Coping With Technological Shifts: Organizational Actions to Adapt IT Infrastructures

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Information technology infrastructures (ITI)—arrangements of shared IT services and technical components that support an organization's strategy and processes—are vital to organizations. They play key strategic roles, which are at the core of the business operations and impact performance. However, technological shifts are major threats to any organizations' ITI. To cope with technological shifts, organizations must sense technological evolutions, seize the related opportunities, and transform their ITI, simply put it, they must become agile. Still, the question for practitioners is: What actions should be deployed to build organizational agility to cope with technological shifts and adapt their ITI? Twenty organizational actions were identified by 29 ITI experts that were grouped into three interrelated vectors: 1) Nurturing proactive technological culture, mindset, and competencies; 2) Codesigning enterprise architecture; and 3) Piloting the ITI. These actions should help organizations become more agile, while guiding practitioners in evolving and adapting their ITI.

> "TECHNOLOGY SHIFTS ARE AMONG THE MOST LETHAL THREATS TO ANY SUCCESSFUL BUSINESS."[1]

This quotation sums up one of the main concerns of practitioners who must maintain and evolve their information technology infrastructure (ITI) while simultaneously coping with the effects of relentless and uncertain technological shifts.[2] It is even more of concern as ITI are "the heart of almost every enterprise [p. 1]."[3] Indeed, as an arrangement of shared information technology (IT) services and technical components (e.g., platform, networks and communication, data, applications), ITI enable competitive performance and helps organizations generate strategic advantages and organizational value.[4] As the pace and scope of technological evolutions are increasing in today's world, organizations have to respond swiftly to the opportunities resulting from these technological shifts, while mitigating the associated threats and transforming their ITI.[5]

Yet, ITI maintenance and evolution are a complex and perpetual work in progress. Practitioners must become tightrope walkers to find the right balance between streamlining and expanding their ITI; between exploiting, maintaining, and stabilizing their existing ITI and identifying, and integrating new ITI components; between short-term and long-term ITI requirements; between limiting spending and maximizing ITI efficiency.[6,7]

Practitioners must therefore develop the ability to acquire, deploy, integrate, reconfigure, and transform their ITI.[7, 8] Organizations must sense, seize, and transform the underlying opportunities and threats of technological shifts through their dynamic capabilities—an organization's capacity to sense opportunities and threats, seize opportunities, and maintain competitiveness by reconfiguring its intangible and tangible assets.[9] In terms of ITI, such capabilities reflect how an organization integrates, builds, and reconfigures its

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competences, processes, and practices to manage the evolution of its ITI.[8]

Given that dynamic capabilities are generated through clusters of organizational actions (OAs) working jointly,[10] organizations must have series of strategies, processes, and practices in place to help practitioners establishing an organizational agility to cope with technological shifts.[11] Yet, what is lacking is a clear understanding of these OAs. The question for practitioners is: What actions should be deployed to develop organizational agility to cope with technological shifts and adapt their ITI? Based on a Delphi study, 29 ITI experts identified 20 OAs (best practices).

COPING WITH TECHNOLOGICAL SHIFTS

Nowadays, organizations are evolving in turbulent business environments. Regarding technological shifts, the main challenge for organizations is to have an ITI that matches both the actual and future organizational needs, i.e., an ITI reliable for today's operations, and open for tomorrow's changes. To do so, organizations must build their organizational agility—the "ability to take some action based on external stimuli (p. 215)."[12] Thus, agility should not be seen as a set of principles or values, but rather a capability to react to external events that affect the functioning of an organization. Four categories of organizational agility enablers have been identified[12]:

1) *technological*, i.e., key properties of ITI resources (hardware, software, and networks);
2) *behavioral*, i.e., management practices;
3) *organizational/structural*, i.e., the high-level issues and decision-making regarding orientation, architecture selection, degree of centralization, etc. and;
4) *environmental*, i.e., contextual factors which affect and shape organizational agility.

The essence of these organizational agility enablers is captured by the concept of dynamic capability that represents an organization's ability to reconfigure its resources, practices, and processes in order to respond to changing environmental conditions.[13] In terms of ITI, such dynamic capability represents an organization's ability to sense technological evolution, respond to the underlying opportunities and threats and transform its ITI accordingly.[7] ITI should provide the foundation for the integration and exploitation of new emerging technologies as well as for further digitalization of an organization's strategic initiatives.[13]

While previous studies have highlighted the impact that dynamic ITI capabilities have on organizational agility, explanations regarding how, in terms of processes, practices, and strategies, these capabilities are enacted are scarce. In addition, research on the "capabilities that enable firms to be agile is still nascent" [p. 22].[8] Thus, the identification of the OAs by which dynamic ITI capabilities are enacted is essential to guide practitioners in forging organizational agility suited to cope with technological shifts. We conducted a Delphi study with 29 experienced ITI experts (average of 24 years of experience) who identified best practices to cope with technological shifts.[14] These best practices provide a complementary perspective to the practices identified in standards such as ITL 4 and ISO/IEC-20000.

OAs AND AGILITY: ADAPTING ITI

Our study identified 20 key OAs to build organizational agility to cope with the opportunities and challenges of technological shifts. OAs are organizational strategies, practices, and/or processes deployed over a period of time with a varying magnitude of effort. As dynamic capabilities are enacted through clusters of interrelated OA,[11] the 20 OA were grouped into three vectors according to their nature:

1) nurturing proactive technological culture, mindset, and competencies;
2) co-designing enterprise architecture; and
3) piloting the ITI (see Table 1).

The vector analogy should help practitioners who must provide directions and ensure sufficient levels of resources and efforts when deploying the OA.

Vector #1—Nurturing Proactive Technological Culture Mindset, and Competencies

To cope with the opportunities and threats created by technological shifts and adapt ITI, one of the first steps practitioners should consider is developing a proactive technological culture, mindset, and competencies. This will help organizations to explore the potential of technological shifts and exploit emerging technological opportunities while mitigating the related threats. To do so, *planning the development of employees' IT skills (1.1)*, on an ongoing basis, is a good action to start with. This can be done by offering in-house training to employees or sending them to seminars. The objective is to ensure that all employees have up-to-date skills to cope with the opportunities

TABLE 1. OAs to Cope With Technological Shifts and Adapt ITIs.

ID	Label	Rank*	E.I.**
Vector #1—Nurturing Proactive Technological Culture, Mindset, and Competencies			
1.1	Plan for continuous development of IT skills	**10**	3.1
1.2	Nurture an open mindset culture	**11**	2.6
1.3	Develop an organizational culture and implement a structure to promote technology watch	**12**	3.0
1.4	Establish a working environment favoring the retention of employees	**13**	2.9
1.5	Use external experts	**14**	4.0
1.6	Outsource	**20**	3.4
Vector #2—Codesign the Enterprise Architecture			
2.1	Foster collaboration between IT and business units	**1**	2.9
2.2	Implement mechanisms for continuous improvement	**4**	3.2
2.3	Establish architectural teams	**5**	3.4
2.4	Define life cycle and design a roadmap	**8**	3.4
2.5	Define a corporate architecture framework	**9**	3.0
2.6	Assess internal and external technological risks	**15**	3.2
2.7	Create a committee for IT monitoring and prioritization	**16**	3.7
Vector #3 – Piloting of the ITI			
3.1	Use indicators to evaluate ITI performance	**2**	3.4
3.2	Use industry standards	**3**	3.5
3.3	Adopt reliable, scalable technologies	**6**	2.9
3.4	Automate technological services in a standardized way	**7**	2.6
3.5	Migrate to cloud computing	**17**	3.2
3.6	Use artificial intelligence	**18**	2.1
3.7	Reuse IT assets	**19**	2.9

* The OA were ranked by the Delphi experts from 1 to 20, for their effectiveness.
**E.I. = Ease of Implementation Scale = 1 = Very difficult to implement to 5 = Very easy to implement.

and threats raised by new technologies and enable technological change readiness. Planning for IT skills development is one strategy to help *establish a working environment favoring employee retention (1.4)*. Encouraging collaboration and knowledge sharing between employees or promoting work-life balance are others tactics to help retain employees. In doing so, organizations are also retaining valuable knowledge essential for adapting and maintaining their ITI.

Developing a technology watch culture and structure (1.3) to continually monitor emerging technologies, trends, and practices should help organizations cope with technological shifts. It should enable organizations to gauge the relevance of technological opportunities for their ITI and anticipate, prepare for, and manage future technological shifts. In addition, practitioners should *promote and facilitate an open mindset culture (1.2)* with regard to the management and evolution of the ITI. In organizations with an open mindset culture, employees embrace challenges, accept criticism, give constructive feedback, are curious, and like to discover new technologies.

Using external experts/consultants (1.5) can be a strategy to gain access to new ITI-related knowledge and alter the organizational culture. External experts can also help plan the ITI evolution, assist in making specific choices, facilitate digital transformations and provide an external evaluation of work practices. Engaging in *outsourcing practices (1.6)* to take advantage of suppliers' expertise and knowledge is another option to access the expertise needed to cope with technological shifts and adapt ITI.

Vector #2—Codesigning Enterprise Architecture

In our study, the ITI experts agreed that *fostering collaboration between IT and business units (2.1)* is the most efficient OA to cope with technological shifts. Practitioners should reinforce regular collaboration between IT experts, users, business units, and decision-makers to identify and clarify ITI-related needs and expectations, develop a common strategy, maintain appropriate alignment of ITI evolution efforts, develop and test new ITI functions. Practitioners should also implement *mechanisms for continuous improvement of the ITI (2.2)* to anticipate technological developments. To do so, interdisciplinary monitoring committees can be established to regularly conduct assessments of ITI use, performance, needs, and expectations.

Defining an enterprise architecture framework (2.5) and evaluating all the elements of this architecture—processes, data, technologies, applications, services, standards, structures, etc.—is essential if organizations are to anticipate and integrate the affordances of technological shifts. A clear, documented

enterprise architecture is also essential to meet business objectives, guide digital transformation and manage changes of their ITI technology. To do so, practitioners should *establish an architectural team (2.3)* composed of two interdependent subteams: 1) a "business architecture team" responsible for developing the enterprise architecture framework, and determining standards and guidelines; and 2) an "operating architecture team" responsible for determining the components—products, services, methods—to add to or remove from the ITI, based on the enterprise architecture framework.

Defining the life cycle of the ITI components and *designing a roadmap (2.4)* for future ITI component replacements will help organizations anticipate technological developments and investments. ITI life cycles and roadmaps allow ITI practitioners to avoid obsolescence, optimize technological changes, and adapt possible technological developments to their organizational environments. In addition, organizations should *create cross-functional committees to monitor and prioritize (2.7)* the evolution of their ITI. This committee ensures that technological transformations to the ITI are aligned with the organization's enterprise architecture framework while raising the organization's awareness of ITI roles and risks. *Assessing internal and external technological risks (2.6)* of the ITI and their potential impacts to identify and prioritize the components to be updated, extended, or replaced depending on the nature of the technological shifts.

Vector #3—Piloting of the ITI

To better manage and adapt their ITI in face of technological shifts, practitioners should first have a solid understanding of how their ITI performs. They should *develop and use indicators to assess the performance of their ITI components (3.1)*, such as costs, volume, downtime, maintenance, security, etc. They will be better positioned to identify which ITI components to keep, and which to replace. When managing their ITI, practitioners should favor the *use of industry standards (3.2)* to facilitate interoperability and easy integration with emerging technologies. Practitioners can also *automate technological services using market standards (3.4)*, such as a software-defined data center, to separate organizational processes from the ITI. This approach should minimize the impact of ITI evolution on organizational processes.

When selecting or developing ITI components, practitioners should promote the *adoption of reliable, scalable technological components (3.3)*. This means adopting flexible, scalable ITI components, which can easily be updated, enhanced and/or extended. Thus, practitioners must continuously explore, test, and adopt new ITI components and management approaches. One such approach is to *migrate on-premises systems to cloud computing platforms (3.5)*. By migrating to the cloud, practitioners can gain greater flexibility, respond more easily to unanticipated high demand, facilitate the scalability of ITI, and avoid in-house system development. Another approach is to *use Artificial Intelligence (AI) tools (3.6)*, such as machine learning, to exploit the data generated by ITI—energy consumption, speed, number of errors, etc.—and be better prepared to deal with technological shifts. *Reusing and adapting (3.7)* existing ITI components when implementing new technological components, to optimize the use of existing technological resources should also be considered.

Three Interrelated Vectors of Organizational Agility Enablers

Figure 1 presents an overview of the best practices, grouped in vectors, to cope with technological shifts, and adapt ITI accordingly. The OAs underlying each vector are interrelated and complementary: the outcomes of the actions underlying each vector will serve as inputs for actions in other vectors.

Vector #1 regroup the OAs related to the nurturing a proactive technological culture, mindset, and competencies. These actions should help organizations identify, develop and assess the opportunities and threats technological shifts raises for the management and evolution of their ITI. They are related to an organization's predisposition to innovate, experiment with new technologies, and support employees in their exploration of new possibilities.

Vector #2 regroups the OA related to the codesigning and guidance of the enterprise architecture. These actions should allow organizations to mobilize the resources needed to identify, assess, and capture the value emerging from opportunities created by technological shifts while mitigating the threats. They will guide organizations in developing a clear vision of their ITI, establish roadmaps of their future ITI changes, and understanding the value of their ITI investments.

Finally, vector #3 regroups the OA related to the piloting of the ITI. These actions should help organizations deploy ITI that are standardized, compatible, modular, and flexible. They will help organizations to better manage and evolve their ITI when faced with technological shifts.[7]

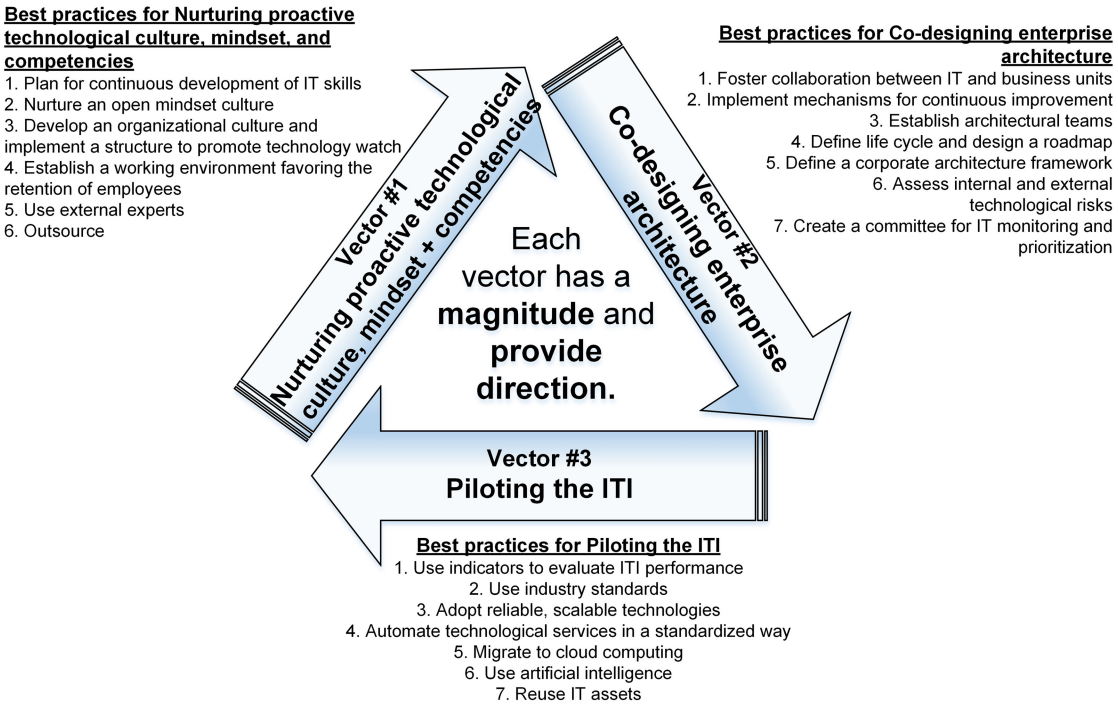

FIGURE 1. Best practices to cope with technological shifts.

COPING WITH TECHNOLOGICAL SHIFTS: RECOMMENDATIONS FOR PRACTITIONERS

Coping with constant technological shifts is an ongoing challenge for practitioners. Based on our analysis of the data collected, we provide recommendations to guide practitioners in sensing technological shifts, responding to the underlying opportunities and threats, and transforming their ITI accordingly.

Recommendation #1—Keep in Mind the Human, Strategic, and Technical Aspects

It would be risky, even unwise, for practitioners to deploy only technology-oriented OA to cope with relentless and uncertain technological shifts. As Figure 1 shows, the OAs underlying Vector #1 put more emphasize on the *human-related aspect* and IT competencies needed to manage and evolve ITI. These OAs reminds us that, despite everything else, humans are at the heart of solutions to cope with technological shifts. The OA underlying Vector #2 put more emphasis on the *strategic-related aspect* of ITI. These OAs focus on the importance of organizational collaboration in developing an enterprise architecture framework, tracking and prioritizing development initiatives, and continuously improving ITI practices. Finally, the OA underlying Vector 3 put more emphasis on the *technological-related aspect* of ITI and highlight the importance of monitoring ITI performance, applying standards, and automating ITI services.

Recommendation #2—Emphasize Employees' Experience and Technology Watch Activities

Practitioners should instill an overarching philosophy and a well-nurtured culture of employee-focused and empowerment that can be characterized as an "engaging management" style.[15] This means that organizations must create working environments in which employees can develop their full potential and have authentic, fulfilling work experiences. Such work experiences should increase employees' engagement and productivity, improve the quality of their work, reduce the turnover rate, tap into their creativity and ultimately help ITI practitioners cope better with technological shifts.

In addition, practitioners should collect information, knowledge, and solutions to handle the challenges of technological shifts. This means cooperating, communicating, and coordinating with employees and external partners to ensure that technology watch insights are circulated and shared, both internally and externally. Practitioners should never forget that

consultants and outsourcing partners can be very useful sources of experience and expertise concerning technological shifts and such partnership should help adapt their ITI.

Recommendation #3—Focus on Collaboration, Strategy, and Architecture

It is essential for practitioners to collaborate with users, business units, and decision-makers to identify, assess and capture the value arising from opportunities due to technological shifts while mitigating the threats. Collaborating with different business units was ranked as the most effective OA for codesigning enterprise architecture.

Practitioners must also ensure that they have a team of experts in place that is responsible for establishing the architecture framework that will help the organization successfully execute its business strategies. This team of experts should plan and implement an enterprise architecture analysis to facilitate, in the short term, daily management of the organization's ITI and, in the long term, the identification and prioritization of IT projects and policies to deploy to ensure that the ITI evolve smoothly. Thus, recruiting, training, and retaining enterprise architecture experts should be a priority.

In addition, practitioners must ensure that the organization's culture and related ITI practices put a premium on continuous improvement. However, before making any changes to an ITI, practitioners must first identify the changes to be prioritized with the help of a committee of specialists and then evaluate the risks of whether making or not these changes.

Recommendation #4—Monitoring, Standards, Automation, and the Cloud to Pilot ITIs

To adapt their ITI to and overcome the challenges of technological shits, practitioners should use performance indicators to monitor progress and identify areas of improvement for their ITI: automate priority technological services, use standards to guide ITI management and evolution, migrate ITI components to cloud computing, rely on business, and AI to support ITI management as well as adapt and reuse reliable, scalable components.

CONCLUSION

While ITIs are managed and evolve over a long period, practitioners must deploy OAs to overcome the threats and exploit the opportunities related to technological shifts while adapting their ITI. As highlighted by the set of 20 best practices identified (see Table 1), practitioners should emphasize on fostering collaboration and an open culture, developing competencies, opting for standardization, and continuously monitoring their ITI. It is essential for practitioners to collaborate with users, business units, and decision-makers to identify the needs and expectations, develop a common vision, ensure that efforts are appropriately aligned and share knowledge between ITI practitioners and business units.

A potential next step will be to identify the combinations and configurations of the 20 OAs, which are the most promising according to the type of organization and context. Furthermore, it would be instructive to make a detailed comparative study between the OAs and the practices proposed in standards such as ITIL 4 and ISO-20000.

By drawing on these best practices, practitioners can enhance their entrepreneurial skills and develop a practical approach to cope with technological shifts. We hope this study will support ITI practitioners in their decision-making processes and help scholars explore issues related to the opportunities and threats posed by technological shifts.

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