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# SOCIO-TECHNICAL INERTIA, DYNAMIC CAPABILITIES AND ENVIRONMENTAL UNCERTAINTY: SENIOR MANAGEMENT VIEWS AND IMPLICATIONS FOR ORGANIZATIONAL TRANSFORMATION

*Research paper*

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## Abstract

*While IT can be seen as leveraging dynamic capabilities, it can also be considered as a core organizational capability for exploitation, and thus as a dimension of socio-technical inertia. This paper investigates the latter. When the environment becomes uncertain or when organizations engage in an organizational transformation, inertia or the propensity of an organization to continue its run on the same path is dangerous. Based on a survey with 108 senior managers, this paper investigates the relationships between three dynamic capabilities and Socio-Technical (ST) inertia. Results supports the general idea that the greater the capability to sense weak signals, to routinize experience of past transformations, and to reconfigure strategic resources, the lower the ST inertia. Moreover, the effect of reconfiguring is amplified with the uncertainty of the environment. Identification and understanding of particular contingencies such as firm size and industry can shed additional light on this phenomenon.*

*Keywords : Socio-Technical Inertia, Dynamic Capabilities, Environmental uncertainty, IS-enabled Organizational Transformation,*

## 1 Introduction

IT is often seen as playing an ambiguous role in supporting the need to innovate and transform, to continually adapt to its environment, meet new demands while also supporting operational excellence and efficiency. On the one hand, IT can be used to leverage dynamic capabilities (Pavlou and El Sawy, 2006, 2011; Mikalef and Pateli, 2016; Mikalef et al., 2016). For instance, digitization, Big data and analytics, Service oriented architectures and Enterprise Systems (ES) offer different digital options leading to greater organizational agility (Kharabe and Lyytinen, 2012; Trinh, 2015), a specific kind of dynamic capability allowing adaptation (Sambamurthy et al. 2003). On the other hand, ES standardize work practices in the company and are thus often seen as core organizational capabilities for daily operations. However, the search for operational excellence may hinder transformation and change. The high failure rate of transformation initiatives over the past years (Beer and Nohria 2000; Besson, 2010) raises questions about IS-enabled Organizational Transformation (ISOT) initiatives (Besson and Rowe, 2012). It may seem paradoxical that an ISOT initiative seeking to create a competitive advantage converts to a failure at the end, but the OT failure phenomenon can be explained by organizational inertia (Audzeyeva and Hudson 2015; Besson and Rowe 2012; Rumelt 1995) and the difficulty to quickly identify risks and new insights despite big data and analytics (Audzeyeva and Hudson 2015; Sharma et al. 2014). Organizational inertia can be defined as the propensity for an organization to continue its run on the same path (Besson and Rowe, 2011). More specifically, this paper views information systems as part of socio-technical inertia, which is arguably a central dimension of organizational inertia that should be of interest to IS researchers (Besson and Rowe, 2012). This paper investigates the relationships between three dynamic capabilities and Socio-Technical (ST) inertia. Results support the general idea that the greater the capability to sense weak signals, to routinize experience of past transformations, and to reconfigure strategic resources, the lower the ST inertia. The effect of reconfiguring is amplified with the uncertainty of the environment. This has implications because, when the environment becomes uncertain or when organizations engage in an organizational transformation, inertia can become dangerous. The paper is structured as follow. First, we introduce the literature focusing on the core concepts of Organizational Inertia and Dynamic Capabilities. Then, we explore the link between these dynamic capabilities and ST inertia, and develop models based on how environmental uncertainty moderates their relationships. Finally, we discuss the findings and their contributions to IS literature, more especially theoretical and managerial implications, followed by an outlook on future research.

# 2 Theoretical Background and Hypotheses

In the following section, we present two central concepts and related theories used to build our model: Organizational Inertia and Dynamic Capabilities. Besson and Rowe (2011) propose four thematic approaches to ISOT literature: 1) the nature of the transformation initiative, 2) the ecology of the transformation, 3) the transformation process, 4) transformation results and measurement. They underline three theoretical schools which stand out and can inform the discourse on ISOT: evolutionism, punctuated equilibrium and institutionalism. Those differ notably on three points: the ecology of the transformation, transformation process, and recommended strategy. Our study focuses on the ecology of the transformation including the concepts of organizational inertia and dynamic capabilities.

## 2.1 Organizational and Socio-Technical Inertia

"Structures of organizations have high organizational inertia when the speed of reorganization is much lower than the rate at which environmental conditions change" (Hannan and Freeman, 1984, p151). Organizational inertia does not negate change, but emphasizes a difficulty to change as fast as the environment requires. Originating from Newtonian physics the concept of inertia qualifies the tendency of an entity to maintain its speed on its current trajectory, if there is no friction. Organization entities can be conceived as sets organizational routines, which are behaviours that are learned, highly patterned and repetitious (Winter, 2003). Over time, routines complexify, they become sticky and create path dependencies (Nelson and Winter, 1982; Besson and Rowe, 2012) and are characterized by lack of plasticity or rigidity (Rumelt, 1993). In this vein, Miller (1994) defines inertia as the tendency of a company to maintain the guidelines adopted in the past (within the company). However, organizational inertia embodies a vital element, the base without which it would be difficult to build new assets and form competitive advantage. Organizational inertia is therefore ambivalent: from its roots in physics, the concept connotes the capacity to maintain its trajectory and efficiency in a stable environment, whereas routines stickiness underline that organizational inertia hinders the company's transformation capacity when the environment becomes uncertain. The literature differentiates several dimensions of organizational inertia. Rumelt (1994) identifies five sources of inertia: perception, motivation, creativity, political, cultural. Besson and Rowe (2011; 2012) conceptualize five types of inertia: socio-technical inertia (skills and systems), economic inertia, political inertia, psychological inertia and socio-cognitive inertia (or cultural). In this paper, we focus on ST inertia. Distinct from psychological inertia or resistance to change (Seddon et al. 2010), ST inertia refers to the dependence on socio-technical capabilities. These capabilities result from the interaction of the social system and the technical system and their joint optimization (Mumford, 2006). However, while socio-technical design tends to emphasize participation and agency (Mumford, 2006), the concept of ST inertia does not. ST inertia is nurtured through skills and systems and by their propensity to maintain their trajectory on the same path due to interactions between these two realms. ST inertia conceives agents as “embedded in socio-technical systems that have their own dynamics especially due to development time and internal consistency” (Besson and Rowe, 2012, p. 106). Typically, development language can create considerable ST inertia. It is both a property of human resources who master this language and of the software developed. If not properly documented and managed, such resources can trap organizations and make it extremely difficult to change (Lyytinen and Newman 2008; Schmid et al., 2016). Beyond some point of complexity, technology can even become uncontrollable and create a drift (Ciborra and Hanseth, 1998). Prior studies have described characteristics of socio-technical inertia (Lyytinen and Newman 2008; Pipek and Wulf 2009; Rezazade Mehrizi and Modol 2012). Rezazade Mehrizi and Modol (2012) have indeed determined nine types of ST attachments; they consider ST attachment as “a rather stable state of adhesion between social and technical elements that requires efforts for disconnecting them”. However, under this label they also include socio-cognitive inertia and other inertia dimensions that we do not consider in this paper. Systems agility and Enterprise Systems assimilation can promote organizational agility (arguably an antagonistic concept to organizational inertia), but much depends on Business competence in IT and on IT competence in Business (Kharabe et al., 2013).

## 2.2 Dynamic Capabilities

“A dynamic capability is a learned pattern of collective activity through which the organization systematically generates and modifies its operational routines in pursuit of improved effectiveness.” (Zollo and Winter, 2002, p.340). Dynamic capabilities can be conceptualized as higher-level routines, which are applicable to operational routines (Winter, 2003). The central argument of this paper is that dynamic capabilities can regulate and reconfigure lower-level capabilities and resources (id.) and hence reduce organizational inertia. While this directional association argument is directly derived from dynamic capability theory, it has not been formulated as such and tested in IS literature. Studies have been developed to test how dynamic capabilities influence functional competencies (Pavlou and El Sawy, 2006) and organizational agility (Trinh et al., 2012), but their effects on organizational inertia and ST inertia have not been published to the best of our knowledge. In addition, dynamic capability literature is growing but there is no strong consensus on what to select as a dynamic capability (Eriksson, 2013). In their seminal strategic management paper, Teece et al. (1997) outline dynamic capabilities as “the firm’s ability to integrate, build, and reconfigure internal and external competences to address rapidly changing environments”. Dynamic capabilities are composed by combinations of unique resources, including competencies, difficult to imitate, and that can provide a competitive advantage to the company in the future. Augier and Teece (2009) state that the dynamic capabilities include the ability to detect and seize new opportunities, to reconfigure and transform company skills and resources, to secure or to gain a competitive advantage. Sensing, seizing and reconfiguring capabilities formed a requirement to achieve change (Teece et al. 1997). Organizations need the capability to detect, then learn quickly and establish new strategic assets. For the respondents to the questionnaire whose results are reported in this paper, Besson and Rowe defined dynamic capabilities as “a structured and persistent collective action scheme that facilitates adaptation (reactive or proactive) of an organization to its environment." Literature presents several facets of dynamic capabilities and numerous capabilities denomination. For instance, Pavlou and El Sawy (2011) developed a research model of four dynamic capabilities addressing new product development processes: sensing, learning, integrating and coordinating, to which Mikalef and Pateli (2016) added reconfiguring. Because we want to assess our theorization from the viewpoint of senior managers, we retained three main dynamic capabilities relevant to strategic management literature when applied to business transformation: detection and interpretation of weak signals, routinization of experience, reconfiguring of assets. Teece (2011) defines these three elements as follows. The detection and interpretation capability (or sensing) is a set of capabilities allowing technological possibilities exploration, probing markets, listening to customers and scanning other business ecosystem components (Pavlou and El Sawy, 2006). This requires that company management should build and test hypotheses about technological change and market evolution while incorporating the recognition of latent demand. The routinization of experience capability refers to the organizational learning (Teece et al. 1997), i.e. the sharing knowledge – experience and absorption capacity (Pavlou and El Sawy, 2006), and to the ability to capitalize on experience (Winter, 2003) of business transformation, to create value. Reconfiguring capability refers to the capacity to execute a radical transformation, as also to periodically make adjustments and soften rigidities developed over the time from assets accumulation, standard operating procedures, and internal flow diversion. Moreover, assets of a company must be kept aligned to ensure better strategic adaptation: the company with the ecosystem, the structure with the strategy, assets with all of them (Teece, 2011). In sum, unlike certain conceptualizations, ours is both more directly applicable to business transformation, and addresses the routinization of routines, which is not so often the case in the empirical literature on dynamic capabilities.

## 2.3 Dynamic Capabilities and Organizational Inertia Interaction

Leonard-Barton (1992) explains how core capabilities change into core rigidities in a changing environment. Schreyögg and Kliesch-Eberl (2007) noted that recent talk in the field of strategic management support in general the idea of dynamic capabilities as to overcome possible rigidities of organizational capabilities. In their research, they imagine capabilities as being in a flux. They show conceptual contradictions between dynamization and original organizational strength. They resolve this contradiction by creating a new function, a monitoring capability. Huff et al. (1992) propose a four phases analysis to explore interactions between inertia and stress in a context of strategic renewal. Therefore, dynamic capabilities form a necessary condition for the achievement of organizational transformation. In this sense, dynamic capabilities allow to overcome organizational inertia. We conclude that literature presents two theoretical concepts, dynamic capabilities and organizational inertia, which are dynamically related and can thus be considered to illuminate top managers' perceptions in an ISOT context. However, to our knowledge, empirical research exploring the nature of these relations, these flux, their direction, their intensity, their reaction, is lacking. Therefore, this literature review confirms the strong importance of our central research question: to what extent can we empirically associate ST inertia with sensing, routinization of experience and reconfiguring? In addition, if ST inertia is relative to environmental uncertainty and if dynamic capabilities are particularly needed, how does environmental uncertainty moderate these relationships?

## 2.4 Modeling Hypotheses with environmental uncertainty

Following previous logic, the three dynamic capabilities considered should influence negatively ST inertia. Hence the formulation of H1, H4, and H7, below. In addition, according to dynamic capability theory, the more the environment becomes dynamic and uncertain, the more these capabilities should be developed (Teece, et al., 1997; Eisenhardt and Martin, 2000). Hence H2, H5, and H8, below. Environmental uncertainty has three components: dynamism itself (stability vs turbulence) characterizing change rates of innovation in production techniques and services as well as in client behaviour and needs, heterogeneity (complexity and dispersion) of resources and hostility of the of the environment (Karimi et al., 2004). In addition to previous hypotheses, we consider that greater environmental uncertainty amplifies the negative influence of dynamic capabilities on ST inertia (H3, H6, and H9), because, in such context, the difficulty of changing trajectory on operational (core) competencies (i.e. ST inertia) is greater with fewer or lack of dynamic capabilities. Finally, H10 follows from Hannan and Freeman's conception of inertia as a concept relative to the environment (cf. quote above). Hence the set of hypotheses: H1: Sensing influences ST inertia negatively. H2: Environmental uncertainty influences sensing positively. H3: Environmental uncertainty amplifies the negative effect of sensing on ST inertia. H4: Experience routinizing influences ST inertia negatively. H5: Environmental uncertainty influences experience routinizing positively. H6: Environmental uncertainty amplifies the negative effect of experience routinizing on ST inertia. H7: Reconfiguring influences ST inertia negatively. H8: Environmental uncertainty influences reconfiguring positively. H9: Environmental uncertainty amplifies the negative effect of reconfiguring on ST inertia. H10: Environmental uncertainty influences ST inertia positively.

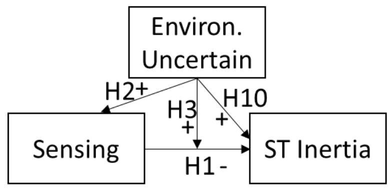


*Figure 1A – Model 1a (H1, H2) and model 1b (H1, H3, H10)*

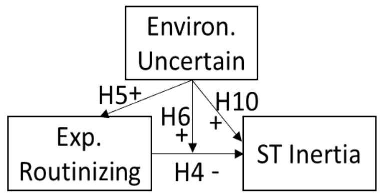


*Figure 1B – Model 2a (H4, H5) and model 2b (H4, H6, H10)*

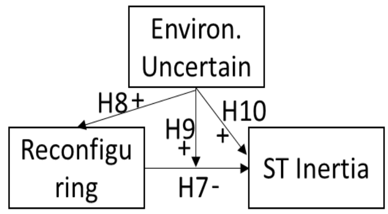


*Figure 1C – Model 3a (H7, H8) and model 3b (H7; H9, H10)*

# 3 Methodology

## 3.1 Research Design and Methods

To test our models, we conducted a survey built on constructs which were adapted from existing scales after a qualitative exploratory phase consisting of 20 interviews with top managers and three rounds of discussion with SYNTEC, the Board of the Association for Consultants in Management in France. Afterwards, questionnaire was reviewed by three academics. Then, the questionnaire was pretested with two CEOs to ensure questions would be received and understood in the same way. The unit of analysis is the business unit in which the respondent has a senior management role (belonging to its executive committee or reporting directly to it).

### 3.1.1 Operationalization of Constructs

The scales we used for most constructs were adapted (Dynamic Capabilities) or borrowed from established ones (Environmental Uncertainty). However, one scale has been developed for this study (ST Inertia). For all constructs the vast majority of items were measured on a Likert scale. All questions relating to these items measure a degree of agreement in relation to a statement. The chosen scale has six response options, prohibiting response "between the two." The scale offers two degrees of agreement, two of disagreement, an option "Do not know" and another one "Not concerned." Other items fit on nominal scales (frequency, length), or ratio scales. A structured coding scheme was generated: "No Answer", "Don't Know" and "Not Applicable" responses have been distinguished clearly and codified separately. However, these answers were not giving any information in the measurement of items. Therefore, these codes have been treated as missing data.

Most existing inertia scales were unsatisfactory. Polites and Karahanna (2012) highlighted inertia scales inadequateness and developed a nine-item scale at an individual level. Our level is organizational. Our ST Inertia construct was adapted from sub-concepts of Human Resources (HR) Competencies (Adner and Helfat 2003; Prahalad and Hamel 1990; Scarbrough 1998), Organizational Processes (Leonard-Barton 1992; Teece 2007), and Information Systems infrastructure flexibility (Duncan 1995; Raymond et al., 2014) which all emphasized the difficulty to change or lack of flexibility in response to changes in the internal or external environment. Dynamic Capabilities are independent variables. Sensing (8 items) was built mostly based on items derived from Teece (2007) and Nonaka (1988), routinizing of experience (6 items) was mostly built from Zollo and Winter (2002), whereas reconfiguring came from Teece (2007) and Helfat and Peteraf (2003) (7 items). To measure environmental uncertainty, we adapted Karimi et al. (2004) scale and its three sub-constructs: environmental dynamism (4 items), hostility (2 items) and heterogeneity (2 items). Following suggestions from the extant literature on organizational agility (Kharabe and Lyytinen 2012; Liang et al. 2007; Tallon and Pinsonneault 2011) we controlled for three variables: industry type of the business unit; firm size; age of the firm.

### 3.1.2 Instrument Development

We developed a scale for ST inertia following MacKenzie et al. (2011) six steps procedures. To develop a conceptual definition of the construct of ST inertia, we made an extensive literature review within IS journals and beyond the IS field. As mentioned by MacKenzie et al. (2011), constructs are not intrinsically reflective or formative. We followed the specifying formative constructs in IS research guideline developed by Petter et al. (2007) which identifies pitfalls to avoid in building constructs and exposes different steps to assess and analyse formative constructs. According to Petter et al. (2007) and Jarvis et al. (2003), four criteria help to identify if a construct is reflective or formative. First, in our research, items define constructs therefore they are formative. The second criterion is interchangeability of the measures. Changes in these constructs do not imply modification in the measures and changes in the measures alter constructs. It means that our measures are not interchangeable. We can illustrate this by dropping some indicators which will modify the construct conceptual boundary. The third criterion is relative to co-variation among indicators. With formative constructs, items should not co-vary with each other. We checked strong correlations to avoid multi-collinearity. Finally, as noted by Petter et al. (2007, p.634), "formative constructs are composites or indices that are made up of measures that may be very different; thus, it is not necessary for the measures to have the same antecedents and consequences". For example, regarding ST inertia, the reasons explaining the difficulty to reconfigure organization processes to core business, in order to meet the transformation imperatives coming from its environment, may differ from the reasons that are causing a lack of IS flexibility that could allow efficient integration of IS with other systems during operations like mergers or acquisitions. Based on these analyses, we defined the concept of ST inertia as an organization tendency to continue its run on the same technical and socio-technical path. In the next step, we generated an initial set of items that fully embodies the conceptual domain of our construct and we filled those items in three sub-constructs: HR competencies, organizational processes and information systems. Theory based confrontation of construct indicators was assessed to evaluate content validity. To assess construct validity, we made a principal components analysis and examined weightings for measures. Most scientific studies assess reliability respecting Cronbach's alpha criteria and show uni-dimensional construct based on multi-item scale's internal consistency (Esposito Vinzi et al. 2010). In our study, Cronbach's alpha for each construct were acceptable regarding Nunnally and Bernstein (1994) criteria except reconfiguring construct: ST inertia (0.763), sensing (0.768), routinizing of experience (0.818), reconfiguring (0.605), environmental uncertainty (0.746). Low Cronbach's alpha was due to multi-dimensional formative construct. Therefore, to evaluate reliability, we examined multicollinearity to determine an acceptable level of variance inflation factor (VIF) as recommended by Diamantopoulos and Siguaw (2006). Then, we formally specified the measurement model as a formative first order construct in accordance to Petter et al. (2007) guidelines. Data were collected and a pre-test was done on a small sample. We analyzed formative constructs through a components-based structural equation modeling with XLSTAT (PLS-PM) to evaluate model's fit via weights assessment, R2 values, reliability and validity.

## 3.2 Data Collection

Because of the sensitivity of these issues, data collection was primarily done face to face in spring 2013 by the first two authors in France, the second author having specific access to the pharmaceutical industry and to top managers. To augment data collection, at the same time, a link to the web-survey was e-mailed to CEOs, CIOs, CHROs and senior managers in Europe. Respondents were assured of complete confidentiality. 107 returned questionnaires were acceptable. Over the 107 questionnaires, 36 were administered in English and 72 in French. All data treatments were performed using Addinsoft software XLSTAT 2016.

| Industry type of the business unit | | | Firm size | | | Age of the firm | | |
|---|---|---|---|---|---|---|---|---|
| | Frequency | % | | Frequency | % | | Frequency | % |
| Pharmaceutical industries | 29 | 27.1 | 1-499 employees | 4 | 3.7 | Unknown | 8 | 7.5 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Others industries | 78 | 72.9 | 500-4999 employees | 35 | 32.7 | 5- years | 3 | 2.8 |
| | | | 5000+ employees | 68 | 63.6 | 5-10 years | 6 | 5.6 |
| | | | | | | 11-20 years | 12 | 11.2 |
| | | | | | | 21-30 years | 5 | 4.7 |
| | | | | | | 31-50 years | 14 | 13.1 |
| | | | | | | 50+ years | 59 | 55.1 |
| Total | 107 | 100 | | 107 | 100 | | 107 | 100 |

*Table 1. Control variables*

### 3.3 Measurement Model and Structural Analyses

Data were screened to identify possible outliers. Missing data were treated with MCMM (Markov Chain Monte Carlo) method. Good to very good Kaiser-Meyer-Olkin (KMO) scores (sensing: 0.780, routinizing: 0.818, reconfiguring: 0.721, environmental uncertainty: 0.710, ST Inertia: 0.757) and significant Bartlett's tests enabled factor analysis. Once we validated formative constructs, we prepared the formative constructs analysis through a PLS components based structural equation modeling analysis. To assess models, we focused on weights analysis, avoiding loadings, and examine R2 as recommended by Chin (1998). Structural equation models were elaborated in XLSTAT – PLSPM in compliance with our models presented in Figure 1. We checked the Robustness of models using a Bootstrap procedure (400 replications) to ensure the robustness and stability of the results. Final models were tested and indices modification checked. Goodness-of-Fit (GoF) represents geometric mean of average communality and mean R2 and it can be interpreted similarly to the R2 index (Tenenhaus et al. 2004). In other words, GoF enables to assess simultaneously measurement models and structural models. Final models had good to excellent GoF. GoF External Model refers to performance of measurement model linked to communalities, how items are linked to their latent variables (LV). GoF internal model presents performance of structural model combined to R2 of endogenous LV, and shows the relationships among LV. A 0.906 GoF score means that the model is able to take in account 90.6% of the achievable fit (Tenenhaus et al. 2004). Henseler and Sarstedt (2012, 2017) challenged the GoF as a goodness-of-fit criterion for PLS-SEM and suggested to follow different steps to evaluate Structural Model, which we did. Notably we have checked other values such as Q2 indicator to assess predictive validity of PLS models. Chin (2010) recommends a Q2 value higher than 0.5 to be considered as a predictive model, a prediction of greater relevance noted by Akter et al. (2011).

| | GoF Internal Model | GoF External Model | $Q^2$ |
|---|---|---|---|
| Model 1<br>Sensing Negatively Impacts ST Inertia | 0.803 | 0.711 | 0.605 |
| Model 2<br>Experience Routinizing Negatively Impacts ST Inertia | 0.832 | 0.702 | 0.559 |
| Model 3<br>Reconfiguring Negatively Impacts ST Inertia | 0.816 | 0.739 | 0.603 |

*Table 2. Models fit and predictive relevance*

## 4 Findings

For each dependent variable, we first ran a partial model without the interaction variable with the moderator (i.e. with only the direct effect of environmental turbulence). Excellent GoF scores were obtained for these partial models (from 0.803 to 0.964 for internal models and from 0.711 to 0.902 for external models). For H1, H2, H4, H5, H7, H8 respective Path Coefficients ranged from 0.3 to 0.6 and were all significant at p<0.001 level. This supported that systematically ST inertia and dynamic capabilities were negatively associated. However, H8 was rejected. In fact, the opposite hypothesis to H8 was supported: Environmental uncertainty and reconfiguring are negatively related. Our interpretation is that too much uncertainty can hinder the development of capabilities for reallocating rare resources and slow down the execution of an adapted strategy. We then ran the full model with moderators so that we could conclude on all hypotheses.

## 4.1 Sensing

Sensing influences ST inertia negatively (corr. -0.449; PC: -0.368; CR: -2.421). The more sensing capabilities increase, the more ST Inertia weakens. The higher environmental uncertainty, the more sensing capabilities are developed (corr.: 0.544; PC: 0.544; CR: 2.842). When adding the interaction variable with the moderator, the explained variance of ST inertia increased from R2 0.293 (CR: 4.394) to 0.621 (CR: 20.842). Path Coefficient for H1 became much lower, slightly significant, and kept the same signs than without the moderator. The correlation between environmental uncertainty and the relation Sensing-ST Inertia is high (corr. 0.823), but not significant (CR: 1.272). Overall, this brings strong support for H1 and tends to invalidate H3. In a general manner, considering the tests with and without the moderator, we consider that H1 and H2 are supported, and not H3.

| Latent Variable | Value (Path Coefficient) | Value (Path Coefficient Bootstrap) | Standard Error (Bootstrap) | Critical Ratio (CR) | Lower Bound (95%) | Upper Bound (95%) |
|---|---|---|---|---|---|---|
| Sensing | -0,275 | -0,175 | 0,181 | -1,520 | -0,309 | 0,270 |
| Environmental Uncertainty | 0,165 | 0,123 | 0,198 | 0,835 | -0,286 | 0,282 |
| Firm age | 0,121 | 0,128 | 0,062 | 1,939 | -0,085 | 0,225 |
| Firm size | 0,107 | 0,102 | 0,068 | 1,578 | -0,124 | 0,202 |
| Industry type | -0,086 | -0,095 | 0,092 | -0,928 | -0,205 | 0,150 |
| Interaction | 0,457 | 0,289 | 0,360 | 1,272 | -0,512 | 0,520 |

*Table 3. Path Coefficients Sensing / ST Inertia*

## 4.2 Experience Routinizing

Experience routinizing influences ST inertia negatively (corr.: -0.487, PC: -0.173) with a significant Critical Ratio (CR: -2.305). Therefore, the more experience routinizing capabilities increase, the more ST Inertia weakens. The higher environmental uncertainty, the more experience routinizing capabilities are developed (corr.: 0.546; PC: 0.546; CR: 1.732). When adding the interaction variable with the moderator the explained variance of ST inertia increases from R2 0.314 (CR: 4.265) to 0.556 (CR: 11.040). Path Coefficient for H4 (-0.173) became much lower and still significant (CR: -2.305) keeping the same sign than without the moderator. Environmental uncertainty is correlated to the relation Routinizing-ST Inertia but it is not significant (corr.: -0.712; CR: -1.094). This tends to invalidate H6. In a general way, considering the tests with and without the moderator, we consider that H4 and H5 are supported, and not H6.

| Latent Variable | Value (Path Coefficient) | Value (Path Coefficient Bootstrap) | Standard Error (Bootstrap) | Critical Ratio (CR) | Lower Bound (95%) | Upper Bound (95%) |
|---|---|---|---|---|---|---|
| Routinizing | -0,173 | -0,126 | 0,075 | -2,305 | -0,254 | 0,052 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Environmental Uncertainty | 0,101 | 0,106 | 0,092 | 1,090 | -0,123 | 0,249 |
| Firm age | 0,186 | 0,139 | 0,090 | 2,066 | -0,082 | 0,300 |
| Firm size | 0,190 | 0,133 | 0,087 | 2,174 | -0,034 | 0,285 |
| Industry type | 0,077 | 0,026 | 0,073 | 1,055 | -0,105 | 0,170 |
| Interaction | -0,478 | -0,445 | 0,437 | -1,094 | -0,779 | 0,724 |

*Table 4. Path Coefficients Routinizing of Experience / ST Inertia*

## 4.3 Reconfiguring

Reconfiguring influences ST inertia negatively (corr.: -0.532; PC: -0.432) with a significant Critical Ratio (CR: -5.194). Therefore, the more reconfiguring capabilities increase, the more ST Inertia weakens. Reconfiguring is also negatively associated with environmental uncertainty (corr.: -0.632; PC: -0.632). Thus, H8 is not supported. When adding the interaction variable with the moderator the explained variance of ST inertia increases from R2 0.381 (CR: 6.171) to 0.625 (CR: 17.483). Path Coefficient for H7 (-0.432) became much lower, stayed significant (-3.217), and kept the same sign than without the moderator. The environmental uncertainty is correlated to the relation reconfiguring-ST Inertia and it is significant (corr.: 0.827; PC: 0.405; CR: 2.317). This moderation contributes up to 53.558% of R2 (R2: 0.625). This tends to validate H9. Combining tests with and without the moderator suggests that there is a strong interaction effect amplifying the negative effect of reconfiguring on ST Inertia. Consequently, considering the tests with and without the moderator, we consider that H7 and H9 are supported, and not H8. We also note that industry sector also has a very significant impact, the pharmaceutical industry having less developed reconfiguring capabilities.

| Latent Variable | Value (Path Coefficient) | Value (Path Coefficient Bootstrap) | Standard Error (Bootstrap) | Critical Ratio (CR) | Lower Bound (95%) | Upper Bound (95%) |
|---|---|---|---|---|---|---|
| Reconfiguring | -0,279 | -0,250 | 0,087 | -3,217 | -0,314 | 0,194 |
| Environmental Uncertainty | 0,166 | 0,199 | 0,097 | 1,709 | -0,223 | 0,269 |
| Interaction | 0,405 | 0,386 | 0,175 | 2,317 | -0,425 | 0,479 |
| Firm age | 0,104 | 0,100 | 0,062 | 1,662 | -0,089 | 0,196 |
| Firm size | 0,153 | 0,149 | 0,042 | 3,686 | 0,065 | 0,229 |
| Industry type | -0,046 | -0,031 | 0,101 | -0,459 | -0,172 | 0,160 |

*Table 5. Path Coefficients Reconfiguring / ST Inertia*

## 4.4 Environmental uncertainty is a strong moderator

We tested the ST Inertia and environmental uncertainty relationship. In the first model (1b) environmental uncertainty influences positively ST Inertia (corr.: 0.297; PC: 0.165), but it is not significant (CR: 0.835). In our second model (2b), there is also a positive association (corr.: 0.411; PC: 0.050) but it is not significant (CR: 0.562). Our third model presents a similar result, except it is significant (corr.: 0.340; PC: 0.166; CR: 1.709) bringing support for H10/3b. In that case, the more environmental uncertainty increases, the more ST Inertia increases. Finally, we tested a complete model with the three dynamics capabilities and their link to ST Inertia (R2 =0.7). Notably we identified clearly a strong and significant impact of environmental uncertainty as a moderator with sensing (corr.: 0.733; PC: 0.402; CR: 1.679) and routinizing (corr.: -0.737; PC: -0.332; CR: -2.895), and at a lesser but significant impact with reconfiguring (corr.: -0.543; PC: -0.064; CR: -1.635). All hypotheses were significant and supported, including direct effect of environmental uncertainty over ST Inertia, except H1.

# 5 Discussion

In this paper, we define ST inertia as the propensity to continue its run on the same path due to the difficulty to change socio-technical systems as quickly as environment changes. Our findings support the general idea that the greater the capability to sense weak signals, to routinize experience of past transformations, and to reconfigure strategic resources, the lower the ST inertia. These relationships are all the more important and have significant implications when the transformation of firms happen in an uncertain environment. Our results offer some empirical and theoretical contributions, notably to dynamic capabilities theory. In the partial model, i.e. without considering the interaction effects between ST inertia and environmental uncertainty, all hypotheses were validated, except for H8. In fact, our hypotheses were primarily developed from the theoretical literature on dynamic capabilities, which is still very normative and lacks evidence. This theory suggests that the more the environment becomes dynamic and uncertain, the more these capabilities should be developed (Teece et al., 1997; Eisenhardt and Martin, 2000). But while they theoretically should, do they really? Whereas this reasoning seems to hold for sensing and experience routinizing, this does not hold for reconfiguring. Our interpretation of the latter result (i.e. that when uncertainty is high, it becomes much harder to develop capabilities for reallocating rare resources and executing an adapted strategy) indicates that decision-making in transformational situations, or decisional agility is probably more difficult to achieve than perception of weak signals or knowledge capitalization in these contexts. This finding needs further testing and might only be valid in countries characterized with high risk avoidance culture, like France. Another contribution to dynamic capabilities perspective is the amplifying effect of this uncertainty on the relationship between reconfiguring and ST inertia which tends to offset the direct effect of environmental uncertainty on ST inertia. We hypothesized that in highly uncertain contexts, the difficulty of changing trajectory on operational (core) competencies and resources was even more associated than in less uncertain contexts with fewer or lack of reconfiguring capabilities. Thus, even though as demonstrated by Kharabe and Lyytinen (2012) Enterprise System might rather promote rather than hinder agility from business and IT executives' viewpoint, what really matters might be the perception of top managers of ST inertia and reconfiguring capabilities, which, as perceived by our instrument, are somehow different and important when having in mind transformation situations. Trinh (2015) finds that when implemented correctly, ES-enabled sensing and ES-enabled responding systems promote organizational agility. However, when looking both at the viewpoint of top managers, whose majority is not from IS, as we did in this paper, it is not evident that socio-technical systems are changing trajectory.

## 5.1 Limitations, Implications and Future Research

This research has several limitations. First, our models develop a theoretical causal reasoning of directional associations. From a methodological standpoint, we measure perceptions and infer correlations. Our theorization and methodology does not offer a causal evidence from a precise chain of events or a causal mechanism for why this is so. Ideally, to demonstrate the directional aspects of the associations, longitudinal studies of a panel of firms would be needed, but collecting data from top managers and the sensitivity of measurement of transformational issues over time, would make this very difficult. Some complementary case studies could also shed some light on the relationships we studied. This would enable to discover some causal mechanisms or conditions explaining the relationships we have surfaced. Conceptually, when we measure difficulty to change core competencies and difficulty of processes and systems to evolve as a proxy to organizational inertia, we are not strictly speaking measuring if the organization is running on the same path. In fact, if it faces such difficulties, it may nevertheless exhibit a change behaviour, even if it is unlikely. Our findings related to reconfiguration show that the relationship between strategic transformational intent, environmental uncertainty, organizational inertia and behaviour of top management needs further clarification. More research on reconfiguration and transformational decision-making is needed (Sharma et al. 2014). We focused on ST inertia because it is obviously embedding IS-related resources, but in a perspective reflecting organizational complexity, it might be important to consider other dimensions of organizational inertia, such as economic inertia or political inertia, how they interact with ST inertia and how they are jointly affected by dynamic capabilities.

Moreover, in an era of digital transformation (Schmid et al., 2016) future research should also consider IT-leveraging capabilities (Pavlou and El Sawy, 2011; Mikalef et al. 2016) and not consider only IS as a component of ST inertia, and thus reach a more balanced view regarding the role of IS or IT.

From a practical viewpoint, complementary evidence obtained from the open questions but not reported in the results above, and particularly on the pharmaceutical industry, illustrate that these organizations experience high ST inertia, and how with some IT-leveraging dynamic capabilities, such as sensing, results improve, but too slowly. Typically, they move from product-centric IS to customer-centric IS. They improve their IT infrastructure and create Business Intelligence (BI) departments to perform big data analysis. However, insights produced by their BI departments are not recognized by other structures in the organization. In this industry Sharma et al. (2014, p. 437)'s statement applies : « insight-generation and decision-making processes associated with the use of business analytics often do not involve key stakeholders from functional areas who will be responsible for implementing those decisions (Shanks et al, 2010; Shanks and Sharma, 2011). » We might interpret this as an interaction effect of political inertia and ST inertia. In an uncertain environment, while the information systems component as well as IT leveraging sensing capabilities may reduce ST inertia, these effects are counteracted by political inertia and possibly by the competence component of ST inertia, which may hinder business transformation. In other words, while sensing can be improved by big data analytics, it reduces ST inertia, but not in a drastic way, and not as rapidly as novel insights are produced. In absorptive capacity language, there is identification of new knowledge but insufficient assimilation and corresponding decisions at the firm level.

# 6 Conclusion

Socio-Technical inertia and dynamic capabilities, are conceptual lenses that are related (Schreyögg and Kliesch-Eberl 2007), yet they represent different order of routines (Winter, 2003). As predicted by dynamic capability theory, environmental uncertainty influences these capabilities. An empirical contribution of this paper is to show that the effects of reconfiguration capability should not be examined like those of the learning (sensing and experience routinizing) capabilities. A better understanding of these relationships, informed by top manager's viewpoints who are sensitive to deep change and transformation is important. It is all the more important when IS is a component of ISOT initiatives, but also because IS and enterprise systems are becoming the backbone of organizations and thus a major component of organizational inertia.

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# Appendix A - Constructs and Items

| C[1] | Item | M.O.[1] | T[2] |
|---|---|---|---|
| STI | **HR Competencies** | | |
| STI | HRC1- It is/would be difficult to upgrade our staff's competencies related to changes in our core[3] business. | (Prahalad and Hamel 1990) | V |
| STI | HRC2- Because of inertia in our company's positioning on the market, it is or would be difficult for our staff's competencies to gain in market value when they are asked to evolve in line with changes in our core business. | (Rumelt 1995)(Burgelman 2002) | V |
| STI | HRC3- It is/would be difficult to recruit human resources with new competencies in response to changes in our core business. | (Adner and Helfat 2003) | V |
| STI | HRC4- Once recruited, it is/would be difficult to integrate new skills with a view to transforming our core business. | | V |
| STI | HRC5- It is/would be difficult to separate the company from human resources that have competencies related to our core business because of the rigidity of the labor market | (Scarbrough 1998) | V |
| STI | HRC6- It is/would be difficult to separate the company from human resources that have competencies related to our core business because of the social responsibility towards loyal employees | (Adner and Helfat 2003) | MD |
| STI | **Organizational Processes** | | |
| STI | OP1- It is difficult to reconfigure our processes related to our core business to meet the transformation imperatives coming from our environment. | From qualitative phase | V |
| STI | OP2- Our process efficiency is unstable when we must meet the transformation imperatives coming from our environment (e.g. regulation) related to our core business. | (Leonard-Barton 1992) | V |
| STI | **Information Systems** | | |
| STI | IS1- The information system of our core business is still based on proprietary software rather than commercial packages and standards. | Duncan 1995) | V |
| STI | IS2- The architecture of the applications of our information system (IS) is not modular enough to allow major evolution of IS in our company. | | V |
| STI | IS3- The architecture of our information system (IS) is not flexible enough to allow efficient integration of our IS with other systems during mergers, sales or groupings. | | V |
| STI | IS4- It is difficult to integrate the information system of our core activities with that of other companies. | From qualitative phase | V |
| DC | **Sensing** | | |
| DC | SEN1- Our company is very capable of sensing weak signals related to new products or services outside of the economic sector in which it is positioned. | (Teece 2007) | V |
| DC | SEN2- Our company dialogues constructively with suppliers to foster innovation. | | V |
| DC | SEN3- Our company is very capable of sensing weak signals coming from our clients' and the needs they express and strategizing these signals. | | V |
| DC | SEN4- We encourage confrontations of ideas among a large portion of the general management team to solve problems caused by weak signals. | From qualitative phase | V |
| DC | SEN5- We encourage confrontations of ideas among a large portion of the general management team and middle management to solve problems caused by weak signals. | (Nonaka 1988) | V |
| DC | SEN6- Our competitive intelligence service provides information that lets us launch new products/services. | From qualitative phase | V |
| DC | SEN7- Our middle management proposes ideas that let us launch new products/services. | (Nonaka 1988) | V |
| DC | SEN8- Our use of consulting firms generates ideas that let us launch new products/services. | From qualitative phase | V |
| DC | **Routinizing experience** | | |
| DC | RTE1- The General Management committee capitalizes on experience acquired after each transformation experience at our company. | From qualitative phase | V |
| DC | RTE2- The General Management committee shares most of the feedback on this experience with middle management at dedicated meetings or management conventions. | | V |
| DC | RTE3- We learn from our strategic initiatives by systematically improving our procedures in this area. | (Zollo and Winter 2002) | MC |
| DC | RTE4- We develop procedures to capitalize on our experience of integrating companies. | | V |

| | | | |
|---|---|---|---|
| | RTE5- Experience in carrying out transformations is an important selection criterion for executives at our company. | | V |
| | RTE6- Our company systematically trains high potential employees in how to execute transformations. | From consulting association | V |
| | **Reconfiguring** | | |
| | REC1- General Management Committee members use consulting firms opportunely to design and implement new business models that help our company. | From qualitative phase | V |
| | REC2- When opportunities to launch a strategic initiative arise, General Management Committee members identify the main organizational changes required. | | V |
| | REC3- General Management Committee members find it difficult to step outside the boundaries of their functions/business. | | V |
| | REC4- When Management decides to launch a strategic initiative, deployment happens quickly at our company. | | V |
| | REC5- When Management decides to launch a strategic initiative, important resources are quickly reallocated at our company. | (Helfat and Peteraf 2003) | V |
| | REC6- During recent strategic initiatives implemented at our organization, General Management demonstrated a real capacity to stick with its objectives, even if it often had to adjust. | From qualitative phase | V |
| | REC7- How often did General Management actively participate in steering the implementation of the last few strategic initiatives? | | V |
| Env. Unc. | **Environmental dynamism** | | |
| | EED1- Your competitive environment has become far more unpredictable | (Karimi et al. 2004) | V |
| | EED2- Clients' tastes and preferences in your main economic sectors have become far more unstable. | | V |
| | EED3- The innovation rate for new operational processes and new products and/or services in your main sector has increased considerably. | | V |
| | EED4- Your principal economic sector's downswings and upswings have become far more unpredictable. | | V |
| | **Hostility** | | |
| | EHO1- Your competitive environment has become far more hostile. | (Karimi et al. 2004) | V |
| | EHO2- Multidimensional competition (prices, supply chain, talent, services, image, reputation) threatens your company's survival. | | V |
| | **Heterogeneity** | | |
| | EHE1- Diversity in your production/service methods required to deal effectively with your various clients has increased considerably. | (Karimi et al. 2004) | V |
| | EHE2- Diversity in your marketing tactics required to deal effectively with your various clients has increased considerably. | | V |

[1] C.: Construct; M.O.: Main origin

[2] T.: treatment; V: validated; MD: deleted for Missing Data rate too high; MC: deleted for multi collinearity too high

[3] The core activities of the company are defined as its domain of strategic activities