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From Productivity to Generative Capacity: Socio-Technical Systems, Industry X.0 and the Governance of Generativity in the Long Term

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Abstract
The concept of productivity has historically structured the interpretation of technological progress and economic development, acting as a central category in industrial, organizational and policy models. However, in contemporary socio-technical systems, characterized by the intangibility of assets, the distribution of agency, systemic interdependence and long time horizons, productivity exhibits structural limits that undermine its analytical adequacy and its capacity to orient value creation over time. Even in the most recent extensions associated with Industry 4.0 and Industry 5.0, it continues to operate as a metric implicitly oriented toward performance optimization, struggling to integrate sustainability, human-centricity and systemic legitimacy in a coherent manner.
This paper proposes a radical conceptual rethinking, replacing the notion of productivity with that of generative capacity, understood as the systemic aptitude of a socio-technical ensemble to generate value over time across economic, social, cognitive, institutional and environmental dimensions. Through a theoretical re-reading that integrates contributions from evolutionary economics, systems theory, organizational sciences and social philosophy, the work reinterprets the Industry X.0 paradigms not as a linear succession of industrial revolutions, but as a stratification of coexisting generative logics.
The paper also introduces the common good as an intrinsic orientation criterion of generative capacity and proposes the horizon of a generative capacity 6.0, understood not as a new technological phase, but as a meta-systemic threshold of reflexive governance in which value creation is also assessed with respect to its direction, its legitimacy and its long-term sustainability. This yields a theoretical basis for rethinking research, governance and public policies beyond the industrial paradigm of productivity.
Keywords: *Productivity; Generative capacity; Common good; Socio-technical systems; Industry 5.0; Industry 6.0; Reflexive governance; Complexity; Human-centricity; Sustainability; Antifragility; Systemic value.*

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I. INTRODUCTION AND HISTORICAL AND CONCEPTUAL ROOTS OF PRODUCTIVITY

For more than two centuries, the concept of productivity has occupied a central position in the economic, organizational and political lexicon through which industrial societies have interpreted technological progress, economic growth and the evolution of production systems. Its apparent semantic neutrality and its translatability into quantitative indicators have facilitated its adoption as a privileged criterion for assessing the performance of economic systems, organizations and, more recently, public policies. Yet this very centrality has progressively concealed the historically situated, normatively oriented and institutionally constructed character of the concept, making its use as a universal analytical category increasingly problematic in contemporary socio-technical contexts [12, 15].

Productivity emerged as a category intimately linked to the rise of the modern factory and to the need to measure the efficiency with which labor, capital and technology are combined to generate output. Within this frame, value is implicitly identified with the quantity produced and with the ability to increase it over time through rationalization, standardization and control. This approach, rooted in classical economic thought and later formalized in neoclassical models, provided a powerful conceptual basis for interpreting industrial economies, but it also crystallized a reductionist view of value that is poorly compatible with the complexity of today's socio-technical systems [13].

During the twentieth century, productivity consolidated as a core indicator both at the macroeconomic and at the organizational level. Economic growth models, grounded in production functions combining labor, capital and technical progress, treat productivity as a synthesis of a system's ability to transform inputs into outputs. In parallel, in management and organizational sciences, productivity becomes the reference parameter for evaluating the effectiveness of processes, structures and decisions, fostering a measurement culture that tends to privilege what is quantifiable over what is meaningful in the long term [16]. In both cases, productivity is

treated as an objective property of the system, improvable through technical and organizational interventions and only rarely questioned in its normative and institutional dimension.

This view begins to fracture when the evolution of economic and technological systems highlights phenomena that escape the linear input-output logic. The emergence of the service economy, the growing relevance of intangible assets, the diffusion of digital technologies and the transformation of organizational forms make it increasingly difficult to identify a clearly bounded productive unit and an output that can be measured unambiguously. In such contexts, productivity continues to be invoked as an evaluation criterion, but often as a metaphor rather than as a rigorous measure, masking a profound ontological discontinuity under an appearance of conceptual continuity [6, 15, 34, 40].

An early attempt to move beyond the limits of the classical productivist paradigm appears in endogenous growth economics, which shifts attention from traditional factors to the internal ability of systems to generate knowledge, innovation and learning. In this perspective, growth is no longer explained as an automatic effect of capital and labor accumulation, but as the result of cumulative processes in which human capital, research, institutions and social interactions play a constitutive role. While retaining the term productivity, this stream introduces a significant conceptual tension, as it implicitly recognizes that what matters is not only how much is produced, but the system's ability to regenerate over time the conditions of its own development [14].

In parallel, organizational sciences and socio-technical systems theory contribute to challenging the idea of productivity as a neutral and localized property. Organizations are increasingly interpreted as complex adaptive systems, characterized by bounded rationality, learning, interdependence and co-evolution with the environment. In this frame, performance is not the result of point optimization, but emerges from dynamic processes involving competencies, routines, decision structures and institutional contexts [16, 17]. Productivity, understood as a simple ratio between inputs and outputs, proves unable to capture the quality of such processes and their capacity to generate value over time.

These transformations make it clear that productivity can no longer be treated as a neutral and universally applicable metric. It appears increasingly as a historical and institutional construction, reflecting a particular way of conceiving value, work and technology. Its persistence in contemporary language, even in recent discourses on digitalization, sustainability and human-centricity, risks producing conceptual inertia, preventing the development of categories better suited to describing and governing the complexity of today's socio-technical systems [6, 15].

Starting from this awareness, this work proposes a radical rethinking of the category of productivity, not through a mere semantic expansion, but through its replacement with an alternative notion, that of generative capacity. The underlying hypothesis is that contemporary socio-technical systems cannot be understood and assessed in terms of productivity without losing sight of fundamental dimensions such as long-term sustainability, the quality of social relations, institutional robustness and the ability to learn and adapt under uncertainty [1, 5].

Generative capacity is introduced as a more appropriate analytical category to describe a system's aptitude to generate value in a broad and plural sense, going beyond the industrial logic of performance. In this perspective, value is no longer reducible to a quantity produced or to an efficiency indicator but coincides with the system's ability to keep the space of possibilities open over time, preserving the material, cognitive and institutional conditions that make collective action possible [1, 4].

This proposal does not position itself in opposition to the economic and organizational tradition. Rather, it critically draws on its contributions while recognizing the need for a conceptual leap. Rethinking productivity means questioning how value is defined, measured and governed, and recognizing that these operations are always embedded in normative, cultural and institutional frames. In this sense, the shift from productivity to generative capacity represents the first step of a broader path, aimed at reinterpreting the evolution of socio-technical systems not as a succession of technological stages, but as a progressive transformation of the logic through which value is generated, oriented and made socially meaningful in the long term

II. THE THEORETICAL LIMITS OF PRODUCTIVITY IN CONTEMPORARY SOCIO-TECHNICAL SYSTEMS AND THE CONCEPTUAL SHIFT TO GENERATIVE CAPACITY

The evolution of contemporary socio-technical systems makes the theoretical insufficiency of productivity as a central analytical category increasingly evident. This insufficiency concerns not only the difficulty of measurement in contexts characterized by high complexity and intangibility, but also the very meaning of what is considered value, as well as the ways in which such value is produced, distributed and made sustainable over time. In classical industrial systems, productivity could be assumed as a relatively stable synthesis of production-process efficiency, because the perimeter of economic action, the technologies employed and the relationships among actors were sufficiently bounded. In contemporary socio-technical systems, by contrast, these assumptions are deeply eroded [6, 7].

A first critical element concerns the growing relevance of intangible assets and immaterial dimensions of value. Knowledge, competences, data, relationships, trust and reputation are now essential components of competitiveness and system sustainability, yet by their very nature they elude direct accounting in terms of output.

Productivity, grounded in a logic of measurable transformation of inputs, tends to marginalize these dimensions or to force them into surrogate metrics, thereby losing the ability to grasp their systemic role and long-term dynamics. This produces an analytical distortion that privileges what is immediately measurable over what is structurally generative [1, 6, 34, 35, 40].

A second limit concerns the distribution of agency in advanced socio-technical systems. Unlike traditional industrial contexts, where productive action could be traced back to relatively autonomous organizational units, contemporary systems operate through complex networks of human and non-human actors, digital platforms, shared infrastructures and multilevel regulatory regimes. In these contexts, value emerges from distributed interactions and coordination processes that cannot be attributed to a single place or a single subject. Productivity, understood as a localized property of an organization or process, is then conceptually inadequate to describe phenomena in which value generation is intrinsically relational and systemic [18, 19].

A further critical element concerns temporality. Productivity is traditionally oriented to short- or medium-term assessments, in which performance improvement is measured through incremental changes in output or reductions in inputs. Many contemporary challenges, from environmental sustainability to social cohesion, from infrastructure resilience to institutional stability, require a long time horizon, in which value cannot be reduced to an immediate result. In this sense, productivity tends to favor decisions oriented toward short-term optimization, even when such decisions compromise the system's ability to generate value in the long term [6, 23, 36, 39].

This tension between short and long term manifests especially in contexts of high complexity and uncertainty. In complex systems, cause-effect relationships are often non-linear, action outcomes may be delayed over time, and interactions among system components can produce unintended emergent effects. Under such conditions, productivity as a synthetic indicator risks providing misleading signals, inducing interpretations of improvement where there is in fact a shift of costs or risks to other system levels or to future generations. Productivity, in other words, can increase locally while the overall system becomes more fragile [6, 24, 41]. Recent empirical evidence on the effective use of artificial intelligence and cognitive automation systems shows, consistent with this reading, that increases in technical capabilities do not automatically translate into cumulative value trajectories, but produce outcomes strongly dependent on organizational contexts, performed tasks and socio-technical integration modalities [43].

To these structural limits is added the problem of the presumed neutrality of productivity. Treated as a technical measure, it tends to conceal the normative and value choices that orient its definition and use. Deciding what counts as input, what counts as output and which time horizon is used to assess performance always implies a stance on what is deemed relevant. Productivity, far from neutral, thus incorporates a worldview that privileges efficiency, quantitative growth and performance maximization, often at the expense of other value dimensions. In contemporary socio-technical systems, this worldview increasingly conflicts with demands for sustainability, equity and social responsibility [15, 1].

In this context, the mere semantic expansion of productivity by adding adjectives such as sustainable, human or inclusive appears insufficient. Such operations, although motivated by corrective intentions, leave intact the underlying conceptual structure, introducing only external constraints to a logic that remains fundamentally oriented toward performance optimization. The result is often an unresolved tension between declared objectives and analytical instruments, which ends up weakening both [6, 10, 11, 28].

To overcome these limits, this work proposes a change in conceptual status, replacing productivity with the notion of generative capacity. This notion does not merely describe the relationship between inputs and outputs, but focuses on the systemic aptitude of a socio-technical ensemble to generate value over time, including economic, social, cognitive, institutional and environmental dimensions. Generative capacity is not a point measure, but an emergent property deriving from interactions among actors, technologies, rules and contexts, and it manifests in the possibility of producing not only results, but also options, evolutionary trajectories and enabling conditions for the future [1, 3, 5].

Introducing generative capacity as an analytical category implies a significant shift of attention, from outcome to process, from output to systemic configuration, from performance to possibility. In this perspective, a system is more generative the more it is able to learn, adapt and regenerate its material and immaterial bases without compromising its sustainability over time. Generative capacity thus enables the integration, within a single analytical framework, of dimensions that productivity tends to treat separately or marginalize, offering a more coherent view of contemporary socio-technical complexity [14, 17].

This conceptual shift does not imply abandoning measurement, but critically reconsidering it. Assessing generative capacity requires plural approaches combining quantitative and qualitative indicators, process analyses and deliberative assessments, recognizing that not everything that matters can be reduced to a single metric [35]. In this sense, generative capacity emerges as a more suitable analytical category to support complex decision-making processes, in which value is not given once and for all, but is continuously redefined through interactions among knowledge, interests and collective purposes [20, 21].

In conclusion, the theoretical limits of productivity in contemporary socio-technical systems are not contingent but structural. They derive from a growing distance between the complexity of the phenomena to be analyzed and the simplicity of the categories used to interpret them. The shift to generative capacity is therefore not a terminological exercise, but a theoretical necessity to understand and govern systems in which value is increasingly distributed, emergent and long-term oriented. On these bases, it becomes possible to build a more articulated re-reading of the evolution of industrial paradigms and to open space for a reflection that leads beyond Industry 5.0 toward a meta-systemic horizon in which value generation becomes the object of reflexive governance.

III. A THEORETICAL CONSTELLATION FOR MOVING BEYOND PRODUCTIVITY AND FOUNDING GENERATIVE CAPACITY

The shift from productivity to generative capacity cannot be understood as an isolated conceptual act or as a simple terminological reformulation. Rather, it emerges from a progressive convergence of theoretical contributions from different disciplinary fields which, despite distinct epistemological and methodological premises, have questioned the idea of productivity as a neutral, localized and self-sufficient metric. This convergence can be read as a theoretical constellation in which each author contributes to decentering its meaning, shifting attention from measuring results to understanding the conditions that make the generation of value overtime possible.

A first fundamental core of this constellation is represented by Joseph Schumpeter, who breaks with the static view of economic equilibrium and interprets development as an intrinsically discontinuous process, grounded in creative destruction. In this perspective, value does not derive from optimizing given combinations, but from the ability to recombine resources, knowledge and organizational arrangements in innovative ways [12, 13]. Productivity, understood as an increase in efficiency, becomes subordinate to a deeper dynamic of structural transformation, in which what matters is the system's capacity to generate new economic and social configurations. This insight finds a natural development in the theory of dynamic capabilities, which interprets long-term performance as a function of the ability to sense, seize and transform opportunities in contexts characterized by uncertainty and continuous change [14]. In this frame, productivity definitively loses the character of an intrinsic property and becomes an expression of a broader generative capacity linked to learning and systemic reconfiguration.

To this first decentering is added an institutional decentering, made explicit by Karl Polanyi. By placing economic activity within a social and normative fabric, Polanyi shows that what is considered productive is always the result of an institutionalization process and not the neutral outcome of market mechanisms [15]. In this key, productivity is not a technical datum, but a historical construction reflecting power relations, social rules and value visions. This shift is crucial for understanding why productivity cannot be assumed as a universal evaluation criterion in contemporary socio-technical systems, in which the legitimacy of value creation is increasingly linked to sustainability, equity and collective responsibility.

Moving beyond productivity as a self-sufficient metric finds further grounding in the contributions of Herbert Simon and Stafford Beer, which render intelligible the functioning of complex systems under conditions of bounded rationality and high variety [16, 17]. In this perspective, a system's performance does not depend on local optimization of single processes, but on the design and cybernetic capacity to govern complexity, absorb variety and maintain internal coherence. Productivity, reduced to an efficiency indicator, becomes an epiphenomenon of deeper decision and organizational arrangements that determine the system's ability to operate in a stable and adaptive way. The notion of generative capacity is located precisely at this level, describing the aptitude of the system to maintain over time the conditions of its own operability and evolution.

This decentering is further radicalized by Niklas Luhmann's theory of social systems and by Bruno Latour's actor-network theory, which dissolve the idea of a privileged locus or subject of productivity [18, 19]. In complex social systems, value emerges from networks of relations, communicative processes and heterogeneous assemblages of human and non-human elements. Productivity can no longer be attributed to an isolated organization or technology, but becomes a distributed, emergent and relational property. In this frame, generative capacity appears as a more suitable analytical category to describe systems in which value is the result of complex socio-technical interactions and cannot be linearly reduced to measurable inputs and outputs.

The theme of governance then assumes a central role, and here Elinor Ostrom's contribution provides a particularly relevant conceptual grammar. The theory of polycentric governance shows how complex systems can be governed effectively through shared rules, distributed responsibilities and collective learning processes, without resorting to centralized hierarchies or deregulated market mechanisms [20]. In this perspective, value production cannot be separated from the governance forms that make it possible and legitimate. Generative capacity, understood as a systemic aptitude to generate value oriented to shared purposes, finds here a solid theoretical basis that enables moving beyond the dichotomy between efficiency and legitimacy.

Human-centricity, made explicit in the most recent discourses on socio-technical evolution, is further clarified through the capability approach developed by Amartya Sen and Martha Nussbaum. In this perspective, development is not assessed in terms of output or quantitative growth, but as the expansion of people's effective capabilities to lead a life they have reason to value [21, 22]. This shift makes it possible to translate human-centricity into operational terms, focusing on enabling conditions rather than immediate results. Productivity, as a measure of efficiency, becomes subordinate to a broader assessment of the system's capacity to generate opportunities, dignity and wellbeing over time.

A further critical contribution comes from reflection on instrumental rationality and acceleration, developed by Hartmut Rosa. The distinction between efficiency and purposiveness, between increasing speed and improving quality of life, highlights one of the central ambiguities of the productivism paradigm [23]. Productivity increases can translate into an acceleration of processes that does not necessarily produce value in a human or social sense, but generates alienation, loss of meaning and systemic fragility. In this context, generative capacity allows the reintroduction of the dimension of purpose as a criterion for assessing performance.

Finally, Nassim Nicholas Taleb's contribution enables the rigorous inclusion of the antifragile dimension as an evolutionary property of systems. A generative system is not only able to withstand shocks, but also to benefit from them, improving its ability to operate in uncertain and volatile contexts [24]. This property, difficult to integrate within a productivism logic oriented to optimization and variance reduction, finds a natural place within the framework of generative capacity, which treats uncertainty as constitutive rather than as an anomaly to be eliminated.

Within this articulated theoretical framework, the 5.0 Paradigm, as elaborated by Oliviero Casale, performs a contemporary synthesis function. It proposes a systemic reading of socio-technical transformation that requires considering knowledge that is often interconnected or interdependent across multiple domains and integrating, without rigid hierarchies, the technological, human, institutional and ethical dimensions of transformation [1–5]. This synthesis makes it possible to reinterpret Industry X.0 paradigms not as progressive technological stages, but as historical configurations of productivity and, more deeply, as expressions of different generative logics. On this basis, it becomes possible to understand the transition toward Industry 5.0 as a passage from an optimization logic to an orientation logic and to conceptually prepare the opening toward a 6.0 horizon in which generative capacity itself becomes the object of reflection, deliberation and governance. In this perspective, the reference to the common good does not introduce an additional external normative layer but represents the logical outcome of the temporal and relational structure of value that generative capacity allows one to describe and orient in the long term [44].

IV. COMMON GOOD AND GENERATIVE CAPACITY

Introducing the notion of generative capacity as an analytical category alternative to productivity makes it unavoidable to reflect on the ultimate criterion through which value generation is oriented, assessed and legitimized in complex socio-technical systems. Within this conceptual space, the concept of the common good reemerges in a renewed form, not as an external normative recall or as a superordinate ethical principle, but as a structuring category for the systemic orientation of long-term generativity. In this perspective, the common good does not represent an additional end to be placed alongside performance, but the frame of reference within which it becomes possible to distinguish between value generation and the mere expansion of technical capacities or localized outputs [1, 5].

In the classical tradition of political philosophy, the common good is conceived as an ordering principle of collective life, linked to the purpose of institutions and the legitimacy of public action. With industrial modernity, this concept progressively loses centrality, absorbed into the public-private dialectic and translated mainly in terms of efficient resource allocation or redistribution of growth outcomes. In this transition, the common good is often reduced to an ex post balancing between individual and collective interests, losing its original function of structurally orienting value-generation processes [15].

In contemporary socio-technical systems, characterized by systemic interdependence, the intangibility of assets and extended time horizons, this reduction becomes increasingly problematic. Value generation produces effects that cross organizational, territorial and generational boundaries, making any evaluation criterion based exclusively on localized performance metrics insufficient. In such contexts, the value generated by a system cannot be judged solely on the basis of its immediate outputs, but must also be assessed with respect to its ability to preserve and regenerate the conditions that make social cooperation, resource sustainability and institutional stability possible [36]. It is precisely in this sense that the common good regains relevance as an analytical category, becoming the principle that enables orienting generative capacity beyond the logic of optimization [20, 34, 38].

Generative capacity, as defined in this work, implies a conception of value as a systemic and temporal property that emerges from interactions among economic, social, cognitive, institutional and environmental dimensions. In this perspective, the common good does not coincide with a predetermined set of substantive

objectives, but with the system's ability to maintain shared conditions of possibility over time, preventing value generation in one domain from occurring at the expense of degradation in other domains. The common good thus operates as a criterion of long-term coherence, enabling assessment of the quality of generativity not only in terms of intensity, but also in terms of direction [1].

This shift makes it possible to overcome one of the main ambiguities of contemporary discourses on sustainability and human-centricity, which are often treated as corrective constraints applied a posteriori to processes oriented primarily to performance. By integrating the common good within the notion of generative capacity, orientation becomes intrinsic to value-generation processes. The question is no longer how to mitigate the negative effects of efficiency-driven growth, but how to configure systems capable of generating value in a way consistent with the sustainability of material bases, with people's dignity and with the robustness of the institutions that make collective action possible [21, 22].

In this perspective, the common good plays an eminently systemic function. It makes it possible to render explicit the trade-offs among different dimensions of generativity, preventing them from remaining implicit or from being resolved exclusively through market mechanisms or technocratic decisions. Generative capacity oriented to the common good instead requires governance forms capable of recognizing conflicts, making power asymmetries visible and including deliberative processes in priority-setting. This does not imply renouncing efficiency or innovation, but repositioning them within a shared frame of meaning [20].

Integrating the common good within generative capacity also enables a more rigorous approach to temporality. Many effects produced by advanced socio-technical systems manifest in the long term and traverse multiple generations, making evaluation criteria based on narrow time horizons inadequate. The common good, understood as maintaining conditions of possibility over time, introduces an intergenerational perspective that aligns naturally with the logic of generative capacity, strengthening its anticipatory dimension and evolutionary responsibility [6, 34, 39].

In this sense, the common good does not take the form of a normative content to impose on socio-technical systems, but as an emergent property of their reflexive governance. A system endowed with high generative capacity oriented to the common good is a system able to learn from its effects, renegotiate its purposes and adapt its trajectories without compromising the possibility of alternative futures. This capacity cannot be reduced to a single actor or level of government, but requires a polycentric and multilevel articulation of responsibilities [20, 5].

The most recent contributions developed within the 5.0 Paradigm and in research streams oriented to moving beyond GDP as a synthetic development metric clearly show that the common good can no longer be treated as an ethical correction, but as a structural dimension of value generation. Rethinking progress metrics, as proposed in Commons Good e Wellbeing Economy. Oltre il PIL nel Paradigma 5.0 tra bene comune e cultura, highlights the need for indicators capable of reflecting the systemic quality of generativity, including dimensions such as resilience, social cohesion, institutional sustainability and collective learning capacity [1].

Within this framework, the common good acts as an integration principle between generative capacity and governance, enabling a performance assessment that does not focus only on outcomes, but also interrogates the conditions that make them possible and the trajectories they contribute to consolidating. This makes it possible to overcome the dichotomy between economic value and social value, recognizing that in complex socio-technical systems these dimensions are intrinsically intertwined and cannot be separated without producing analytical and decision distortions [5].

Introducing the common good as an orientation category for generative capacity thus prepares the ground for the subsequent re-reading of Industry X.0 as a stratification of generative logics and, above all, for the opening toward a 6.0 horizon. In such a horizon, the central issue is no longer only defining objectives or integrating values into production processes, but the collective capacity to govern generativity itself in a legitimate, sustainable and shared manner. The common good becomes the criterion that allows one to distinguish between an uncontrolled expansion of capacities and a socio-technical evolution oriented to quality, duration and systemic coherence.

V. GENERATIVITY AS A SYSTEMIC ISSUE: CULTURE, COSTS AND BENEFITS

Integrating the theoretical pathways that move beyond the productivity paradigm within a common-good-oriented vision clarifies the application domain of generative capacity. Assumed as a systemic aptitude to generate and regenerate value over time across economic, social, cognitive, institutional and environmental dimensions, generative capacity manifests as an emergent property of complex systems. Territory constitutes the minimum domain of observation and intervention, because interdependencies and cross-impacts make visible the difference between local productivity and systemic generativity. Productivity can coexist with generative capacity only when it is brought back within a non-deterministic and non-short-term logic, consistent with value generation over time.

It follows that the generative transition cannot be exhausted within the corporate perimeter, while recognizing enterprises as central transformative agents. It requires an enabled territorial ecosystem that is recognized and cultivated by institutions, communities and intermediary actors.

This centrality of territory is consistent with evidence on the spatial ramifications of the 5.0 transition. Recent analyses show that the adoption of 5.0 technologies tends to distribute skills and opportunities unevenly, with a marked concentration of high-tech employment in some countries and in a few metropolitan regions, and with accentuated territorial divides even within the same states, such as strong regional contrasts in Italy between more advanced areas and southern regions. Moreover, dynamic can take the form of a fictitious tertiarization. Activities and operational presences diffuse locally, but standards, digital infrastructures and decision levers, including platforms, cloud, software and data, tend to remain concentrated, producing only apparent territorial autonomy. Such evidence confirms that value generation is not a neutral outcome of technology, but depends on territorial, infrastructural and governance conditions, strengthening the need for indicators and policies capable of reading and orienting generative capacity on a multilevel basis [48].

A further territorial implication, often overlooked, concerns the so-called periphery paradox. Some peripheral regions, while presenting structural constraints such as smaller markets, lower infrastructural density and distance from major hubs, can reveal effective advantages for innovation when firms manage to compensate location disadvantages through external knowledge acquisition and collaboration agreements. In this perspective, a territory's generative capacity does not coincide with a simple endowment of assets or proximity to metropolitan poles, but with the relational and absorptive capacity that enables grafting knowledge, skills and resources from wider networks into local development trajectories. It follows that generativity-oriented indicators and policies should measure and support not only where innovation concentrates, but how territories, including peripheral ones, build connections, cooperation and collective learning over time [48].

In this sense, the transition toward a generative economy requires a collective transformation involving public institutions, social cultures, citizens and governance instruments. In other terms, while identifying the territorial productive sector as one of the most relevant transformative agents for implementing the paradigm, generative capacity must necessarily be expressed, and therefore activated, not so much as a firm's mode of action, but as the outcome of an ecosystem that must be enabled, recognized and cultivated.

This aspect is particularly relevant in application. Every paradigm shift inevitably generates organizational and systemic costs. In the case of generative capacity, for example, the paradigm shift entails first a series of costs borne by enterprises, including changes in processes, decision models, governance and evaluation criteria. These actions are inevitably associated with the affirmation of an Industry X.0 in which the productivist engine enters a circular relationship with its reference domain.

These observations therefore highlight the need to act according to multidimensional logic, including actions that enable the emergence of a culturally widespread awareness.

In the absence of public or institutional recognition, the costs internalized by the productive context may represent an unsustainable threshold, especially for the Italian productive fabric predominantly composed of micro, small and medium-sized enterprises.

In concrete application, productive organizations may be willing to bear these costs only if there is a prospect of benefits proportionate to the impact generated, also in the long term. The risk otherwise is that generativity remains the prerogative of a few pioneers rather than becoming a systemic and scalable option, which are instead essential characteristics to produce real change.

Numerous recent empirical findings and theoretical reflections support this thesis. As shown by AICCON research [45], firms that integrate collective-impact objectives into their models tend to generate above-average economic, reputational and human-capital attractiveness returns. However, this effect is amplified only in the presence of a context that publicly values such impacts, in fiscal, regulatory and cultural terms.

It therefore becomes necessary to develop a system of collective and territorial indicators that allows public administrations to define informed objectives and act within complexity through multilevel and integrated measurement tools, allows enterprises to understand their impacts on the territory, communicate them transparently and generate engagement with citizens, suppliers and workers, and allows the national system to recognize, also through fiscal, regulatory and reputational measures, a return proportionate to the generated generative impacts.

In this perspective, as Vairani emphasizes [47], it is necessary to define collective-impact indicators that go beyond ESG metrics or classic corporate KPIs. Such indicators must measure not only how much impact is generated, but also for whom, where and with what systemic effects. Only with a metric oriented to impact distribution will it be possible to define a proportional recognition policy and stimulate a widespread cultural transition.

Experiences are already underway, such as Benefit Corporations or B Corp models, offer important methodological insights. However, to overcome fragmentation, it is necessary for corporate metrics to be brought into dialogue with public ones through interoperability systems and shared languages.

As Mercati recalls [46], without trust between enterprise and territory there is no generativity. Yet trust is built from transparent measurement systems and shared rewarding mechanisms. Systems in which enterprises, rather than acting in isolation, feel part of a broader generative network in which every investment finds recognition, every positive impact yields a return, and every collective cost finds a balancing mechanism.

In conclusion, if the generative paradigm is to be truly implementable, it is not enough to intervene on enterprises. A new cultural and institutional pact is needed, an alliance involving citizens, administrators, entrepreneurs and intermediary actors. An ecosystem that makes it possible and desirable to generate value for others and that rewards those who choose to do so.

To build such an ecosystem, it is necessary on the one hand to activate transformative actions in enterprises as nodes of the relevant territorial domain and on the other hand to promote diffuse cultural and institutional drivers that make it possible and desirable to generate value for others. In this way, a virtuous cycle is triggered in which public culture supports planning and strategic choices oriented to generative capacity, with measurable and communicable objectives and with information sets that make the contribution of different actors readable.

On these bases fits the re-reading of Industry X.0 as a stratification of generative logics and, above all, the opening toward a 6.0 horizon, in which the collective capacity to govern generativity in a legitimate, sustainable and shared manner becomes central. The common good becomes the criterion that allows one to distinguish between an uncontrolled expansion of capacities and a socio-technical evolution oriented to quality, duration and systemic coherence.

VI. RE-READING INDUSTRY X.0 AS A STRATIFICATION OF GENERATIVE LOGICS

Representing Industry X.0 as a linear succession of industrial revolutions has historically served an important descriptive and communicative function, but today it shows increasingly evident analytical limits. Such a representation suggests a progressive and cumulative path, in which each phase replaces the previous one through the introduction of new dominant technologies. The stratification of Industry X.0 should instead be understood not only as the co-presence of different technological configurations, but as the superimposition of governance logics, value criteria and decision modalities that continue to act simultaneously in socio-technical systems [44]. In real socio-technical systems, empirical observation shows a persistent coexistence of heterogeneous technologies, organizational models and value logics that interact, overlap and at times enter into tension. Re-reading Industry X.0 through the notion of generative capacity makes it possible to move beyond this simplification, interpreting these phases as stratifications of generative logics that coexist and recombine over time [7, 41, 42].

In this perspective, each X.0 does not represent the supersession of the previous ones, but the emergence of a specific modality through which socio-technical systems generate value. These modalities do not disappear with the advent of new technologies, but continue to operate as active layers within increasingly complex configurations. The Industry X.0 sequence thus takes on a different analytical meaning, becoming a conceptual map for reading the plurality of logics contributing to value generation, rather than a hierarchical ladder of technological progress [2, 7].

The generative logic associated with what is conventionally termed Industry 1.0 can be understood as the first systematic form of extending human action through tools and machines. In this context, value generation is tightly linked to the amplification of physical force and to the possibility of making transformative action on the environment more stable and reproducible. Generative capacity remains strongly constrained by the presence of the human operator and by material conditions, but it introduces a decisive element, namely the possibility of accumulating technical experience and exceeding mere subsistence. This logic remains fully operative wherever materiality, energy and the physical transformation of resources continue to constitute an indispensable basis of value generation.

With what is identified as Industry 2.0, generative capacity undergoes a qualitative transformation linked to the introduction of scale, standardization and systematic work organization. Value no longer derives only from amplifying individual action, but from the ability to coordinate and replicate processes coherently and controllably. Generativity thus shifts from the single productive act to the configuration of the organizational system, which becomes able to sustain higher complexity through defined roles, standardized procedures and coordination mechanisms. This logic introduces a growing separation between design and execution, laying the groundwork for a conception of productivity as a property of the organized system rather than of the individual.

The phase commonly associated with Industry 3.0 marks a further step in the configuration of generative capacity through the introduction of automation, control and process regulation [17]. In this context, value is generated by the ability to reduce variability, increase reliability and maintain constant performance over time. Generativity takes on a more predictive and regulated form oriented to stability and repeatability, while also freeing cognitive and decision resources, progressively shifting the human role from execution to supervision and

design. This logic remains structurally relevant wherever safety, quality and operational continuity constitute essential requirements.

With Industry 4.0, generative capacity is further reconfigured through the integration of physical and digital systems, the diffusion of data and real-time connectivity. Value increasingly emerges from the ability to coordinate complex systems dynamically, adapt processes to operating conditions and learn from experience through continuous feedback. In this phase, generativity becomes explicitly systemic and emergent, resulting from interactions among distributed technological, organizational and cognitive components. Industry X documents emphasize that this adaptive coordination capacity is the true distinguishing element more than any single enabling technology [7, 41]. Nonetheless, productivity continues to be interpreted mainly as the ability to optimize performance dynamically, preserving an implicit performance orientation.

With Industry 5.0, a relevant conceptual discontinuity is introduced, not so much on the technological plane as on that of telos. European documents and recent research contributions highlight that value generation can no longer be assessed exclusively in terms of efficiency or flexibility, but must be explicitly oriented to human-centricity, sustainability and resilience [2, 10, 11, 28, 29]. In this perspective, generative capacity is reoriented toward declared purposes, and technology is repositioned as a means serving socially legitimate objectives. Previous generative logics are not abandoned but recomposed within a broader frame of meaning that requires an explicit balancing of economic, social and environmental dimensions.

This re-reading helps explain why contemporary socio-technical systems are characterized by hybrid configurations in which 1.0, 2.0, 3.0, 4.0 and 5.0 logics coexist and interact. Within the same system, logics oriented to physical amplification, standardization, automation, digital adaptation and value orientation can operate simultaneously, generating tensions that cannot be resolved through a single performance criterion. The challenge then becomes governing the coexistence of such logic, avoiding that a logic oriented exclusively to stability or efficiency compromises the overall system's capacity to generate value in the long term [6].

In this perspective, the Industry X.0 sequence definitively loses the character of a linear evolutionary narrative and becomes an interpretive tool for reading the complexity of real systems. It enables analysis of how specific generative logics are activated, combined or marginalized depending on institutional contexts, governance choices and collective priorities. This analytical shift is fundamental for preparing the opening toward a horizon beyond Industry 5.0, in which the central issue is no longer only orienting the system to declared purposes, but the capacity to reflect, deliberate and govern over time the conditions of generativity itself.

It is precisely this need to govern the coexistence of generative logics, made evident by the 1.0–5.0 stratification, that opens the conceptual space for introducing a 6.0 horizon, a horizon in which complexity is not simply managed through more advanced technological tools, but assumed as a constitutive dimension to be governed through institutional, deliberative and anticipatory processes. On these bases, it becomes possible to further shift the analytical center of gravity from describing capacities to responsibility for their evolutionary direction, preparing the ground for the next chapter.

VII. BEYOND INDUSTRY 5.0: GENERATIVE CAPACITY 6.0 AS A META-SYSTEMIC HORIZON

The emergence of Industry 5.0 as a paradigm oriented to human-centricity, sustainability and resilience has represented a relevant discontinuity with respect to previous narratives, explicitly introducing the question of purpose within socio-technical systems. Yet precisely when telos is made explicit, a further level of complexity becomes apparent, making reading limited to the value orientation of production processes insufficient. The coexistence of different generative logics, the growing interdependence among technological, institutional and social systems and the multiplication of unintended systemic effects pose a problem that goes beyond defining objectives, involving the systems' capacity to govern their evolutionary direction over time [2, 6, 25, 38].

In this context lies the possibility, and to some extent the theoretical necessity, of pushing reasoning beyond Industry 5.0 by introducing a conceptual horizon that can be defined as generative capacity 6.0. This horizon should not be understood as a new technological phase or as the announcement of a future industrial revolution, but as a meta-systemic threshold that makes explicit the need to govern generativity itself as a long-term property of socio-technical systems [27]. If Industry 5.0 marks the passage from performance optimization to orientation toward declared purposes, Industry 6.0 emerges when the central issue becomes how such purposes are defined, renegotiated and transformed over time in light of produced effects [6, 8, 9].

The first element strengthening this reading comes from forward-looking analyses on productivity and the future of the global economy. The most recent World Economic Forum work shows clearly that the impact of advanced technologies on productivity does not follow linear or cumulative trajectories, but depends on unstable combinations of technological, organizational, institutional and cultural factors [6]. In these scenarios, increased technical capacity does not by itself guarantee a sustainable increase in value, neither economically nor socially. Productivity thus appears less as a structural property of systems and more and more as a contingent outcome, strongly dependent on governance modalities and on integration between humans, technology and institutions.

This finding has profound implications. If productivity can no longer be assumed as a stable and cumulative variable, then the analytical and political problem is no longer how to maximize it, but how to govern the capacity of systems to generate value in a coherent, sustainable and adaptive manner over time. It is precisely within this gap that the notion of generative capacity 6.0 is situated, understood as the capacity of a socio-technical system to reflect on its trajectories, learn from produced effects and intervene not only on means, but also in the very criteria through which value is defined and assessed [1, 4].

Emerging narratives on Industry 6.0, often focused on advanced artificial intelligence, cognitive automation and autonomous systems, correctly capture the intensification of technological complexity and the acceleration of decision processes [8, 9]. However, such narratives risk reproducing a new form of technological determinism, in which the ability of systems to self-organize is confused with the ability to govern the effects of such processes in the long term. Empirical analyses of actual artificial intelligence usage patterns show strong dependence on organizational arrangements and application contexts [43].

The notion of generative capacity makes it possible to overcome this limit, offering an interpretive key that integrates the technological dimension with the institutional, cognitive and normative ones. In this perspective, Industry 6.0 is not defined by the introduction of a specific technology, but by the explicit recognition that value generation in advanced socio-technical systems inevitably produces systemic effects that require forms of reflexive governance. Generative capacity 6.0 can thus be understood as the capacity to govern possibility, that is to keep the space of future options open without collapsing into irreversible trajectories driven by short-term logic or technological automatisms [3, 5].

A central aspect of this horizon concerns reflexivity. A system endowed with generative capacity 6.0 does not merely adapt or optimize its processes but develops institutional and cognitive mechanisms to continuously interrogate its purposes, assess the impacts of its choices and renegotiate priorities considering new information and contexts. Reflexivity is not understood here as abstract introspection, but as the operational capacity to integrate complex feedback includes plural perspectives and recognizes the limits of one's knowledge. In this sense, generative capacity 6.0 incorporates uncertainty as a constitutive element rather than as an anomaly to eliminate [16, 18].

This reflexive dimension is tightly intertwined with anticipation. In advanced socio-technical systems, the ability to predict action outcomes deterministically is structurally limited. Yet it is possible to develop anticipatory capacities that are not based on point forecasting, but on scenario construction, exploration of plausible futures and the institutionalization of doubt as a decision resource. Generative capacity 6.0 is grounded in this form of distributed anticipation, enabling systems to prepare for a plurality of futures without binding themselves to a dominant scenario [6, 24, 39].

A further distinctive element of the 6.0 horizon concerns the capacity to introduce limits, thresholds and deliberate brakes to one's own expansion. In previous paradigms, increases in technical and organizational capacities were often interpreted as a good in themselves, to be pursued without questioning long-term systemic consequences. Generative capacity 6.0, by contrast, recognizes that a system's maturity is also measured by its ability to self-limit, selectively de-potentiate certain dynamics and preserve redundancies and margins of maneuver. In this sense, generativity no longer coincides with maximizing possibilities, but with managing them responsibly [24, 37, 38].

Human-centricity, already affirmed in Industry 5.0, takes on a further transformed meaning in this frame. Humans are no longer only beneficiaries or ethical correctives of technological processes but become custodians of the system's directionality. This implies a responsibility that concerns not only immediate results, but the structural conditions that make certain outcomes possible and exclude others. Generative capacity 6.0 is therefore intrinsically political in the high sense of the term, as it concerns the collective definition of priorities, limits and responsibilities in contexts characterized by high interdependence [20, 21].

In conclusion, opening toward a 6.0 horizon is not a speculative exercise, but a response to a real conceptual crisis of the productivity paradigm and its most recent extensions. Scenario multiplication, instability of productivity trajectories and the growing complexity of socio-technical systems require shifting the analytical focus from performance to generativity and from generativity to its reflexive governance. In this sense, generative capacity 6.0 does not add itself to prior phases as another stage, but encompasses them, making explicit the need for a meta-systemic level of reflection and governance that enables systems to evolve without losing control of their direction.

VIII. DISCUSSION, THEORETICAL AND GOVERNANCE IMPLICATIONS, CONCLUSIONS AND RESEARCH DIRECTIONS

The argumentative path developed in this work enables several concluding considerations of a theoretical and systemic nature regarding the meaning and implications of shifting from productivity to generative capacity as the central analytical category for interpreting contemporary socio-technical systems. This shift does not represent a mere semantic evolution nor an attempt to update the industrial paradigm lexicon, but responds to a

deep conceptual crisis generated by the growing distance between the complexity of the phenomena to be governed and the simplicity of the traditional metrics used to describe and orient them [6, 15].

From a theoretical standpoint, the main contribution of the paper lies in showing that productivity, while historically fundamental in supporting industrialization and economic growth, is no longer able to act as a unifying category in contexts characterized by intangible assets, distributed agency, systemic interdependence and long time horizons. Its apparent neutrality conceals a value vision oriented towards performance optimization and immediate measurability, increasingly in tension with sustainability, human-centricity and institutional legitimacy requirements [1, 23].

The notion of generative capacity proposed in this work makes it possible to overcome these limits by offering an analytical category capable of integrating economic, social, cognitive, institutional and environmental dimensions within an extended temporal perspective. In this sense, generative capacity does not merely replace productivity but makes its implicit assumptions explicit and moves beyond its reductionist logic, shifting attention from outcome to systemic configuration, from output to possibility, from performance to evolutionary trajectory [1, 3, 5].

Re-reading Industry X.0 as a stratification of generative logics constitutes a second relevant theoretical result. It enables abandoning the linear narrative of industrial revolutions and interpreting socio-technical evolution as a cumulative and non-linear process in which different logics coexist and interact. This perspective makes it possible to better understand the structural tensions traversing contemporary systems, in which demands for efficiency, stability, adaptation and value orientation operate simultaneously and cannot be reduced to a single performance criterion [7, 10].

Within this frame, Industry 5.0 emerges not as a definitive endpoint, but as a conceptual threshold in which the question of purpose is made explicit. Yet this very explicitness reveals the insufficiency of a paradigm that merely declares objectives without interrogating how such objectives are defined, renegotiated and governed over time. It is within this space that the introduction of the 6.0 horizon is situated, understood not as a new technological phase, but as a meta-systemic level of reflection and governance of generative capacity itself [8, 9, 28].

The 6.0 horizon makes it possible to rigorously address the issue of reflexive governance of advanced socio-technical systems. In contexts characterized by high uncertainty, non-linearity and the multiplication of unintended systemic effects, mere adaptation and optimization are insufficient. What becomes central is the capacity to continuously interrogate one's trajectories, learn from produced effects and intervene on the very criteria that define value. In this sense, generative capacity 6.0 shifts the discourse from managing means to responsibility for direction [16, 18].

Introducing the common good as an intrinsic orientation criterion of generative capacity represents a further element of theoretical and governance relevance. Far from configuring itself as an external ethical recall or an additional normative constraint, the common good emerges as a systemic property enabling assessment of value generation quality with respect to long-term coherence. In this perspective, the common good does not coincide with a predetermined set of substantive objectives, but with the system's capacity to maintain and regenerate over time shared conditions of possibility for collective action [1, 20].

From a governance-implications standpoint, shifting from productivity to generative capacity suggests a deep rethinking of evaluation, regulation and policy instruments. If value can no longer be reduced to an output or efficiency metric, then public policies and organizational strategies must move from performance optimization to capacity building [26, 38]. In this sense, deliberative evaluation concerns not only tools or metrics, but also institutional architectures capable of making value criteria themselves interrogable, renegotiable and adaptable over time [44]. This implies emphasis on enabling conditions, on managing interdependencies and on institutionalizing processes of collective learning and deliberation [20, 21, 31, 35, 41].

Within this frame, polycentric governance, anticipatory capacity and institutional reflexivity play a central role. Governments, organizations and communities are called not only to define objectives, but to build institutional spaces in which such objectives can be continuously interrogated, adapted and renegotiated in light of produced effects. Generative capacity 6.0 therefore requires institutions capable of recognizing knowledge limits, integrating plural perspectives and managing uncertainty as a resource, avoiding both technocratic automatism and decision paralysis [6, 24].

On the research plane, the work opens several directions for further inquiry. First, it invites the development of conceptual and methodological tools capable of analyzing systemic properties and long-term dynamics, moving beyond dependence on synthetic and immediately comparable indicators [27]. This does not imply abandoning measurement, but critically reconsidering it, integrating quantitative and qualitative analyses, process assessments and deliberative moments. Second, generative capacity provides a theoretical basis for exploring more richly the relationship between technology, institutions and values, highlighting how technical choices are always also normative and political choices [6, 34, 35, 39].

A further research direction concerns the empirical analysis of generative configurations across different sectoral and territorial contexts. The proposed perspective can be used to interpret case studies in which different generative logics coexist and confront each other, showing how specific governance choices affect the system's capacity to generate value over time. In this sense, generative capacity can serve as a bridge between theoretical analysis and empirical research, offering a flexible but conceptually rigorous interpretive frame.

In conclusion, this work proposes a radical rethinking of how the evolution of socio-technical systems is interpreted and governed. Shifting from productivity to generative capacity makes it possible to overcome the limits of a historically situated category and to adopt a language better suited to contemporary complexity. Re-reading Industry X.0 as a stratification of generative logics and opening toward a meta-systemic 6.0 horizon shift the debate from performance to responsibility, from optimization to direction, from growth to evolutionary sustainability. In this sense, generative capacity represents not merely a new analytical category, but a proposal to reorient socio-technical thought, connecting technology, humanity and institutions within a long-term perspective oriented to the common good [30, 32].

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