Knowledge as the Energy Flow of the Project Ecosystem

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Abstract: An ecosystem is a community of organisms and their physical environment interacting together. Ecosystem involves both biotic (living) organisms (plants, animals, microbes) and abiotic (non-living) physical surroundings (air, water, soil, sunlight). A project is an ecosystem because it is a dynamic, interdependent community of living parts (stakeholders) and non-living parts (OPA – Organizational Process Assets and EEF – Enterprise Environmental Factors). The parts of an ecosystem are linked together through an energy flow, essential for its survival. Energy flow relies on a source, mostly solar. If energy flow stops, an ecosystem will rapidly and completely collapse. Without a continuous flow of energy to maintain complex structures, biological organization breaks down into simple components. Similarly, knowledge is the energy flow that assures the life of the project ecosystem. Without knowledge project naturally moves toward disorder, entropy and chaos. The local profile of the single stakeholder (history, values, and culture, reputation, distinctive skills, organizational structure, and, last but not least, its interest and power over the project), prevails over the global dimension of the project (common goal, synergies, collective way of working, contamination of ideas, points of view, perspectives). This paper is aimed at discussing how to address the peculiarities of a project ecosystem through the energy flow of knowledge. Project peculiarities are: limited life cycle; interdependent stakeholders; fragile relationships; adaptation and learning; emergent value; agency for change. First of all, each peculiarity is briefly explained in terms of meaning, strengths and weaknesses. Then, the practical use of knowledge is discussed for enhancing strengths and reducing weaknesses. Finally, some advices are provided to project key roles, such as project manager, subject matter experts, agile coach, in order to become more familiar with knowledge as the energy flow of the project ecosystem. The topics of this paper may effectively feed the integration of knowledge management other business disciplines, project management first and foremost.

Keywords: Energy Flow, Project ecosystem, Stakeholders engagement, Knowledge sharing, Complexity theory, Second law of thermodynamics, Serendipity

1. Profile of an Ecosystem

An ecosystem is a community of organisms and their physical environment interacting together. Ecosystem involves both biotic (living) organisms (plants, animals, microbes) and abiotic (non-living) physical surroundings (air, water, soil, sunlight). These two are inseparable but inter-related, forming a dynamic system. Main types of ecosystems are terrestrial ecosystem, forest ecosystem, grassland ecosystem, desert ecosystem, tundra ecosystem, aquatic ecosystem, freshwater ecosystem, marine ecosystem. Ecosystems are fundamental for life. The parts of ecosystem are linked together through an energy flow, essential for survival. Energy flow relies on a source, mostly solar. If energy flow stops, an ecosystem will rapidly and completely collapse, as life is an energy-driven process that cannot be sustained without constant feed. It leads to entropy and chaos. The behavior of an ecosystem can be basically explained referring to the second law of thermodynamics: This law states that *"the entropy of the universe tends to a maximum"* (Clausius, 1867). Particularly: a) heat spontaneously flows from hotter to colder objects ("heat flow"), b) energy conversions through trophic levels aren't completely efficient ("10% rule of energy conversion efficiency"), c) the total disorder of an isolated system always increases over time ("increase of entropy"); d) disorder increases because it is statistically more likely than order ("statistical mechanics"); e) an ecosystem can only unfold in one sequence, where the transition from concentrated energy to dispersed chaos determines that the past and future are never interchangeable ("arrow of time").

2. Project as an Ecosystem

In a broader context, the term "ecosystem" is used to describe complex systems of interacting people, businesses, and technologies. Weick argues that *"organized action under uncertainty is maintained through ongoing interpretation and enactment"* (Weick, 1995). Applied to projects, this quote suggests that project coherence does not persist automatically; it must be continually reproduced through shared sensemaking. Projects, especially complex ones, do not simply "run" once designed; they remain coherent only while participants continuously reconstruct shared meaning about goals, risks, priorities, and actions. Thus, a project may be represented as an ecosystem because it is a dynamic, interdependent community of "living" parts. It's a temporary ecosystem because its functions as a short-lived, collaborative environment, bound by an ad-hoc mission rather than a permanent institutional lifespan. Peculiarities of projects as ecosystems are: a) limited life cycle (project is initiated, planned, and executed within a defined timeframe and then it dissolves one the goal is met); b) interdependent stakeholders (projects bring together a heterogeneous mix of individuals,

departments, organizations that must rely on one another to succeed); c) fragile relationships (because the project structure is temporary, trust and coordination are vital; if one party hoards resources, the entire system can fail, much like a diseased organ in a body); d) adaptation and learning (like natural systems, projects must undergo steep learning curves and adapt rapidly to internal or external changes to carry out the expected result); e) emergent value (a project should generates value that exceeds what was strictly contracted, similar to how biological ecosystems produce emergent traits); f) agency for change (projects are often set up as temporary units to bypass the inertia of permanent organizations, allowing for faster experimentation and innovation). In a project ecosystem, stakeholders can be assimilated to living organisms, while OPAs and EEFs to non-living physical surroundings. Each stakeholder is unique due to its intrinsic characteristics and the environment in which it lives and works. Similarly, the stakeholder's action is conditioned (limited and/or facilitated) by its own endogenous assets and by exogenous environmental factors. The single stakeholder with its profile and its specific environment is the atomic component of the project ecosystem. The more numerous, heterogeneous and geographically distributed the stakeholders are, the more complex the project ecosystem is. Lundin and Söderholm (1995) conceptualize projects as temporary organizations characterized by limited duration, specific tasks, transition, and contextual embeddedness, which makes them inherently less stable than permanent organizational forms. Thus, we can represent the initial state of a project ecosystem as a multitude of unique subjects seeking for emergent relationships within the scope and duration of the project. By analogy with the second law of thermodynamics, a project ecosystem tends toward entropy unless it receives continuous sustaining input. In projects, this sustaining input takes the form of knowledge flow, communication, coordination, and shared sensemaking, which function as the organizing energy that preserves coherence. Without a continuous flow of energy, breaks down into simple components moving toward disorder. The consequence is that project becomes *"mission impossible".*

3. Knowledge as the Energy Flow of the Project Ecosystem

> *"Much of the theory associated with project management is explicitly organized according to taxonomic Bodies Of Knowledge (BOK). Although such BOK are conceptually simple and easily disseminated, their generally static and explicit nature is out of phase with the dynamics of critical, tacit knowledge as it flows through the project organization. We argue for a more descriptive view of project management theory, one that captures the dynamics of knowledge flows, addresses tacit knowledge and provides new insight into interrelationships between the management of project knowledge and the management of project activities in the enterprise". (Snider Nissen, 2003).*

Thus, knowledge should be the energy pervasive flow of the temporary project ecosystem. In ecosystems, energy is what sustains processes and interactions, enabling the system to function and thrive. Similarly, in a project ecosystem, knowledge drives the behavior of each stakeholder and interactions among stakeholders, from decision-making and problem-solving to collaboration and innovation. It flows in various forms, such as shared information, lessons learned, vertical expertise, insights, and communication. This exchange feeds collaboration, aligns stakeholder efforts, enhances collective actions, coherent and effective towards the common goal of the project. Moreover, the quantity and quality of knowledge can amplify or limit the performance of the project ecosystem: knowledge sharing fosters trust and alignment among stakeholders, while bottlenecks in knowledge transfer can create misalignments and conflicts. In short, knowledge not only powers the project, but essentially binds its parts together, enabling stakeholders to work collectively and adaptively, as a cohesive whole. Viewing knowledge as the energy flow of the project ecosystem can radically shift how to consider project dynamics and success. In projects, knowledge is the vital force that sustains coordination, adaptation, learning and collaboration. When knowledge does not flow across the project ecosystem, the project loses its adaptive energy: decisions weaken, silos deepen, learning slows, risks intensify, and the likelihood of delay, rework, and failure increases. *PMI® states that "Managing knowledge involves more than just documenting explicit knowledge for transfer lessons learned at the end of the project for use in future projects. It entails that tacit knowledge, often deeply ingrained in experts' experience and intuition, can be shared within a project by fostering a collaborative and trust-filled environment. This effort involves creating opportunities for knowledge transfer (A/N sharing) through open communication, mentoring relationships, team-building activities. Encouraging face-to-face interactions and hosting regular brainstorming sessions can help make implicit knowledge more accessible" (PMI, 2025).*

4. Knowledge in Limited Life Cycle

A project is temporary adventure based on limited life cycle. "The project life cycle provides the foundational framework for managing the project. The project life cycle should be flexible enough to meet or exceed the

project target objectives in a way that protects and enhances the project's value proposition as much as possible". (PMI, 2025). Project must be initiated, planned, executed and closed within a defined timeframe in terms of final deadline and intermediate milestones. The life cycle consists of a set of phases. Each phase is unique in terms of purpose, contents, management style, way of working, requested behaviors. For example, on the one hand the phase "Feasibility" has this profile: the purpose is to determine whether the project idea is viable, the focus is on understanding the problem or opportunity, exploring alternatives, and deciding whether to proceed; typical contents include business need analysis, high-level scope, cost-benefit review, risk identification, stakeholder analysis, and possible options. The team tries to build enough understanding to support a go/no-go decision; the management style is usually exploratory, analytical, and flexible. Project manager encourages investigation, discussion, and critical thinking rather than strict control of delivery; the way of working is research-oriented and collaborative. The team gathers information, evaluates assumptions, compares options, develops early recommendation. Activities often involve workshops, interviews, studies, and concept reviews; requested behaviors entail that people are expected to be curious, open-minded, realistic, and willing to challenge. Assumptions, strong communication, learning, and stakeholder engagement are important because uncertainty is high. On the other hand, the phase "Construction" has this profile: the purpose is to build the approved project deliverables. The focus shifts from deciding what should be done to making sure the work is completed effectively, on time and on budget; typical contents include detailed execution, resource deployment, procurement, coordination of teams, quality control, schedule tracking, cost control, issue resolution, progress reporting; the management style is more structured, controlled, and performance-driven. The emphasis is on coordination, productivity, compliance, and meeting milestones; the way of working is execution-focused and follows approved plans, designs, and specifications. Team performs defined tasks, monitor progress, manage changes, and resolve operational problems quickly; requested behaviors entail people to be disciplined, accountable, safety-conscious, and delivery-oriented. Team members need good coordination, responsiveness, and commitment to quality and deadlines. According to this scenario the knowledge flow must be tailored on the uniqueness of each project phase. In other words, the energy flow must enlighten and fuel each phase in a different way. For example, on the one hand the knowledge flow for the "Feasibility" phase should be broad, exploratory, and analytical, so the team can evaluate options, test assumptions, and make a sound go/no-go decision; implicit and tacit knowledge usually prevail over explicit knowledge. On the other hand, the knowledge flow for the "Construction" phase should be structured, fast, and operational. Information needs to move continuously among planners, engineers, suppliers, management roles and others stakeholders to coordinate execution, solve issues quickly, control quality, and keep the work aligned with schedule, cost, and scope; explicit knowledge usually prevail over implicit and tacit knowledge. In short, during Feasibility knowledge flow supports understanding and decision-making, while during Construction knowledge flow supports execution and control. Summing up: "The management of projects requires different emphases at different stages in the project life cycle." (Turner, 2009); "Knowledge has to be improved, challenged, and increased constantly, or it vanishes." (Drucker, 1993).

5. Knowledge Among Interdependent Stakeholders

Project is a dynamic and emergent system of interests, less declared and more implied. By their nature, these interests are not necessarily aligned with the project objective. Moreover, interests of a stakeholder are related with the interests of another stakeholder. They can converge, diverge, coexist. The result is a complex network of relationships. According to the Cynefin framework, *"a complex system has the following characteristics: it involves large numbers of interacting elements; the interactions are nonlinear and minor changes can produce disproportionately major consequences; the whole is greater than the sum of its parts, and solutions can't be imposed, rather they arise from the circumstances, this is frequently referred to as emergence; unlike in ordered systems (where the system constrains the agents) or chaotic systems (where there are no constraints), in a complex system the agents and the system constrain one another, especially over time"* (Snowden Boone, 2007). Therefore, a project can be understood as a complex system because it involves many stakeholders whose interactions are interdependent, dynamic, and not fully predictable in advance. Therefore, the project manager should create the conditions where knowledge moves across boundaries and where stakeholders collectively make sense of what is happening. Knowledge as energy flow can support project managers in addressing interdependencies among stakeholders. How? We can refer to the topics of the second law of thermodynamics. For *"heat flow"*: in projects, heat tends to flow from the most pressured stakeholders to the less pressured ones. For example, if a regulator raises compliance concerns, that pressure moves to the sponsor, then to the project manager, then to the delivery teams, and finally to suppliers who must adjust designs or documentation. This helps to explain why unresolved issues do not stay local. Project manager should use knowledge flow to channel

and absorb pressure before it becomes disruptive, converting pressure into actionable understanding so that stakeholder reactions are informed rather than emotional. For *"10% rule of energy conversion efficiency"*: in projects, every stakeholder handoff loses value across trophic levels. A strategic objective from the project sponsor is rarely received with full fidelity by other stakeholders. For example, the sponsor message "to improve customer experience" may become for a supplier "to reduce click count," which is only one fragment of the original intent. Project manager should use knowledge flow to protect the original purpose by creating traceability. For example, the sponsor message "to improve customer experience" should be translated into business requirements, design choices, testing criteria, and adoption measures in a visible chain. Because of this PMI suggests to adopt a holistic view: *"this perspective aligns with the concept of system thinking, which emphasizes the interconnectedness of elements within a project. It provides a framework for viewing interrelationships in their full context and for seeing patterns rather than static snapshots"*. (PMI, 2025). For *"increase of entropy"*: a project stakeholder isolated from the normal flow of communication, feedback, decisions, and shared understanding gradually increases disorder in the project ecosystem. Because of this isolation decisions become guided more by local priorities than by shared project objectives. For example, a department that was consulted at project initiation but not engaged afterward. Over time, it develops its own interpretation of the project purpose, believe its needs are being ignored, and begins resisting implementation decisions. Project manager should use knowledge flow to open the isolated stakeholder, even if supportive, through regular exchanges: governance meetings, stakeholder check-ins, risk reviews, and updated communication tailored to each audience. For *"statistical mechanics"*: in projects disorder is often more probable than order because there are many more ways for coordination to go wrong than to go right. It takes only one missed dependency, one ambiguous approval, or one unshared assumption to create friction, while successful coordination usually requires multiple conditions to align at once. For example, a project for the launch of an innovative product involves marketing, compliance, IT, sales, and customer support. There are countless combinations of partial readiness that produce confusion, but only a relatively narrow set of coordinated states that produce a smooth launch. The project manager should use knowledge flow to design structure against the natural probability of confusion, through stakeholder map, RACI matrix, formal escalation thresholds, and standard reporting formats. For *"arrow of time"*: once stakeholder decisions are made, contracts signed, architecture chosen, or trust damaged, the project ecosystem cannot simply reverse to an earlier condition without additional costs. For example, the sponsor publicly announces a delivery date before technical stakeholders validate feasibility. That announcement changes behavior across the projects: procurement accelerates, teams compress testing, suppliers negotiate around urgency and customers form expectations. Even if the date was unrealistic, the project cannot return to the pre-announcement state. The project manager should use knowledge flow to improve the quality of irreversible decisions. He/she should ensure that when stakeholders make those choices, they do so with enough knowledge about impacts, dependencies, and risks. For example, before committing to a delivery date, the project manager should organize a round table among project sponsor, technical leads, and operations stakeholders for fostering a shared visibility of feasibility constraints and downstream implications.

6. Knowledge Across Fragile Relationships

The temporary dimension of the project influences the relationships among stakeholders. In many cases these relationships can't rely on stable and codified rules, long-term routines, shared history, but must instead be built quickly and put in action under pressure. For this reason, relationships are contingent, precarious, unstable, ephemeral. In short, fragile. The fragility of relationships is undoubtedly a critical factor for the success or failure of a project. It depends on how they are nurtured. Fragility is defined as *"a concave sensitivity to stressors, where an entity has more to lose than to gain from random events. A fragile system is one that is short- volatility, performs worse as disruption increases and breaks under large shocks"* (Taleb, 2012). This means that project relationships, if not protected, are damaged by stressors: an intact better shape before stress versus a broken worse shape after stress. A stressor is *"any form of disorder, volatility, randomness, uncertainty, or external pressure that acts upon a system"* (Ibidem). Stressors are the inhibitors that cause a fragile system to break, degrade and become weaker. Speaking about projects, under the term "stressor" we can group errors, changes, failures, attacks, risks, unforeseen events, malfunctions. How to protect the fragility of project relationships? Knowledge can protect this fragility because it acts as the medium through which relationships can gain consistency, trust, and continuity, preventing them to break. In which ways? The first way is through a shared understanding. Fragile relationships often suffer from ambiguity. Stakeholders may not fully understand each other's roles, expectations, constraints, or motivations. When knowledge flows openly and continuously, uncertainty decreases. Stakeholders begin to see not only what others are doing, but why they are doing it. The

second way is through a swift trust. Project stakeholders usually don't have the advantage of developing trust over long periods. Swift trust can be developed through reliable exchanges of knowledge: clear communication, transparent decisions, visible assumptions, timely escalation of risks, and honest sharing of constraints. Thus, stakeholders perceive relationships as dependable, even if they are new and fragile. The third way is through the visibility of interdependences. During the project execution, stakeholders depend on one another in asymmetrical and changing modes. Fragility increases when one stakeholder's actions unexpectedly disrupt another's work. Continuous knowledge flow makes dependencies more visible. In this way, knowledge flow acts as a "glue" against instability created by fragile interdependences.

7. Knowledge in Adaptation and Learning

At first sight, this peculiarity of the project may appear obvious. New knowledge derives from learning and learning is based on current knowledge. However, this is not such a foregone conclusion. Learning during the project life cycle is not innate and free, but instead requires an ad-hoc strategy, investment and action plan. *"Organizations learn only through individuals who learn. Individual learning does not guarantee organizational learning. But without it no organizational learning occurs".* (Argyris Schön, 2007). The project is an incredible learning opportunity that is too often under and poorly exploited. The consequence is that the project doesn't socialize the experiences gained in the field, doesn't translate them in lessons learned, and accordingly doesn't adapt the way of working and interacting for the remaining part of the project. The file rouge *"inspect, reflect, learn, adapt"* is broken! A key principle of the adaptive (agile) approach for managing projects states that *"at regular intervals, the team reflects on how to become more effective, then tunes and adjusts its behavior accordingly"* (Authors of agile manifesto, 2001). The Disciplined Agile toolkit entails the process "Evolve way of working". The focus of is *"continuous improvement to support and enable teams to choose their way of working and share learnings across the organization"* (Ambler Lines, 2019). If the project fits an agile approach, knowledge flow for learning and adaptation should be based on techniques that are frequent, transparent, collaborative, and iterative. Some typical techniques are: Daily standups that help the team surface blockers, dependencies, and progress in real time, which strengthens short-cycle coordination; Sprint reviews that help the project adapt based on feedback from the field more than initial assumptions; Sprint retrospectives that help the agile team to reflect on what worked, what failed, and what should change in the next iteration; Information radiators that make knowledge visible and strengthens collective awareness; Pair work that helps agile people to learn directly from one another while work is being done, instead of only after work is done. For a waterfall or predictive approach, knowledge flow for learning and adaptation should be based on techniques that are planned, documented, sequential, and controlled across phases. Some typical techniques are: Requirements documentation that captures stakeholder needs helping to preserve a shared understanding early in the project; Design reviews that allow to analyse results before execution moves forward. They create opportunities to validate assumptions, surface errors, and improve solution quality before costly downstream work begins; Phase-gate reviews that organize learning at transition points. At the end of each phase, the project team can assess what has been achieved, what risks remain, and what knowledge must be transferred before the next phase begins; Formal handoffs that protect continuity across specialized teams and sequential work stages; Lessons learned registers that support organizational learning by regularly capturing experiences, recurring problems, and good practices; Change control procedures that ensure that new knowledge about scope, risk, quality, or stakeholder needs is not ignored but incorporated in a structured way; Configuration management that helps to maintain the integrity of project knowledge by controlling versions of requirements, designs, specifications, and deliverables; Status reports that keep knowledge flowing across managerial and governance levels (portfolio, strategic objectives).

8. Knowledge for Emergent Value

A project justified itself if creates value (positive exceed between achieved benefits and incurred costs). This challenge requires to move across the value chain, particularly along the time-lined sequence *"deliverables – outcomes – benefits".* Deliverables are useless if not translated into outcomes and benefits are not achievable without outcomes. An example: a project has built *"a car with seat belts compliant with specific safety standards".* This deliverable is useless if the outcome *"car drivers fasten their seat belts regularly"* is not in place. Only if this outcome is in place the benefit *"fewer deaths and injuries while traveling by car"* is achieved. Outcome is the bridge between deliverable and benefit, too often badly and poorly addressed. The value of the project may be planned upfront but also emerges in progress. The project is an ecosystem whose dynamics are better discovered, understood and addressed through a combination of structured management and a serendipity-oriented mindset that remains open to emergent signals, unexpected connections, and unplanned

opportunities. Serendipity is *"the faculty of making happy and unexpected discoveries by accident"* (Walpole, 1977). A serendipity approach can be useful for sensing and leveraging unexpected patterns, weak signals, informal insights, accidental discoveries, beneficial unplanned connections. For example, in an R&D project, a supplier raises a concern that seems marginal to the initial scope. Instead of ignoring it, the project manager explores it and discovers a broader interoperability issue that could later affect regulators, users, and future partners. What appeared as an unexpected side comment becomes a powerful system insight. This example points out that serendipity is not random luck alone, it is more like disciplined receptivity. This way, serendipity can foster outcomes that are not fully predictable from the plan alone. The project manager should create the conditions in which unexpected but useful knowledge can surface and then acts on it. Knowledge flow may be a powerful enabler of the emergent side of project value. It connects the production of deliverables with their effective use in practice, allowing intended outcomes to materialize and consequent benefits to be realized. Through continuous sharing, interpretation, and application of knowledge, the project moves beyond output delivery toward sustained value creation. For example, at the outcomes level, knowledge flow becomes the key that enables deliverables to be understood, adopted, uses used, embedded in practice. Outcomes are not generated automatically by handing over deliverables. They emerge when users, sponsors, operators, and affected stakeholders understand what a deliverable is for, how it changes work, and how it should be integrated into existing processes. In this sense, knowledge flow converts a delivered artifact (things) into a new operational state (people).

9. Knowledge as Agency for Change

Project, by its nature is an agency for change. Deliverable must be translated into outcomes. Outcomes occur when people alter behavior, routines, decisions, and interactions in response to the deliverable. Thus, project outcomes (new organizational state) may be in place only through change management. The goal is to move from to current state (as-is) to the future state (to-be). The wider is the gap, the bigger is the change management effort. We can argue that change management addresses the transition from deliverables (things) to outcomes (people). Change management is a *"comprehensive, cyclic and structured approach for transitioning individuals, groups and organizations from a current state to a future state with intended business benefits"* (PMI, 2013). Change management runs parallel to project management, right from the start of the project, regardless the project approach selected: waterfall, agile or hybrid. Change management entails different approaches. The main types are: "Fully prepared to act", "Continuously sustain action", "Deliberately build capacity", "Quickly organize to act". The choice of the approach that best fits with the change to address depends on the combination of two factors: urgency to change and readiness for change. With no doubt, the project manager is accountable to set-up and coordinate the change management plan, including in the project team specialized roles such as change ambassadors, change catalysts, change leads. In which way knowledge as energy flow of the project ecosystem can make the difference in change management? Mainly in four connected ways. First, it gives stakeholders sensemaking capacity, helping them interpret the purpose of the change and their role within it. Second, it provides relational connectivity, linking people who must coordinate to implement the new reality. Third, it enables adaptive learning, allowing the organization to respond to resistance, misunderstanding, and unintended effects as they emerge. Fourth, it supports reinforcement, so the new ways of working become normalized rather than temporary compliance behaviors. Summing up, knowledge flow is what keeps the project ecosystem responsive and coherent across the full transition from delivery to adoption to sustainment.

10. Conclusions

Project is an ecosystem which behavior can be basically explained referring to the second law of thermodynamics. Heat flow, 10% rule of energy conversion efficiency, Increase of entropy, Statistical mechanics, Arrow of time can be applied to discover and understand the complexities of the project ecosystem. Knowledge is the pervasive energy flow of the temporary project ecosystem. Knowledge flow is essential to address the peculiarities of the project: limited life cycle, interdependent stakeholders, fragile relationships, adaptation and learning, emergent value, agent for change. Project managers, and more in general project key roles, should improve their awareness in using knowledge from an ecosystem point of view. With no doubt, this is a big challenge that must be embraced and that can lead to improved project performance in terms of benefits and value. Otherwise, the project ecosystem is left at the mercy of entropy and chaos.

Ethics and AI Declarations: For this paper, an ethics declaration is not required, AI Infinity chatbot by PMI® was used for finding key concepts and definitions, adapting them within the text for the purpose of the paper.

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