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Investment Decision-Making Model Applied to Upstream Projects Under Risks and Uncertainties

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ABSTRACT

A substantial portion of the literature on organisational routines has traditionally focused on the stability and transformation of organisational operational activities. This study extends this perspective by emphasising that organisational routines may also play a significant role in investment decision-making processes within oil companies, particularly in the upstream segment of the oil and gas industry.

Based on technical, business and academic literature, an Investment Decision-Making Model was developed to illustrate how organisational routines support strategic investment decision-making related to new capital assets under conditions of risk and uncertainty in this segment. Furthermore, the study identifies and discusses the principal macroprocesses (higher-level routines) employed within the upstream sector.

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I. INTRODUCTION

Economic literature consistently emphasises the inherent challenges associated with investment decision-making processes, particularly in capital-intensive industries. When examining, in particular, the business environment of the Exploration and Production (Upstream) segment

within the oil and gas industry, it becomes evident that investment decisions are developed progressively, taking into account the following aspects: organizations possess distinct objectives, goals, and cultures; decisions involve multiple technical and managerial processes; organizational processes engage numerous individuals with unique cognitive characteristics; such processes encompass diverse disciplines and features specific to the business segment in question; each organization operates within a unique and complex context (e.g., economic, institutional, historical, geographical, geopolitical, among others); and, depending on the segment, this complex context is in constant flux, thereby introducing risks and uncertainties for decision-makers.

As illustrated in Figure 1, business decisions may give rise to both financial losses and gains, as they are made under conditions of certainty, risk, and uncertainty. Cases in which the actual effects of decisions can be predicted with precision are rare; conversely, for a range of decisions, it is possible to estimate the probabilities and impacts of future outcomes; and, in a large proportion of cases, neither the likelihood nor the effects of such outcomes are known. Outcomes of decisions affected by uncertainty may be viewed as blind bets (dependent on chance), whereas decisions that entail a certain degree of predictability can be more effectively addressed through planning, considering sound risk management practices, whereby opportunities and threats can be estimated. In this context, firms formulate strategies to sustain themselves, grow, and adjust their trajectories over time within the market.

To this end, firms require resources (financial, physical, and human capital); routines and processes (organisational capital); as well as capabilities and knowledge that enable flexibility to implement adaptations and even innovations. In the Upstream segment, which involves long-term investment decisions on the order of millions and billions of dollars, companies invest substantially in planning to mitigate risks and uncertainties and to enhance the predictability of desired outcomes.

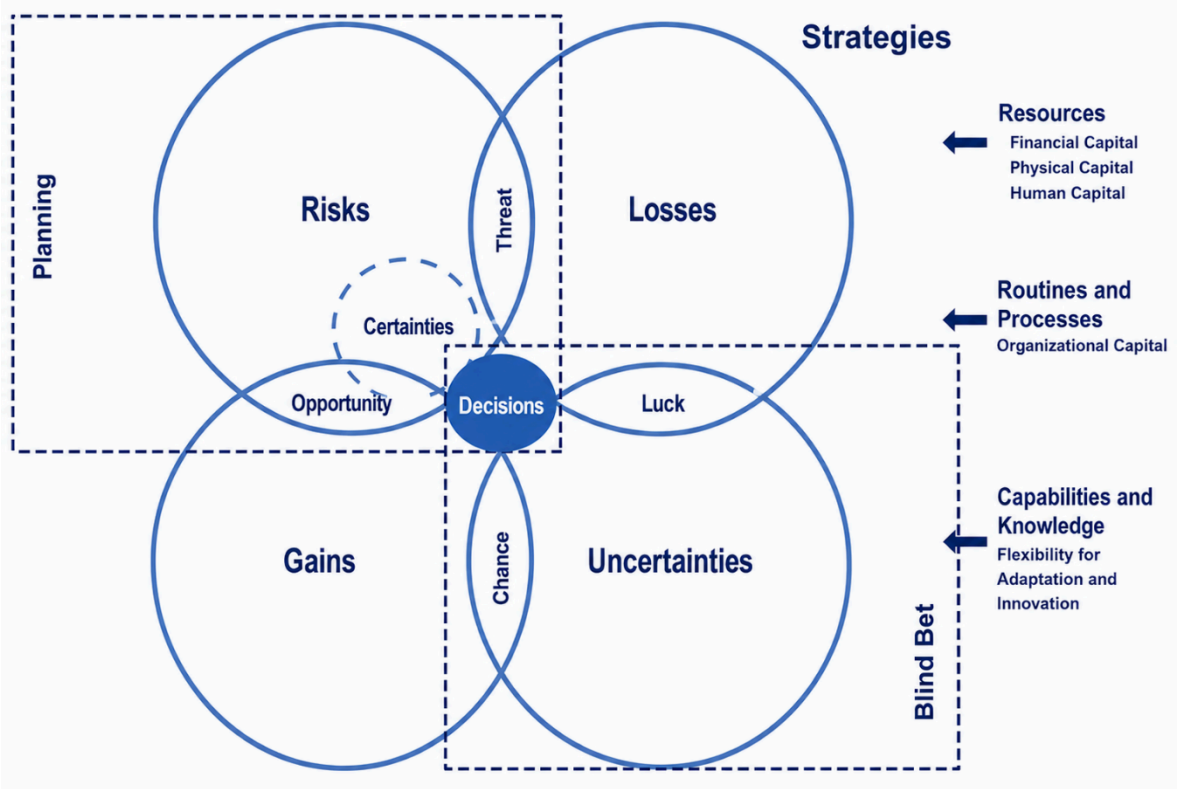
Regarding the distinction between the concepts of risk and uncertainty, the definitions adopted here are those of Luce and Raiffa (1957), as presented in the book Games and Decisions. Becker and Knudsen (2005: 747) argue that these two authors were responsible for popularising the classification that decisions can be made under conditions of certainty, risk, and uncertainty.

While certainty refers to a known outcome, risk and uncertainty are distinguished by whether the probabilities associated with different possible outcomes are known. In other words, when the probability of occurrence of a given event is unknown, the situation is characterised as one of uncertainty; when a probability can be assigned - whether objectively or subjectively - the situation is characterised as one of risk. Nevertheless, it should be emphasised that, in real-world settings, few decisions are made under conditions of certainty in which the exact future outcomes are fully known.

The above definition of uncertainty remains consistent with the classical perspectives of Knight (1921), Keynes (1936), and March and Simon (1958), who conceptualised situations in which not all scenarios and their associated probabilities are known, despite increases in the availability of information. Accordingly, they posited that decisions made in such environments occur under conditions of generalised uncertainty ("pervasive uncertainty").

Furthermore, this study adopts the premise that most firms are risk- and uncertainty-averse, an assumption supported by the works of Pratt (1964), Arrow (1965), March and Shapira (1987).

Figure 1: Business Decisions in Environments of Certainty, Risk, and Uncertainty



Source: Adapted from Gandra and Pinto Junior (2023).

A substantial portion of the literature on organisational routines focuses on firms' operational and innovation-related aspects. References linking the application of routines to investment decision-making are relatively scarce. In general, within the economic literature, investment decisions are often treated as autonomous.

Thus, the contribution of this study is limited to providing elements to address the following questions: how can organisational routines be integrated into the processes of strategic investment decision-making in new capital assets within large Upstream operating companies, given the sector's risks and uncertainties? And what are the principal technical and managerial macroprocesses employed by firms to achieve this objective?

To address this question, the study is structured as follows: Section 2 examines the theoretical foundations concerning the concepts, characteristics, roles, and purposes of organisational routines, as well as their relationship with organizational learning processes, dynamic capabilities, and strategic decision-making; Section 3 describes the characteristics of Upstream business activities from the perspective of operating companies; Section 4 discusses the risks and uncertainties associated with investment decisions in the Upstream segment; Section 5 presents an Investment Decision-Making Model applied to Upstream Projects (IDMM-UP), along with the principal macroprocesses that influence investment decisions; and Section 6 concludes the study.

The literature review was conducted based on both peer-reviewed academic literature and documented industry practices. The principal contribution of the present study is the provision of a more detailed and comprehensive description of the proposed model, together with additional evidence drawn from both the academic literature and documented industry practices.

II. ORGANIZATIONAL ROUTINES

The concept of organisational routines was originally developed within Economics by Nelson and Winter (1982) with the publication of An Evolutionary Theory of Economic Change. Following this influential work, the concept has been extensively discussed and further developed by numerous researchers.

It can be argued that the Evolutionary Theory of Nelson and Winter examines how firms channel the actions of diverse and heterogeneous individuals toward common objectives to achieve economic outcomes. In contrast to Orthodox Economic Theory - and drawing on the ideas of Schumpeter (1942) regarding the drivers of economic change, as well as on the contributions of Herbert A. Simon, concerning bounded human rationality - the central objective of Nelson and Winter (1982: 17) was to develop "an evolutionary theory of the capabilities and behaviour of firms operating in a market environment."

According to Nelson and Winter (1982: 35), a firm's routines define a set of functions that determine its behavior as a function of various external variables (such as market conditions) and internal variables (such as capital stock, profits earned in recent periods, and the capabilities of its human resources). Accordingly, Nelson and Winter (1982: 36–37) argue that three classes of routines can be identified within firms:

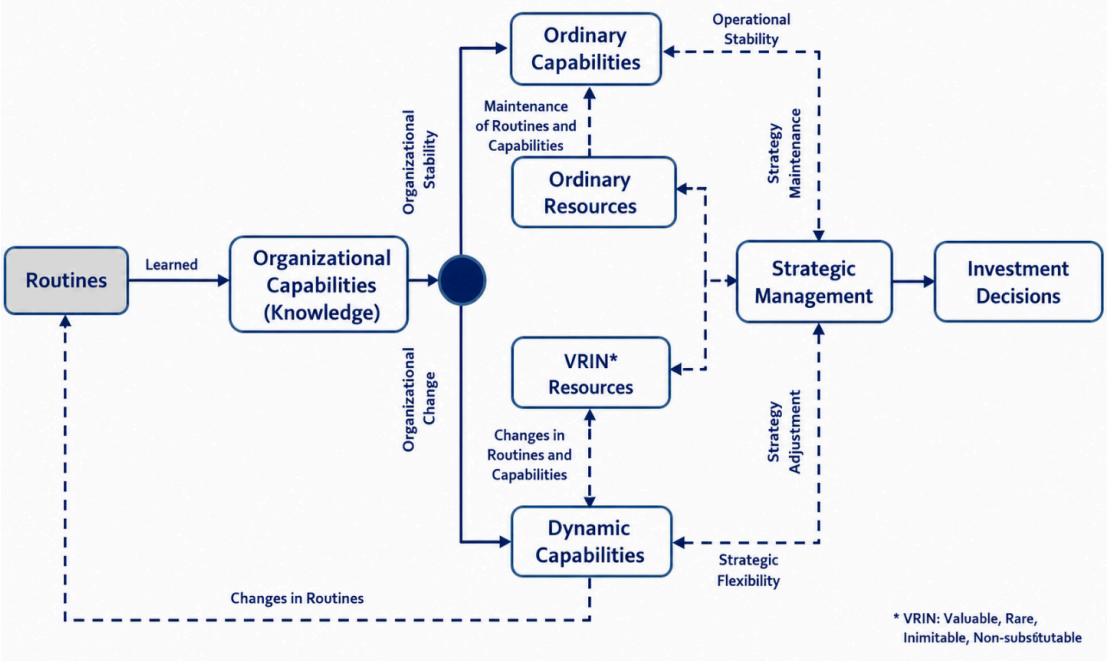
- **Operational routines,** which relate to what the firm does at any given point in time, given its stock of equipment and other fixed factors of production that cannot be expanded in the short run.
- **Investment routines,** which concern decisions regarding the expansion or contraction of the firm's capital stock in each period.
- **Search routines,** which modify various aspects of the routines themselves over time through "rule-guided" processes. These routines pertain to the firm's internal reflection on its operational characteristics over time, including how it will behave and where it will operate. In this sense, firms possess search processes that may generate changes in their routines, organisational structures, and decision-making.

As previously noted, the central commitment of Evolutionary Theory is to explain how firms transition from one period to another, demonstrating that this process is not constrained to a single path driven solely by profit maximisation. On the contrary, firms may choose their trajectories through internal mechanisms of routine-based search and selection. In this context, investment routines and search routines play a crucial role in explaining the dynamic trajectory of firms, as they operate through processes aimed at identifying new opportunities for growth - technological, managerial, and business-related - with the objective of achieving competitive advantages in the market.

As illustrated in Figure 2, this study assumes that routines constitute the links between organisational capabilities, resource utilisation, strategic considerations, and investment decisions. The maintenance and modification of these linkages provide, respectively, organisational stability and change. Accordingly, routines play the role of sustaining stability in organisational processes and in investment intentions.

In conjunction with the Dynamic Capabilities framework, as discussed later, routines may be regarded as repositories of knowledge that feed organisational memory, and thus can largely be viewed as the "building blocks" of organisational capabilities. In this sense, operational routines govern ordinary capabilities, providing regularity in the firm's operations, management, and governance; whereas learning routines govern dynamic capabilities, enabling variation (new insights), selection (opportunity exploitation), and retention (transformation). Further details can be found in Gandra (2019, 2022) and Gandra and Pinto Junior (2021).

Figure 2: Organisational Routines Understood as the Links Between Organisational Capabilities, Strategic Management, Resources, and Investment Decisions



(*) Valuable, Rare, Imperfectly Imitable, and Non-substitutable Resources (VRIN), a concept introduced by Jay B. Barney (1991), one of the leading authors of the Resource-Based View (RBV). Source: Adapted from Gandra and Pinto Junior (2023).

Becker (2000: 1; 2004: 643) argues that, since 1982, Nelson and Winter established the concept of routines as a central unit of analysis for organisations and economic change, and many researchers have embraced this research program. However, despite the theory's academic diffusion, several ambiguities have emerged regarding the concept of routines, as well as their purposes and effects within organisations.

Becker (2010: 7) further contends that "order" plays a fundamental role across all fields of the Social Sciences, yet the concept of routines has not received sufficient attention outside these domains—particularly in Business Management and Economics. According to Becker (2010: 3), since routines are ubiquitous in organisations, understanding them is tantamount to understanding organisations themselves. Similarly, Hodgson (2010: 15) argues that routines are vital to all organisations, as it is difficult to identify any organisation without them.

Broadly speaking, routines can be considered the building blocks of organisations, as they shape the ways in which organisations perform tasks and make decisions. Accordingly, the following sections summarise the definitions, characteristics, roles, and purposes of organisational routines, as well as their relationship with organisational learning.

2.1 Definitions of the Concept of Organisational Routine

According to Nelson and Winter (1982: 172–189), routines are organisational skills that are performed without full conscious awareness - that is, without deliberate attention or control by top management. In their view, organisational routines may be understood as the firm's "way of doing things." Becker (2004: 662, 2010: 4), in turn, argues that the term organisational routine refers to a broad range of regularities in economic activity and, based on a review of the literature, identifies three of the most frequently observed types of concepts, as outlined below.

In the first interpretation, routines may be understood as behavioural regularities (recurrent behavioural patterns), described as "recurrent patterns of interaction" which, according to Becker (2004: 664), appear in the empirical literature as "patterns of behaviour." Feldman (2000: 611) shares

this perspective, stating that "organisational routines are repeated patterns of behaviour that are bound by rules and customs and that do not change very much from one iteration to another." Cohen et al. (1996: 3) adopt a similar view, focusing on action patterns that may be characterised as routines: "our clear principal focus is on action patterns that can be called 'routine'." Furthermore, Pentland, Feldman, Becker, and Liu (2012), as well as Pentland and Hærem (2015), and Feldman et al. (2016), suggest that routines can be considered "recognisable, repetitive patterns of action."

In the second interpretation, routines may be understood as cognitive regularities (i.e., rules or procedures), such as rules, standards, procedures, policies, and codes. This conception reflects a more formal and objective perspective. Milagres (2011: 165) emphasises that Cyert and March (1963) are key representatives of this view, in which routines are understood as operating procedures.

A third, more recent interpretation – advanced by Hodgson (2003, 2010), Hodgson and Knudsen (2004a, 2004b), and Knudsen (2010) – has gained prominence in academic literature and is adopted as a premise in this study. This perspective suggests that routines are not behaviours per se, but rather "stored behavioural capacities" (i.e., dispositions or potential behaviours). From this viewpoint, routines encompass knowledge, memory, and individual habits that can be activated as needed, thereby generating sequential behaviour. Accordingly, routines may be understood as a repertoire of possible behaviours that can be enacted depending on circumstances, context, and specific needs.

2.2 Characteristics of Organisational Routines

In addition to the definitions presented above, it is important to emphasise that, according to the literature review, routines exhibit several characteristics, as illustrated in Table 1.

Table 1: Summary of the Characteristics of Organisational Routines

Characteristics	Description	References
Patterns	Historically, routines have been defined as "recurrent patterns of interaction" or "recurrent patterns of collective activities."	Winter (1964), Nelson and Winter (1982), Becker (2004)
Collective	"The second feature of the organisational routines concept that sets it apart from other, collective-level concepts is to relate the individual level to the collective level. Organisational routines capture stable structures in collective actions that emerge from the interrelating of individual action". (BECKER, 2010: 5-6)	Levitt and March (1988), Nelson and Winter (1982), Becker (2004, 2010)
Recurrence / Repetitive / Persistent	Repetition ensures consistency and predictability. Recurrence is essential, as routines imply repeated occurrences. These features reduce volatility and enhance stability and predictability.	Becker (2000, 2004), Winter and Szulanski (2002), Knudsen (2010), Milagres (2011)
Non-deliberative or mindless or Effortful accomplishment	Markus C. Becker (2004: 648) emphasises that one of the most contested issues among scholars concerns whether routines are non-deliberate (i.e., mindless) or deliberate (i.e., effortful accomplishments). Proponents of the former perspective argue that individuals follow routines without devoting conscious attention to them, whereas proponents of the latter contend that individuals enact routines with deliberate attention. Becker (2004: 648) further argues that the boundary between these two perspectives ultimately depends on empirical verification: the non-deliberate view is primarily supported by conceptual literature, whereas the deliberate view finds stronger support in empirical studies.	Proponents of Non-deliberate Routines: Nelson (1995), Ashforth and Fried (1988), Dosi, Nelson and Winter (2000), Nelson and Sampat (2001) Proponents of Deliberate Routines: March and Simon (1993), Cohen *et al.* (1996)

Processual Nature	Routines depend on the types of issues they are intended to address. Since firms are generally specialised in particular products and services, they adopt specific tools and methods that are repetitive and aligned with the nature of the problem to be solved. Consequently, routines possess a process-oriented character; that is, to generate solutions (outputs), routines must transform information and resources (inputs) through established techniques, methods, or tools.	Becker (2000, 2004)
Context-dependent / Embedded / Specifics	Some authors argue that routines are embedded within organisations in specific contexts. This view is consistent with the notion that general rules and procedures must be implemented in accordance with different contexts, organisational structures, cultures, and business-specific characteristics.	Teece and Pisano (1994), Becker (2000, 2004), Howard-Grenville (2005), Milagres (2011), Bertels, Howard-Grenville and Pek (2016)
Path dependent	It is widely accepted in academic literature that routines are historically shaped by their trajectories, exhibiting a form of path dependence.	Teece, Pisano and Shuen (1997), Becker (2000, 2004), Milagres (2011), Pentland, Feldman, Becker and Liu (2012)
Triggered	Routines are interconnected; therefore, they may be activated or triggered by other routines or by other processes.	Cohen *et al.* (1996), Becker (2000), Nelson and Sampat (2001)
Decomposed	Martha S. Feldman and Brian T. Pentland (2003), as well as Anne S. Miner, Michael P. Ciuchta, and Yadong Gong (2010), argue that higher-level routines may encompass multiple sub-routines (lower-level micro-routines). In general, routines can be hierarchically decomposed, with the possibility of a "parent routine" encompassing several subordinate routines. Accordingly, organisations commonly structure their routines across three levels: strategic, tactical, and operational.	Miner, Ciuchta and Gong (2010), Feldman and Pentland (2003), Greve (2010)

Source: Adapted from Gandra and Pinto Junior (2023).

Although a broader overview of the characteristics of organisational routines has been presented, with respect to the focus of this article, it is important to highlight the following: processual, standardised, triggered, and decomposed.

2.3 Roles and Purposes of Organisational Routines

In addition to the definitions presented above, it is important to emphasise that, according to the literature review, routines perform several roles, as illustrated in Table 2.

Table 2: Summary of the Roles and Purposes of Organisational Routines

Roles and Purposes	Description	References
Coordination and Control	Routines contribute to improving the flow of information by reducing noise, standardizing communication channels, and aligning behaviors and language. In this sense, routines support the coordination of activities by providing coherence, logical sequencing, and uniformity in the actions of individuals within the organization.	March and Simon (1958), Cyert and March (1963), Nelson and Winter (1982), Langlois (1992), Teece, Pisano and Shuen (1997), Becker (2000, 2004), Milagres (2011)

Conflict Reduction or Truce Promotion	Routines establish behavioral reference frameworks that help reduce potential conflicts. That is, when routines indicate or signal the behaviors accepted by the organization, they contribute to minimizing conflicts of interest. According to Herbert A. Simon (1993), this concept may also be associated with the potential for altruistic behavior among individuals.	March and Simon (1958), Cyert and March (1963), Nelson and Winter (1982), Simon (1993), Becker (2004), Milagres (2011), Bertels, Howard-Grenville and Pek (2016)
Economizing on Cognitive Resources	Routines enable the economization of cognitive effort by facilitating information processing and accommodating the bounded nature of decision-making capacity. Firms can develop patterns and routines to align incentives, monitor activities, and control employee behavior through a streamlined and efficient organizational structure.	Simon (1957), March and Simon (1958), Becker and Knudsen (2005), Becker (2004), Milagres (2011)
Stability	The most widely recognized role of routines is the promotion of organizational stability. In this regard, routines constrain or encourage certain behaviors among agents. As long as a given routine yields satisfactory results, no conscious cognitive effort is triggered to seek alternative ways of performing tasks and achieving the same objectives.	March and Simon (1958), Cyert and March (1963), Nelson and Winter (1982), Heiner (1983), Nelson (1994), Becker (2000, 2004), Zollo and Winter (2002), Milagres (2011), Feldman, et al. (2016)
Dynamic Changes	One of the most relevant empirical findings is the notion that routines can foster endogenous change within organizations. While routines promote stability, there is also evidence that they evolve in response to experience, organizational learning, and changes in the external environment. They may also be associated with deliberate organizational efforts to search for innovation. In this context, the literature points to the existence of search routines, which are dedicated to identifying, selecting, and retaining new procedures to achieve improvements and competitive advantages. These routines are closely related to the development of dynamic capabilities.	Nelson and Winter (1982), Teece, Pisano and Shuen (1997), Becker (2000, 2004), Zollo and Winter (2002), Milagres (2011), Teece (2007, 2014, 2017), Feldman et al. (2016)
Knowledge Storage	Routines may be considered repositories of knowledge within organizations. When a solution implemented proves successful in addressing a specific problem, it can be activated as an option to resolve similar problems on a recurring basis, thereby becoming a routine. An important characteristic of routines is their ability to incorporate both explicit (documented) and implicit (tacit) knowledge.	Nelson and Winter (1982), Teece, Pisano and Shuen (1997), Becker (2000, 2004), Hodgson (2003, 2010), Hodgson and Knudsen (2004a, 2004b), Knudsen (2010), Milagres (2011), Teece (2007, 2014, 2017)
Constitutive Role	Institutions and routines incorporate a "symbolic dimension" that encompasses specific values and worldviews. In other words, the institutional framework (both within and outside the organization) becomes internalized in individuals' value systems. Since routines may embody cultural	Chang and Evans (2005)

	and ideological values, individuals tend to adhere to them not through coercion, but by principle.	
Risk and Uncertainty Reducing	The reduction of uncertainty can be regarded as one of the most important roles of organizational routines in the business context. According to Herbert A. Simon (1997), given bounded rationality, the choices made by business actors are based on relatively simple decision rules, as they do not possess all the capabilities required to process the full range of available information. Decisions are therefore grounded in a repertoire of routines, through which agents draw on past experiences and apply them to present situations or problems by means of trial and error.	March and Simon (1958), Cyert and March (1963), Knight (1921), Nelson and Winter (1982), Heiner (1983), March and Shapira (1987), Simon (1997), Becker (2000), Almeida (2004), Becker and Knudsen (2005), Greve (2003b, 2010), Knudsen (2005)

Source: Adapted from Gandra and Pinto Junior (2023).

Although a broader overview of the roles and purposes of organizational routines has been presented, with respect to the focus of this article, it is important to highlight the following: coordination, control, and the reduction of risks and uncertainties.

Regarding the relationship between routines and uncertainty, it is important to highlight the conclusion of Heiner (1983: 570): "(...) greater uncertainty will cause rule-governed behavior to exhibit increasingly predictable regularities, so that uncertainty becomes the basic source of predictable behavior". As will be shown, this conclusion also applies to investment decisions in the upstream segment.

2.4 Organizational Routines and their relationship with Organizational Learning Processes, Dynamic Capabilities and Strategic Decisions

Pisano (2017: 749) argues that, in examining why firms exhibit differing levels of profitability, the concept of "Five Forces", proposed by Porter (1980), proved to be remarkably successful. This is because the framework is logically consistent, capable of explaining a broad set of empirical observations, flexible enough to address a wide range of contexts and strategic problems, and amenable to translation into analytical tools and concepts that assist practitioners in understanding the business environment and formulating strategies.

Nevertheless, this approach has not been able to explain the high degree of intra-industry variability in profitability over extended periods. In other words, firms operating within the same industry, and often pursuing similar strategies, may exhibit markedly different performance outcomes.

Based on the book, The Theory of the Growth of the Firm, published by Penrose (1959), the Resource-Based View (RBV) gained prominence between the 1980s and 1990s. This theoretical approach - exemplified by Jay B. Barney (1991) - sought to explain intra-industry performance differences through the possession of valuable, rare, imperfectly imitable, and non-substitutable (VRIN) resources, such as tangible and intangible assets, patents, and reputation.

Within this framework, scholars recognized that some organizations were more effective than others in creating and developing resources to achieve competitive advantage. This line of research suggested that certain firms are more capable of renewing their skills and building new competencies over time.

However, much like Porter "Five Forces", the Resource-Based View (RBV) offered limited insights into the dynamics underlying the creation of organizational capabilities. Addressing this gap, Teece and Pisano (1994), as well as Teece, Pisano and Shuen (1997), developed an approach to better understand differences in organizational capabilities across firms and how managers could make more effective strategic decisions, thereby establishing the Dynamic Capabilities Theory.

This approach seeks to explain how firms develop and sustain competitive advantages, based on the premise that the business environment is characterized by intense competition driven by innovation on a global scale. According to Teece (2017), the pursuit of profit, growth, and

differentiation is fundamental for capitalist firms, with value creation stemming from the development and maintenance of dynamic capabilities.

Teece, Pisano and Shuen (1997: 517–518) argue that firms' competitive advantages reside in their managerial and organizational processes, which are shaped by their specific positions (in terms of technology, intellectual property, capital, skilled personnel, knowledge, customer base, and supplier relationships, among others) and by the paths they have chosen that lead to new opportunities.

The authors further contend that managerial processes (or organizational routines) perform three key functions in the formation of organizational capabilities: coordination/integration (a static concept), learning (a dynamic concept), and reconfiguration (a transformational concept).

Teece (2014: 337) emphasizes that learning is a critical dimension of dynamic capabilities, as it enables firms to understand what customers want, what new technologies make possible, which aspects of the business model are working, and whether the current strategy is effective in sustaining long-term growth.

Since routines play an important role in shaping processes of coordination, learning, and transformation, David J. Teece (2014: 328–330) argues that learning generates:

- **Ordinary (or common) capabilities;**
- **Dynamic capabilities,** which, according to David J. Teece (2007: 1319–1320), encompass the ability to create and augment the VRIN resources required to adapt to new technological opportunities and evolving customer demands. They also reside in firms' capacity to shape the ecosystems in which they operate, develop new products and processes, and design and implement viable business models. In sum, dynamic capabilities involve adaptation, orchestration (i.e., the alignment and deployment of resources), and innovation.

Through routines and ad hoc problem-solving, organizations can generate a continuous flow of learning, thereby expanding their knowledge base. It is through internal learning processes, supported by routines, that firms accumulate strong dynamic capabilities, enabling them to build and renew their businesses in response to changes in both the external and internal environments.

According to Teece (2007, 2014, 2017), dynamic capabilities influence and enable strategic decision-making aimed at achieving competitive advantages within firms. However, he emphasizes that strong dynamic capabilities are not a given; rather, they must be deliberately built through investments in discovery and learning.

For Teece (2014, 2017), a dynamic capability involves the construction and orchestration of resources to perform a variety of tasks in constantly changing environments. The relationship between resources and dynamic capabilities is therefore critical to understanding how firms define their strategies. Dynamic capabilities both shape and are reinforced by VRIN resources that underpin long-term competitiveness.

In this sense, the joint presence of strong dynamic capabilities, VRIN resources, and sound strategy constitutes a necessary condition for firms to achieve superior long-term performance (as illustrated in Figure 1). Teece (2014: 330–334) further notes that the mere possession of strong dynamic capabilities does not necessarily guarantee success. That is, dynamic capabilities do not operate in isolation; they must be combined with effective strategies and VRIN resources to generate sustainable competitive advantages.

In addition to capabilities, resources, and strategies, Teece (2014, 2017) highlights the importance of the managerial decision-making profile and entrepreneurial heritage or organizational culture in leading and orchestrating capabilities (both ordinary and dynamic), resources (both ordinary and VRIN), and strategic decisions.

In other words, top-level managers, together with organizational culture, play a fundamental role in the creation of dynamic capabilities within an organization, as they are responsible for defining strategic objectives and authorizing the mobilization of resources.

III. CHARACTERISTICS OF UPSTREAM SEGMENT FROM THE PERSPECTIVE OF OPERATING COMPANIES

The generation of economic results in the Exploration and Production (Upstream) segment involves the discovery and transformation of hydrocarbon potential into effective commercial production. By its extractive nature, the Upstream segment is strongly oriented toward capital projects and is directly associated with three fundamental objectives: (i) to discover, evaluate, and delineate oil and gas reservoirs; (ii) to develop and construct production systems or assets to exploit these reservoirs; and (iii) to produce and commercialize oil and gas in order to generate revenues that exceed all expenditures and the opportunity cost over the long term.

As illustrated in Figure 3, to achieve these objectives, it is considered best practice for operating companies to divide the life cycle of their business assets into three stages: the Exploration Stage, the Production Development (PD) Stage, and the Production Stage.

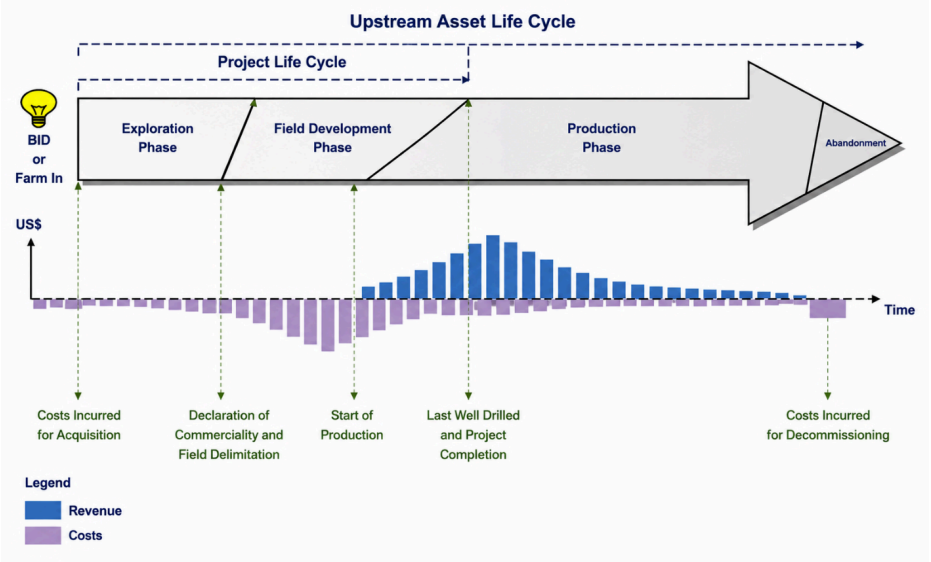
In the Exploration and Production Development (PD) stages, operating companies invest capital and resources to acquire and process information to identify hydrocarbons, assess and delineate hydrocarbon volumes, and develop production assets. In the Production stage, revenues are generated through the extraction and commercialization of these hydrocarbons.

The Upstream asset life cycle is extensive, and operating companies organize their activities around "best practices," as illustrated in Figure 3. Once an opportunity is identified within the firm, it proceeds to the Exploration stage. Following the completion of exploratory activities, the project advances to the Production Development (PD) stage, where the milestone of first oil is achieved and concludes with the tie-in of the last well. Only after the completion of project close-out activities is the asset transferred to the end user, that is, to the operations team (in the Production stage).

As different objectives are pursued at each stage, operating companies structure their organizations, resources, processes, and capabilities to achieve these goals. In other words, each stage requires distinct information, which must be processed, decomposed, and triggered across activities by different professionals with diverse skills, backgrounds, and qualifications, thereby demanding specific resources and processes.

Moreover, each stage may involve segregated investment portfolios, given that the objectives to be pursued differ. It is also important to emphasize that a key characteristic of the Upstream segment is the intense interaction among various types of agents - both within and outside the firm - and the dependence on an extensive supply chain, which further increases the complexity of investment decision-making.

Figure 3: Typical Business Life Cycle of a Capital Asset in the Upstream Segment



Source: Adapted from Gandra and Pinto Junior (2023)

Despite the complexity of the Upstream segment imposing a range of challenges and uncertainties on firms, they cannot remain inactive; rather, they must make continuous decisions to sustain and/or expand their presence in the market, given their extractive nature. It is observed that most investments within the Asset Life Cycle are concentrated in the Project Life Cycle, particularly in the Exploration and Production Development (PD) stages, the latter accounting for the largest share of physical and financial investment resources.

Given the high sensitivity of the Upstream segment to investment decisions, firms typically develop capabilities and design structured processes – standardized, triggered, and decomposed across strategic, tactical, and operational levels – in order to enhance coordination, control, and the reduction of risks and uncertainties (influenced by the temporal dimension of the business cycle and by several other factors to be discussed in the next section).

IV. RISKS AND UNCERTAINTIES IN INVESTMENT DECISIONS IN THE UPSTREAM SEGMENT

As noted in Table 2, one of the crucial roles of organisational routines is the reduction of risks and uncertainties in decision-making processes. In addition to technical challenges, Newendorp and Schuyler (2000: 327) highlight several risks that must be considered in petroleum exploration, such as the possibility of a dry exploratory well, the risk that discovered volumes may not cover exploration costs, fluctuations in oil and gas prices, and the influence of economic, environmental, market, and institutional factors.

In addition to the factors mentioned above, risks and uncertainties are further amplified by the involvement of multiple stakeholders (both internal and external to the organization), the extensive supply chain, the large volume of resources required, the rapid pace of technological change, the high levels of capital investment involved, and the long-time horizon associated with asset returns.

Operating within a complex environment, characterized by long maturation periods and irreversible impacts, investment decisions are also constrained by the bounded rationality of decision-makers.

Veiga and Silva (2020) present a systematic literature review on sources of risk in project management. Following the same rationale, Table 3 provides a practical example of a risk breakdown structure commonly customized by firms to map the main sources of risk in capital projects within the Upstream segment.

Table 3: Risk Breakdown Structure

General Sources	Specific Sources
Technical	Generation of Innovations
	Obsolescence
	Performance of the Technical Team
	Availability of Skilled Human Resources
	Availability of Physical Resources
	Design and Engineering Errors
	Logistical Errors
	Errors in Reserve Assessment and Production Curve Estimation
	Exploratory Errors
	Performance of Health, Safety, and Environment (HSE) Management
Project Management	Performance in Project Integration, Leadership, and Conflict Resolution
	Performance in Scope Definition
	Performance in Schedule Planning and Management
	Estimation of Investments, Operational Costs, and Decommissioning

	Performance in Quality Management
	Performance in Communications
	Performance in Resource Planning
	Performance in Procurement
	Performance in Stakeholder Management
	Performance in Risk Management
	Performance in Change Management
	Performance in Economic Valuation Modeling and Assumptions
Corporate	Organizational Structure and Organizational Leadership
	Organizational Strategy
	Availability of Financial Resources
	Knowledge Management
	Agency Issues / Personal Interests
	Organizational Processes
	Performance in Exploration Portfolio Management
	Performance in Production Development Portfolio Management
	Performance in Production Portfolio Management
	Organizational Culture
	Compliance
External	Clients
	Availability of Technology
	Technological Innovations
	Substitute Products
	Suppliers
	Availability of Skilled Labor
	Environmental and Socioeconomic Aspects
	Partnerships
	Competition and New Entrants
	Oil and Gas Price Volatility
	Legal and/or Regulatory Aspects
	Licensing Aspects
	Customs-Related Aspects
	Taxation Aspects
	Political and Geopolitical Aspects
	Oil and Gas Demand
	Oil and Gas Supply
	Infrastructure
	Macroeconomic Aspects (inflation, interest rates, exchange rate fluctuations, etc.)
	Labor Aspects
	Wars and Conflicts
	Environmental Conditions
	Force Majeure

Source: Adapted from Gandra and Pinto Junior (2023)

In line with Heiner (1983), given the high levels of risk and uncertainty, investment decisions in the Upstream segment are not made automatically. On the contrary, they must be constructed, discussed, aligned, and refined over a period before being evaluated and ultimately implemented.

Assuming that most firms are risk- and uncertainty-averse, investment decision-making is influenced by strategic vision, planning, managerial leadership, organizational culture, knowledge, resources (physical, financial, organizational, and human), as well as processes and methods. Firms also consider the characteristics of the environment in which they operate to develop their own routines and strategies aligned with their profiles and objectives.

Highlighting the main organizational routines involved in the investment decision-making process for new capital assets, an IDMM-UP was developed. Subsequently, some of the key technical and managerial macroprocesses (higher-level routines) applied by large firms will be presented.

V. INVESTMENT DECISION-MAKING MODEL APPLIED TO UPSTREAM PROJECTS (IDMM-UP)

Having outlined the main characteristics of the Upstream segment, this section presents an Investment Decision-Making Model applied to Upstream Projects (IDMM-UP) for the Exploration and Production Development stages. This model represents a large, privately owned oil company operating in the Brazilian context.

It should be noted, however, that despite existing similarities and the sharing of market "best practices," firms do not operate in the same way, as they have their own governance models, adopt distinct investment strategies, and employ specific management systems.

Before presenting the model, as previously noted, most firms in the Upstream segment are averse to risks and uncertainties. However, the degree of such aversion depends on the profile of managerial decision-makers and on the organization's entrepreneurial heritage or organizational culture.

It is important to emphasize that, although the model presented here adopts a completely distinct structure, it was based on the works of Milani Júnior, Bomtempo and Pinto Júnior (2005, 2007) who employed System Dynamics techniques to model decision-making in the Upstream segment. The System Dynamics literature approaches problem-solving in complex environments through the construction of a representative map of reality. According to Sterman (2000: 4–5), System Dynamics is a tool inspired by Mathematics, Physics, and Engineering, and can be used to model human behavior by incorporating cognitive, social, and economic aspects.

Furthermore, it is important to consider Sterman's caution regarding the need to model a problem rather than a system, since the primary purpose of models is to support problem-solving.

Even though the model is not intended to be quantified, IDMM-UP will assist in mapping the main variables and processes that influence investment decisions in large Upstream firms. In other words, the aim is to emphasize that investment decisions in the Upstream segment require appropriate routines, and that certain routines can generate changes in the routines themselves as well as in investment decisions.

Based on Barney (1996), the model developed by Milani Júnior, Pinto Júnior and Bomtempo (2007) considers the following stocks (or resources):

- Financial Capital (representing the firm's cash holdings);
- Physical Capital (representing hydrocarbon reserves); and
- Human Capital (representing the workforce).

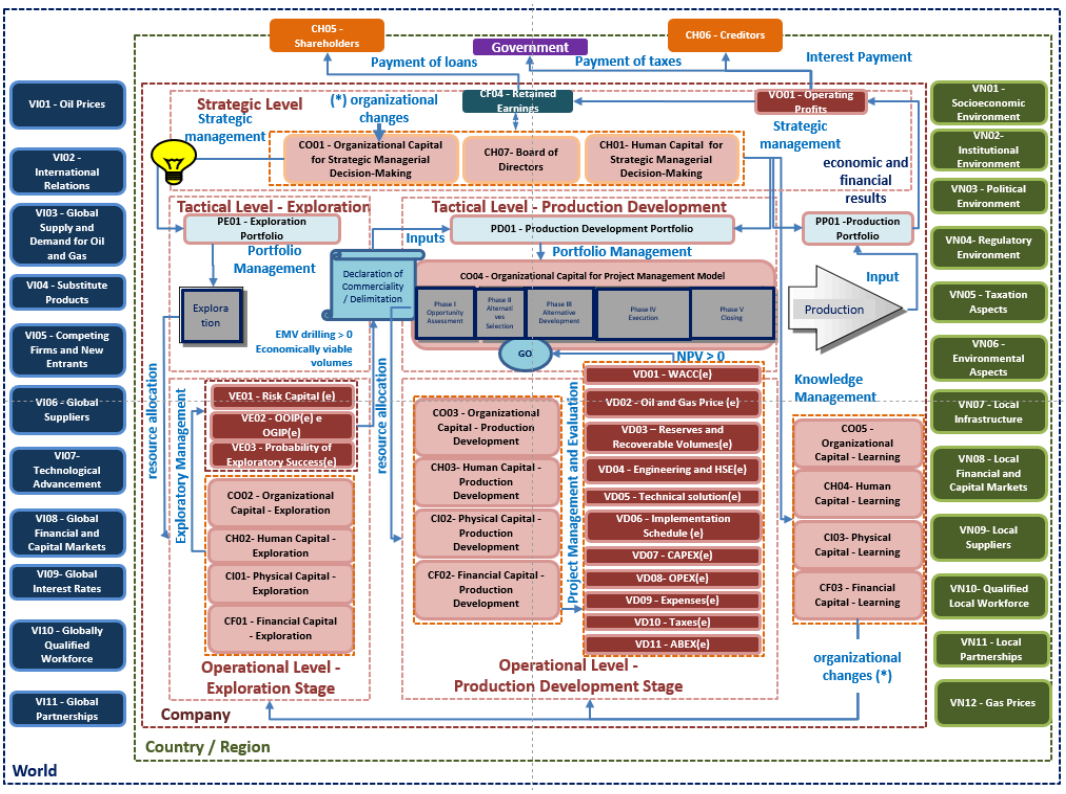
Organizational capital (representing organizational capabilities or the knowledge that governs management models and corporate processes) was linked to the three resource categories outlined above. That is, it was not"explicitly represented in the model," but rather "emerges from the interaction of stocks (resources) and their flows" (Milani Júnior, Bomtempo, and Pinto Júnior, 2005: 22–23).

However, since the adoption of specific routines plays a fundamental role in investment decision-making processes, it is precisely organizational capital that encourages, builds, constrains, shapes, and transforms firms' strategies, routines, and investment decisions.

Given that Upstream activities involve substantial risks and uncertainties, firms require knowledge and organizational routines at all levels – strategic, tactical, and operational – to increase the confidence of decision-makers, improve or adapt management systems, and enhance the reliability of decisions.

Accordingly, IDMM-UP is illustrated in Figure 4, whose purpose is to clarify how a large fictitious company in the Upstream sector makes investment decisions supported by routines dependent on organizational capital. Appendix 1 describes each component of IDMM-UP.

Figure 4: Investment Decision-Making Model applied to Upstream Projects (IDMM-UP)



Source: Adapted from Gandra and Pinto Junior (2023)

Considering that the model must be embedded within an organizational, institutional, socioeconomic, and geopolitical context, IDMM-UP portrays a firm operating in an environment shaped by multiple external variables (both national and international).

Furthermore, IDMM-UP assumes that the fictitious firm is a large Upstream company that, at a given point in time, already holds a portfolio of assets across the exploration, production development, and production stages. In addition, this Upstream company possesses a stock of human, physical, financial, and organizational resources to support investments in new assets and organizational learning and is structurally organized across the following domains.

- Strategic level, comprising Organizational Capital for Strategic Managerial Decisions (CO01), which represents the capabilities or knowledge that define the Governance and Strategic Management Model, aligned with the profile of managerial decision-makers and the organizational culture that guide high-level processes and routines at the strategic level. In addition, it includes Human Capital for Strategic Managerial Decision-Making (CH01), representing Chief Executive Officers, Chief Financial Officers, Chief Operating Officers. These individuals are responsible for Strategic Management, in which they define the firm's overall objectives and goals, as well as make decisions regarding the firm's organizational structure, the allocation of results (including

dividend payments, profit-sharing with employees, investments in new assets, and investments in learning and innovation). It should also be noted that, within this model, strategic decisions are subject to evaluation by the Board of Directors (CH07).

- Tactical level, for both exploration and production development, where middle managers supervise technical activities and manage the Organizational Capital for Project Management Model (CO04), representing the capabilities or knowledge that govern the processes required to manage the portfolio of investment projects and producing assets. For the sake of model simplification, the same managers are responsible for the Exploration Portfolio Management (PE01), the Production Development Portfolio Management (PD01), and the Production Portfolio Management (PP01). The PP01 was not explicitly modeled, as the focus of this study lies on investment decisions in capital projects rather than on production activities.

- Operational level, for both exploration and production development, where managers and teams carry out the technical activities required to identify, analyze, and delineate viable hydrocarbon volumes (Exploration Management), as well as the activities related to planning, estimation, implementation, monitoring, and delivery of the entire production infrastructure (Project Management and Evaluation).

IDMM-UP illustrated in Figure 4 assumes, as a starting point, that the firm has selected a new opportunity represented by the "light bulb" (as a symbol of an idea) at the strategic level, through participation in a bidding process (BID Round). This decision to enter a bidding process may originate from strategic decisions made by the Human Capital for Strategic Managerial Decision-Making (CH01).

Once this opportunity is incorporated by the firm, one can consider the subsequent sequence of events and decisions that follow.

A. The opportunity enters the Exploration Portfolio (PE01) at the tactical level of the Exploration stage, where its potential is assessed through portfolio management processes.

B. Once the exploration of this opportunity is authorized, human, organizational, physical, and financial resources at the operational level of the Exploration stage are allocated and mobilized to carry out Exploration Management. To explore and evaluate potential discoveries, the firm issues a Discovery Appraisal Plan (DAP) detailing the relevant activities and timelines. In order to analyze the economic viability of drilling exploratory wells, the company estimates the Original Oil in Place (OOIP), the Original Gas in Place (OGIP), the probability of exploratory success and the risk capital. After gathering this information, the decision rule for drilling exploratory wells is based on the condition that the Expected Monetary Value (EMV) must be greater than the option of not drilling. If the no-drilling option has zero cost, then the EMV of the drilling option must be greater than zero.

C. Once the presence of hydrocarbons has been confirmed through exploratory wells, the firm proceeds to delineate the field and assess its petroleum potential. If this potential is deemed economically viable, the company may consider it appropriate to submit a Declaration of Commerciality.

D. In this specific model, following field delineation, the assessment of petroleum potential, and the Declaration of Commerciality, the opportunity transitions to the Production Development Portfolio (PD01) at the tactical level of the Production Development stage. At this stage, through portfolio management processes, the strategic alignment of the field's development is evaluated.

E. If the opportunity is aligned with the firm's strategy, a new project is initiated at the operational level of the Production Development stage, following the procedures and processes defined by the Organizational Capital for the Capital Project Management Model (CO04). In this example, consistent with industry's best practices, the model is governed by decision gates or a stage-gate process. At

this stage, human, organizational, physical, and financial resources are mobilized to conduct the development studies of the production asset capable of exploiting the petroleum potential. In other words, Project Management and Evaluation processes are initiated, in which the required activities for each phase of the Capital Project Management Model (CO04) are carried out. In this case, the project progresses through the following phases.

- Phase I – Opportunity Assessment, in which the project is evaluated in terms of its alignment with the firm's portfolio and overall strategy.
- Phase II – Alternative Selection, in which, among various options, the most suitable technical, economic, and Health, Safety, and Environment (HSE) solution is identified.
- Phase III – Alternative Development, in which technical information and estimates are detailed to support the economic model that composes the Technical and Economic Feasibility Study (TEFS). In this phase, multidisciplinary teams carry out activities such as: detailed engineering design (including wells, facilities, lifting systems, flow assurance, HSE, reservoir, operability, and constructability, among others); and estimates of recoverable volumes, project implementation schedule, Capital Expenditures (CAPEX), Operational Expenditures (OPEX), expenses, taxes, abandonment costs, Weighted Average Cost of Capital (WACC), and oil and gas prices to be incorporated into the discounted cash flow model. At the "GO decision" milestone, if the project is deemed economically attractive—i.e., if the estimated Net Present Value (NPV) is greater than zero (NPV > 0) and the project is approved—the company issues the Development Plan (DP) and submits it to the appropriate governmental authority.
- Phase IV – Execution, in which resources are mobilized and contracts are executed to implement the project as closely as possible to the targets defined in the Development Plan (DP) and the Technical and Economic Feasibility Study (TEFS). Monitoring and control of construction activities and contracts are also carried out at this stage. It should be noted that achieving targets in complex projects of this nature is challenging. To do so effectively, firms must demonstrate discipline, knowledge, resources, capabilities, commitment, accountability, well-defined and integrated processes, motivation, and leadership. In recognition of these challenges, the Project Management Institute (2017) recommends, as a market "best practice," that organizations implement organizational processes (routines) to increase the likelihood of project success.
- Phase V – Closeout, in which the asset is transferred to the end user (the operations team), and project closure activities are carried out, including contract closeout, administrative closure, and financial/accounting closure.

F. Following the First Oil milestone (the start of production), the asset is transferred to the Production Portfolio (PP01) at the operational level of the Production stage, where economic results are expected to be generated (e.g., Operating Profit, Return on Capital Employed, among others).

G. Once the asset is generating Operating Profit (VO01), and after the payment of interest to creditors and taxes to the government, net profits are determined and, in each period, a portion is retained as Retained Earnings (CF04).

H. Returning to the Strategic level, the Human Capital for Strategic Managerial Decision-Making (CH01)—that is, the

managerial decision-makers responsible for Strategic Management—deliberate on the allocation of Retained Earnings (CF04), either in the form of dividends to shareholders (CH05) or as reinvestment options within the firm.

I. If the Human Capital for Strategic Managerial Decisions-Making (CH01) chooses to reinvest portions of Retained Earnings (CF04) within the firm, this may lead to the expansion of production systems (through new capital asset projects) and the enhancement and innovation of technical and managerial knowledge bases (through knowledge management routines), thereby strengthening the firm's dynamic capabilities.

J. It is observed that the directions of Strategic Management, Exploration Management, Portfolio Management, Project Management and Evaluation, and Knowledge Management are subject to endogenous variables as well as exogenous conditions arising from both national and international environments.

K. IDMM-UP assumes that, through Knowledge Management, the introduction of technical and process improvements and innovations can trigger gradual changes in the overall management system.

L. IDMM-UP considers that Knowledge Management, by fostering innovation and strengthening the firm's dynamic capabilities, feeds back into the entire system, thereby promoting both stability and change in organizational routines, strategies, and investment decisions. New learning may even influence the Organizational Capital for Strategic Managerial Decisions (CO01) and the Organizational Capital for the Capital Project Management Model (CO04), leading the firm to adopt a new dynamic.

Aligned with IDMM-UP, a review of empirical studies made it possible to demonstrate the application of six technical and managerial macroprocesses (higher-level routines) that influence decisions and investments, as illustrated in Table 4.

Table 4: Macroprocesses Influencing Investment Decisions in the Upstream Segment

Macroprocess	Description	References
Strategic Management	Examples of how firms routinely establish and revise their Corporate Governance and Strategic Planning processes.	Grant (2003), Asrilhant, Meadows and Dyson (2006), Project Management Institute (2008), Badiru and Osisanya (2013), Shuen, Feiler and Teece (2014)
Portfolio Management	Presents the market "best practices" employed by firms in managing their portfolios.	Adekunle (2006), Project Management Institute (2008), Belaid (2011), Barbosa *et al.* (2013)
Capital Project Management Model	One market "best practice" adopted by some large oil and gas companies in the upstream segment is the development of a corporate capital project management framework designed to align investment decisions with the level of project definition, while also supporting the management of risks and uncertainties.	Merrow (2012), Barbosa *et al.* (2013)

Exploration Management	During the Exploration stage, managers focus on activities aimed at identifying indications of hydrocarbons, assessing discovery volumes, delineating accumulations, and declaring the commerciality of the field. Given the risks and uncertainties involved, these processes are carried out through well-defined technical and managerial routines.	Newendorp and Schuyler (2000), Macmillan (2000), Margueron (2003), Suslick, *et al.* (2009), Feiler and Teece (2014)
Project Management and Evaluation	During the Production Development stage, managers focus on activities related to: the preparation of engineering designs; the definition of the technical solution scope; the estimation of schedules, costs, and risks; the planning of project execution; the estimation of all relevant information required for decision-making ("GO decision"); the assessment of project economic feasibility and the preparation of the Technical and Economic Feasibility Study (TEFS); the monitoring and control of the project (or construction activities); and the delivery of the asset to the end user.	Galli, Armstrong and Jehl (1999), Nepomuceno Filho and Suslick (2000), Macmillan (2000), Margueron (2003), Adekunle (2006), Asrilhant, Meadows and Dyson (2006), Suslick, *et al.* (2009), Project Management Institute (2017)
Knowledge Management	Although Knowledge Management is carried out at the operational level, it may be directly associated with firms' strategic objectives when they consider investments in learning and innovation to be important.	Shuen, Feiler and Teece (2014), Garcia, Lessard and Singh (2014), Feiler and Teece (2014)

Source: Adapted from Gandra and Pinto Junior (2023)

Enhancing the coordination of activities and managing risks and uncertainties in a standardized and recurrent manner, firms develop their own (customized) processes, methodologies, and tools, generally supported by established "best practices." One widely used reference in the Upstream industry is the PMBOK Guide published by the Project Management Institute (2017), which presents a comprehensive set of project management processes.

According to the Project Management Institute (2017: 22), "project management processes are logically linked by the outputs they produce. Processes may contain overlapping activities that occur throughout the project. The output of a process generally results in one of the following: an input to another process, or a deliverable of the project or project phase."

This perspective clearly reinforces the key characteristics of organizational routines highlighted in Table 1: processual, standardized, triggered, and decomposed. It is also worth noting that a significant number of Upstream firms develop their own project management methodologies based on the PMBOK Guide.

Although the IDMM-UP has not been empirically tested in the present study, it was developed through the integration of academic research with technical and managerial literature documenting the governance practices adopted by capital-intensive industries. In particular, the model draws upon the Front-End Loading (FEL) and stage-gate literature, which demonstrates the widespread use of structured capital project governance systems to support investment decision-making. Motta et al. (2014), based on a survey of Brazilian companies in the oil and gas, mining, engineering, and construction sectors, found that 92% of mining and metals companies and 87% of oil and gas companies were familiar with the FEL methodology, while 60% of oil and gas companies actively applied it. Furthermore, 40% of respondents expressed full confidence in the methodology, and 50% considered it essential, in most cases, for aligning projects with corporate strategy (Motta et al., 2014: 406–407). Additional evidence indicates that major organizations—including Chevron, Shell, Petrobras,

Vale, Anglo Coal, Xstrata Coal, Equinor, and others—have implemented their own structured capital project governance systems based on stage-gate decision processes (Weijde, 2008; Motta et al., 2011, 2014; Aramayo et al., 2013). Consequently, although conceptual in nature, the IDMM-UP is grounded in well-established managerial practices and documented organizational processes used to improve project maturity, strategic alignment, coordination, and the management of risks and uncertainties in investment decision-making.

Furthermore, the conceptual development of the IDMM-UP was informed by the authors' combined more than 25 years of professional experience in the upstream oil and gas industry. This experience encompasses regulatory agencies, national oil companies (NOCs), international oil companies (IOCs) and independent operators. This broad professional background provided practical insights into the governance structures, portfolio management practices, and capital project decision-making processes adopted by different types of organizations operating under distinct regulatory and competitive environments.

Across these organizations, a common managerial principle emerges: the more robust, structured, and procedural the investment governance model, the greater the organization's ability to balance portfolio risks and expected returns. Rather than eliminating uncertainty, structured governance frameworks improve the quality, consistency, transparency, and traceability of investment decisions by establishing standardized decision gates, multidisciplinary reviews, portfolio governance mechanisms, and organizational learning processes. The IDMM-UP was designed to synthesize these recurring practices into an integrated conceptual model consistent with both the academic literature and observed industry practice.

VI. CONCLUSION

A substantial portion of the literature on organizational routines focuses on firms' operational and innovation-related aspects. References that link the application of routines to investment decision-making are relatively scarce.

Through the development of IDMM-UP, and in light of the multiple sources of risk and uncertainty, the contribution of this article is limited to clarifying that firms can also develop organizational routines or processes - standardized, triggered, and decomposed across strategic, tactical, and operational levels - in order to enhance coordination, control, and the reduction of risks and uncertainties, thereby increasing the predictability of investment decisions.

In other words, investment decisions in large capital assets are not as autonomous as commonly assumed in literature; rather, they also exhibit an endogenous component.

Furthermore, through a review of empirical studies, it was possible to demonstrate the application of six technical and managerial macroprocesses (higher-level routines) that influence decisions and investments. Naturally, firms take into consideration the characteristics of the environment in which they operate in order to develop customized routines and strategies aligned with their managerial profiles, capabilities, resources, and objectives. After all, firms are heterogeneous.

Finally, IDMM-UP considers that oil companies also possess organizational learning routines that generate dynamic capabilities, thereby enabling greater flexibility in resource allocation and strategic adaptation. However, the examination of this relationship in terms of generating differentiation and competitive advantages among firms was not explored in this study. It is therefore suggested that the application of IDMM-UP for this purpose warrants further investigation.

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VIII. APPENDIX 1 – DESCRIPTION OF THE ELEMENTS OF THE IDMM-UP

The variables mapped for construction of IDMM-UP were classified as external to the firm's boundary (exogenous) and internal to the firm's boundary (endogenous). The criterion adopted for this classification is the extent to which managers can influence each variable.

Within these variables, stocks or resources (referred to as capitals) were also identified, as well as portfolios of capital assets that define the state of the system at a given point in time. Additionally, information flows generated within the firm and those originating outside the firm - both of which condition investment decisions - were identified.

In the IDMM-UP, the flows resulting from decisions lead to changes in stock levels, in line with the principles established in the System Dynamics literature.

Considering only the Exploration and Production Development stages (excluding the Production stage), the stocks or capitals were subdivided as follows.

- **Organizational Capital**
  - CO01 – Strategic Managerial Decision-Making (representing the capabilities or knowledge that define the Governance and Strategic Management Model, aligned with the profile of decision-makers and the organizational culture that govern high-level organizational processes and routines at the strategic level).
  - CO02 – Exploration (representing the capabilities or knowledge that govern the processes and organizational routines required to discover and delineate economically viable petroleum potential at the operational level).
  - CO03 – Production Development (representing the capabilities or knowledge that govern the processes and organizational routines required to plan, execute, monitor, and deliver the projects necessary to exploit petroleum reserves at the operational level).
  - CO04 – Project Management Model (representing the capabilities or knowledge that govern the processes required to manage the investment project portfolio at the tactical level. In other words, the capabilities that govern the corporate capital project management framework, which, in this case, operates through a "stage-gated decision process" or "stage-gate process").
  - CO05 – Learning (representing the capabilities or knowledge that govern the processes required for generating learning and promoting changes in the management model and corporate processes that permeate all organizational levels, as well as for technological innovation).

- **Financial Capital**
  - CF01 – Exploration (representing the company's budget allocated to discovering and delineating economically viable petroleum potential at the operational level).
  - CF02 – Production Development (representing the company's budget allocated to planning, executing, monitoring, and delivering the projects required to exploit petroleum reserves at the operational level).
  - CF03 – Learning (representing the company's budget allocated to generating learning and promoting changes in the management model and corporate processes that permeate all organizational levels, as well as to technological innovation).
  - CF04 – Retained Earnings (representing the stock of financial resources retained within the company as a result of operational assets in the portfolio, which may, through strategic decisions, be reinvested).
- **Physical Capital**
  - CI01 – Exploration (representing the physical resources - such as machinery, equipment, facilities, and databases - used by the company to discover and delineate economically viable petroleum potential at the operational level).
  - CI02 – Production Development (representing the physical resources - such as machinery, equipment, facilities, and databases - used by the company to plan, execute, monitor, and deliver the projects required to exploit petroleum reserves at the operational level).
  - CI03 – Learning (representing the physical resources, machinery, equipment, databases, and facilities required to generate learning and promote changes in the management model and corporate processes that permeate all organizational levels, as well as to support technological innovation).
  -
- **Human Capital**
  - CH01 – Strategic Managerial Decision-Making (representing the Chief Executive Officer, Chief Financial Officer, Chief Operating Officers, and other executives responsible for defining Strategic Management and the Organizational Structure, in alignment with the profile of decision-makers and the organizational culture that govern high-level organizational processes and routines at the strategic level).
  - CH02 – Exploration (representing the company's human resources dedicated to discovering and delineating economically viable petroleum potential at the operational level).
  - CH03 – Production Development (representing the company's human resources responsible for planning, executing, monitoring, and delivering the projects required to exploit petroleum reserves at the operational level).
  - CH04 – Learning (representing the human resources required to generate learning and promote changes in the management model and corporate processes that permeate all organizational levels, as well as to support technological innovation).
  - CH05 – Shareholders (representing the set of individuals and organizations that hold shares in the corporation and become owners of a portion of the company according to the number of shares acquired).

- CH06 – Creditors (representing the set of individuals and organizations that finance the company's activities in exchange for remuneration through interest payments).
- CH07 – Board of Directors (representing external individuals appointed to collectively supervise the organization's activities and strategic decisions).
- Government (although not a form of Human Capital directly linked to the firm, it represents the institutional structure that requires the payment of taxes).

The capital asset portfolios, also considered as stocks, were subdivided as follows.

➔ PE01 – Exploration Portfolio (representing the portfolio of exploratory assets).
➔ PD01 – Production Development Portfolio (representing the portfolio of assets under production development).
➔ PP01 – Production Portfolio (representing the portfolio of producing assets).

In turn, IDMM-UP considers endogenous variables, representing the information flows generated within firms that affect decision-making, subdivided as follows. It should be noted that variables whose names end with the code "(e)" represent "estimates."

- **Organizational Variables**
  - VO01 – Operating Profits, resulting exclusively from the operation of the enterprise.
- **Exploration Variables**
  - VE01 – Risk Capital (e), representing the estimated expenditures required to drill an exploratory well.
  - VE02 – OOIP (e) and OGIP (e), representing the estimated Original Oil in Place (OOIP) and Original Gas in Place (OGIP) volumes.
  - VE03 – Probability of Exploratory Success (e), representing the estimated probability of discovering hydrocarbons in one or more reservoirs through the drilling of an exploratory well.
- **Production Development Variables**
  - VD01 – Weighted Average Cost of Capital – WACC (e), used to discount project cash flows.
  - VD02 – Oil and Gas Prices (e), since hydrocarbons possess different characteristics, they are priced according to their specific properties. When a specific pricing benchmark does not exist, companies generally adopt the prices of West Texas Intermediate (WTI) and Brent crude oil as reference.
  - VD03 – Reserves and Recoverable Volumes (e), representing estimates prepared by geologists, geophysicists, and engineers regarding the volumes that may be recovered.
  - VD04 – Engineering and HSE (e), covering conceptual, basic, and detailed engineering designs related to facilities, lifting systems, flow assurance, reservoirs, operability, and constructability, considering Health, Safety, and Environment (HSE) factors.
  - VD05 – Technical Solution (e), representing the technical solution to be adopted for the construction of the production system.
  - VD06 – Implementation Schedule(e), representing estimates of task durations, dependencies among activities, and the allocation of resources required for achieving project delivery targets, as defined by the project team.
  - VD07 – CAPEX (e), representing estimates of the investments or Capital Expenditures (CAPEX) required for the production system.

- VD08 – OPEX (e), representing estimates of the operational costs or Operational Expenditures (OPEX) associated with the production system.
- VD09 – Expenses (e) or overhead, representing estimates of expenditures not directly related to the company's productive activities, but which must nevertheless be allocated to the project.
- VD10 – Taxes (e), representing estimates of taxes levied on production and investments, as well as analyses of the most advantageous tax arrangements for the project (e.g., special tax regimes).
- VD11 – ABEX (e), representing estimates of the decommissioning costs associated with the production system.

IDMM-UP also considers exogenous variables (both national and international), representing the information flows generated outside the firm that influence decision-making. In addition to Porter Five Forces proposed by Michael E. Porter (1980), this broader model incorporates several other variables that may affect variables and decisions across all organizational levels - strategic, tactical, and operational - as exemplified below.

- **National-Level Variables**
  - VN01 – Socioeconomic Environment
  - VN02 – Institutional Environment
  - VN03 – Political Environment
  - VN04 – Regulatory Environment
  - VN05 – Taxation Aspects
  - VN06 – Environmental Aspects
  - VN07 – Local Infrastructure
  - VN08 – Local Financial and Capital Markets
  - VN09 – Local Suppliers
  - VN10 – Qualified Local Workforce
  - VN11 – Local Partnerships
  - VN12 – Gas Prices
- **International-Level Variables and Geopolitical Variables**
  - VI01 – Oil Prices
  - VI02 – International Relations
  - VI03 – Global Supply and Demand for Oil and Gas
  - VI04 – Substitute Products
  - VI05 – Competing Firms & New Entrants
  - VI06 – Global Suppliers
  - VI07 – Technological Advancement
  - VI08 – Global Financial & Capital Markets
  - VI09 – Global Interest Rates
  - VI10 – Globally Qualified Workforce
  - VI11 – Global Partnerships

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