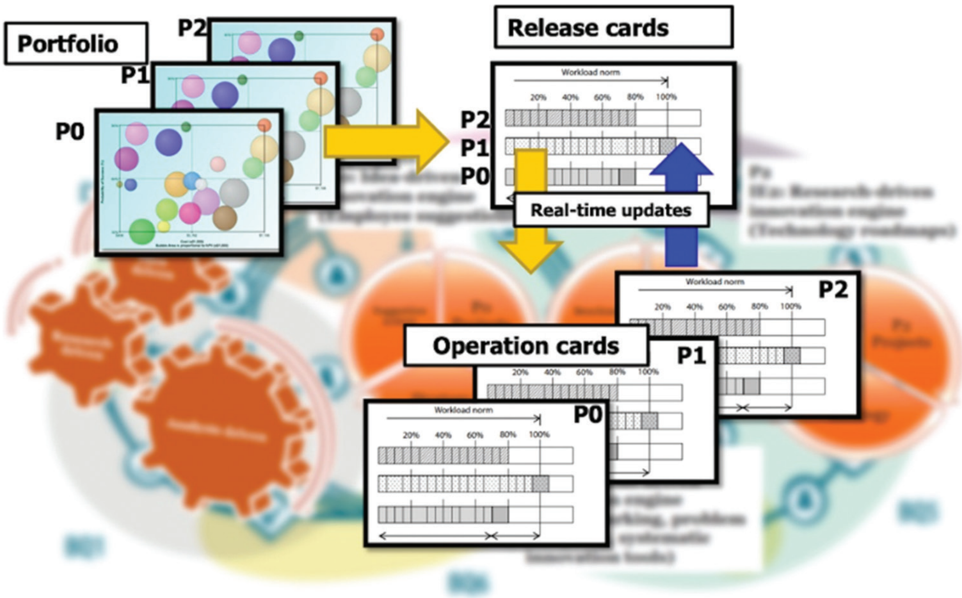


Fig. 5. Keeping innovation engines synchronized using a card-based control approach

As depicted in Fig. 5, the IEM takes tangible form. The determination of release card quantities is executed with careful consideration for maintaining a harmonious equilibrium among the project engines.

At this pivotal stage, the adoption of discrete event simulation is recommended for conducting "what-if" analyses and simulation optimization.

Following the quantification of release card quantities, project releases receive authorization if an adequate number of release cards is available on the panel. These release cards become integral to the authorized projects, and upon the completion of their respective stage gates, they revert to the panel. Within practical contexts, the management of these processes in real time finds a suitable ally in a BPM-Business Process Management system.

5.2. Simulation Modeling

In this section, we extend our discussion with a simulation study conducted using the Simio environment. The choice of Simio was driven by its ability to easily model working scenarios, especially those involving limited Work-in-Progress (WIP) systems. Simio's buffer logic concept enables these models to be implemented without extra complexity. Our simulation model employs state variables to model release cards in a constrained manner, tailored to specific project types. For instance, for *P0* projects, the card limit was set at *31*; for *P1* projects, it was *47;* and for *P2* projects, it was *22*. Fig. 6 displays the initial screen when running the simulation model.

Each new project entry is constrained by the availability of these cards. Depending on the project workload, card assignments are made during project entries. As projects complete their stage-gate phases, these cards are released, creating new capacity. The stage-gate sections can be customized according to each project's workflow. In this example model, we assume that each project type follows a 4-phase process.

In Fig. 7, we illustrate a scenario where the absence of available cards blocks the entry of projects into the system. After the warm-up period, the simulation model continues to operate with the constrained capacities as reflected in the distribution of

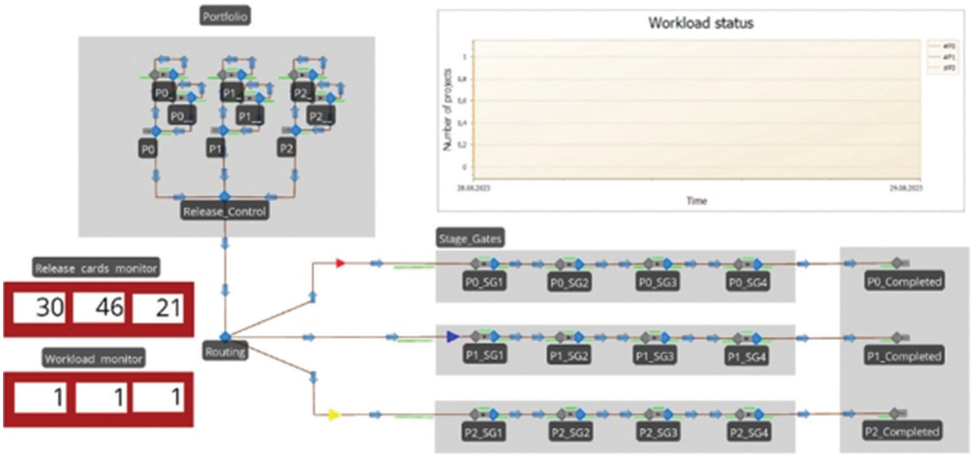


Fig. 6. The initial screen when running the simulation model

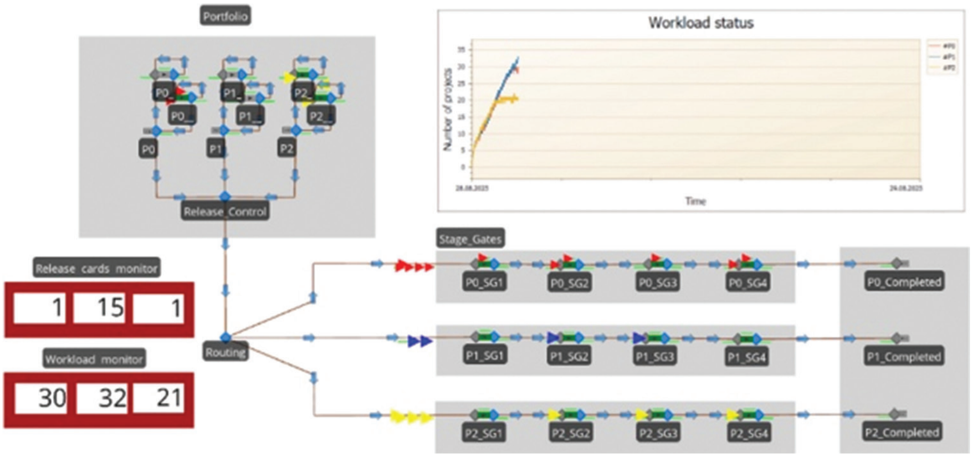


Fig. 7. Blocking the entry of projects into the system

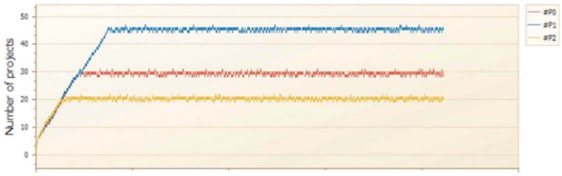


Fig. 8. The workload status

workload. The long-term workload status is depicted in Fig. 8, affirming the ability to control project workload balance through card-based control.

It is important to note that while this study establishes the feasibility of managing project workload using card-based control, a real-world implementation would involve using detailed operational data to fine-tune the system's parameters for optimal performance. In light of this, the model's adaptations can guide the design efforts toward an efficient real-world setup.

6. Concluding Remarks

Harmonizing IEM with theoretical foundations, the CIP metric, and practical strategies offers organizations a comprehensive toolkit for sustainable success. By fostering a holistic understanding of innovation engines, project types, resource allocation, and performance measurement, the model equips organizations to navigate the complexities of innovation management, propelling them toward excellence and growth.

Future research can contribute to the refinement and enrichment of the IEM, making it an even more potent tool for organizations seeking to excel in the dynamic landscape of innovation management. Several areas offer promising avenues for future research and exploration: Conducting in-depth case studies of organizations that have adopted the IEM can provide practical insights into its implementation, challenges faced, and lessons learned.

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