Project portfolio risk assessment in digital transformation: challenges and opportunities

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Abstract: Digital Transformation (DT) has its own challenges and demands on organizational strategy and processes. Consequently, DT also has implications on Project Portfolio Risk Assessment (PPRA). Thus, this study is focused on identifying these implications based on a structured search and content analysis of the literature in the field, which led to the identification of eight implications for risk assessment. Then, through qualitative analysis and according to the nature of each implication identified, a set of five challenges and three opportunities were established for PPRA considering DT context. This research shows that DT not only demands new considerations for PPRA but also offers opportunities to face them, leading to improve the PPRA impact on project portfolio management decision-making process. The present study contributes to the current PPRA research by outlining a view of how PPRA can be integrated into organizational DT. The challenges and opportunities identified could be used by practitioners and scholars to research, design, and implement PPRA in DT context.

Keywords: Digital transformation, Project portfolio, Risk assessment.

1. Introduction
Projects and programs grouped in project portfolios, represent a fundamental element for achieving organizational strategic goals [1]. Integrated management of projects’ risks and of intrinsic Project Portfolio Risks (PPR) [2], allows to develop products or capabilities to contribute to organizational sustainability [3]. In this regard, proper Project Portfolio Management (PPM) and Project Portfolio Risk Management (PPRM) contribute to project portfolio success, and consequently, leading to positive impacts on business strategy [1,4].

PPRM are immerse in the organizational environment, and therefore, it should recognize environmental implications and the way in which the project portfolio is impacted by them. In this concern, organizations are operating within intricate and dynamic competitive environments [3], in which most of the competitive advantages of an organization can be matched or even exceeded by competitors in relatively short periods [5]. Thus, business strategy and organizational processes have been oriented to agile and flexible configurations [3], for which, emerging digital technologies have opened up new organizational possibilities [5].

Accordingly, organizations have been incorporating a set of strategic goals, strategic initiatives, projects and programs aligned to Digital Transformation (DT) [3,5]. However, DT has its own...
challenges and demands on organizational strategy and processes, as well as on team members capabilities [5,6]. For example, these new strategies and operational models lead to frequently recalibrating the path and goals of the organization, and required constantly new resources such as new technologies and new capabilities, generating several and severe risks to organizations [5].

Thus, new implications for PPM and particularly for PPRM are derived from DT, opening up, in turn, both challenges and opportunities. In this regard, considering that Project Portfolio Risk Assessment (PPRA) is the element of the PPRM oriented to providing information on the importance of risks and of risk trends [7], this study addresses the following research question: What are the digital transformation implications for PPRA?

To address the research question, this paper begins with in a conceptualization of DT and PPRA. Then, the first cycle of a systematic literature search carried out is described, as well as the content analysis conducted. Resulting from the literature analysis, a set of DT implications on PPRA are established, and then categorized as challenges and opportunities. Finally, this paper presents the main conclusions.

2. Background

2.1. Digital Transformation

"Since the late 1950s, digital technologies have been used to facilitate strategic and operational changes across different sectors around the world" [5, p. 810]. Thus, the continuous evolution of the technology, the intensive use of internet and mobile communications, and the constant and fast emergence of new digital technologies such as, 5G, internet of things, big data, artificial intelligence, distributed ledger technologies, and multi-cloud environment have led to organizations forwarding a volatile digital economy [5]. In this concern, DT “has been described as the modern-day fight to survive the existential threat of digital disruption” [5, p. 809].

Therefore, organizations need a certain degree of DT to stay competitive in a context immerse in a volatile digital economy; for that, they have incorporated advancements of information and communication, and new operational technologies [8]. However, due to the continuous emergence of new digital technologies, DT is described as a perpetual process during which both the path and goals should be constantly evaluated and recalibrated [5]. Hence, DT refers to continuous adoption and integration of information, communication and operational technologies to constantly update, build, and incorporate digital capabilities that support the strategic and operational transformation in favor of creating new competitive advantages in a digital economy environment [5,8].

2.2. Project portfolio risk and DT

DT projects and programs emerge to add value to an organization by the development and improvement of organizational digital capabilities based on the extensive use of digital technologies [3]. Thus, a set of digital projects and programs may be represented as a digital project portfolio aligned with strategic objectives and priorities which seek to develop constantly competitive advantages [3].

The inherent risk of digital projects and programs, the continuous new emerging technologies and, the volatile digital economy in which organization are immersed, are issues that may generate a different and more complex risk environment for the project portfolio. Nevertheless, the risk could be mitigated through an adequate configuration of projects oriented to incremental and radical transformations that can achieve cumulative and sustainable competitive advantages [5].

Consequently, risk associated to DT may look as more than a technology issue, it represents also a business issue [8]. In this regard, the risk derived from digital economic environment is not exclusive of digital project portfolios, but also covers and impacts all the projects and portfolios of an organization. DT brings a certain degree of risk, therefore, establishing a digital risk management strategy is critical for both the success of digital project portfolios implementation and to achieve organizational competitive advantages [8].
2.3. Project portfolio risk assessment
A project portfolio for which the risks are analyzed, evaluated and distributed across several projects, is one which will have better probability of success [1,9]. In this regard, the literature in the field of risk management has progressively evolved from project risk management to PPRM [10].

PPRA, like PPR identification and PPR response, is an element of PPRM. PPRA is oriented to providing information on the importance of risks and of risk trends, among other factors, for supporting risk response decisions [7]. Thus, PPRA should allow for the identification, qualification and quantification of the effects of risk factors at each different stage of PPM. It should also generate greater approximations to reality, giving decision-makers a systemic project portfolio view, and allowing for efforts and resources to be focused on the factors that are really relevant [2,11].

3. Research methodology
The research methodology has been based on the steps summarized by Svejvig and Andersen [12] for a structured literature review: planning and scope definition; conceptualization of topic; searching, evaluating, and selecting literature; and literature analysis.

Planning and scope definition: Only papers published in scientific journals were used. In professional disciplines, papers in scholarly and research journals should form the core of the literature review [13]. The selected papers should have a direct and explicit relationship with DT and risk management, or DT and portfolio management. Once identified the set of potential papers, only papers in which their abstract showed an explicit focus on the themes mentioned should be included. It was also defined that the literature search would be carried out using the SCOPUS database.

Conceptualization of topic: This step was developed simultaneously with the ‘planning and scope definition step’. Thus, the topics DT, PPR, and project portfolio assessment were conceptualized. Their main aspects are briefly described in Section 2.

Searching, evaluating, and selecting literature: A structured search using two search strings in keywords, title and abstract was conducted: first ‘digital transformation’ and ‘risk management’, and second ‘digital transformation’ and ‘portfolio management’. Twenty-one potential publications were identified. Considering the focus established in the ‘planning and scope definition’ step, abstracts of these publications were analyzed, and fourteen articles were selected.

Literature analysis: To analyze the articles selected a conventional content analysis was conducted [14]. As analysis of the publications progressed, and considering risk assessment from a general perspective, topic areas related to implications of DT on risk assessment were identified and categorized. In this regard, each article analyzed could address information about only one of the implications identified or provide information regarding two or more implications. Likewise, each new article identified could lead to divide or reconstruct some of the implications previously defined or could lead to establish an additional implication. Thus, eight implications were identified.

Based on qualitative analysis, these implications of DT on risk assessment were contrasted against PPRA characteristics, establishing, in a specific way, a set of challenges or opportunities for PPRA according to the nature of each implication previously identified.

4. Main implications of DT on risk assessment
According to the literature analysis conducted eight main implications of DT on risk assessment were identified, namely: shorter strategic cycles, technological vulnerabilities interconnection, extent of risk impacts, new risk sources, real-time risk information, data integration, highly dynamic competitive environment, and complexity of the environment. Each implication is briefly described as follows.

Shorter strategic cycles: Due to rising market volatility and innovation, as well as a highly dynamic and increasing competitive environment derived from DT, strategic cycles are getting shorter [15]. In this regard, it is relevant to take into account the risk factors generated by these shorter and more dynamic strategic cycles, and consequently, how these risk factors will be handled, and how to ensure that decisions related to risk management remain in line with the corporate strategy [16,17].
Technological vulnerabilities interconnection: Technological vulnerabilities are interconnected [18,19]. Therefore, the materialization of a technological risk factor may influence the parameters of other risk factors, leading to transform some risk factors in possible risk factors pivots [18]. In addition, the likelihood and severity of risk factors are not static but change continuously and rapidly [18]. Therefore, the risk assessment should be considering the risk factors in an integrated way, recognizing an environment of multiple risk vectors and stages, accounting for more than each risk factor individual implication [15,18,20].

Extent of risk impacts: The organizational systems are interconnected [21], for that, risk factors derived from a specific organizational subsystem (in this case generated by the project portfolio) can lead to extended impact on the whole organization [15,18]. In this regard, a rich understanding of potential consequences is necessary for supporting the risk management decisions [18,19]. Thus, the interconnection between organizational systems should be considered within, and as part of the risk assessment. [15,18,21]. Understanding and assessing the cumulative risk impact supports better decision-making from a risk management perspective [19].

New risk sources: Organizations are evolving from physical to cyber-physical systems leading to the convergence of the information and operational technology domains [18]. Consequently, the landscape of risk sources in DT context is changing too [18,22]; for example, the high degree of dependence on external technology partners is increasingly important in the DT context [15]. In addition, the risk factors in DT context are related to highly dynamic variables [15,18,23]. This new configuration of risks factors is still poorly understood [15,18].

Real-time risk information: DT helps to share information in real-time and align requirements of each group of interest [15,19,20]. Since risks are managed in different ways depending on the role and decision-making level in the organization, it is essential that stakeholders know and understand the risk information in real-time [19]. Likewise, capture information in real-time from stakeholders allows to keep updated the state of the risk factors previously identified and identify possible new risk factors [19]. Thus, massive, comprehensive and real-time data sets enable all levels of the organization to focus on the more relevant risk factors [16,19].

Data integration: Based on risk models to support all levels of decision-making, DT can help to upgrade the integration of risk management at the organizational level [15,19,20]. However, data consistency must be ensured, which requires large organizational and technical efforts [15,16], for which, automated systems require to be integrated with specialists who interpret the results [22]. Another aspect to consider is the amount of data generated and handled, which must be controlled too [15,20].

Highly dynamic environment: The shorter technology and innovation cycles, rising market volatility, and highly dynamic and increasing competitive pressure represent some of the DT current challenges [17]. This dynamic environment may lead to a continuous shift of the conditions under which the organization competes [15,17,18]. Therefore, risk factors related to expected organizational results can shift or increase quickly. For instance, the risk of late investments versus the risk of investment in poor and often immature technologies [15].

Complexity of the environment: The high dynamism of the environment, the existence of new and highly dynamic risk factors, organizational system interconnexion, and interconnexion between vulnerabilities configure a complex environment for organizations in the DT context [15,18,21]. The risk analysis should be able to recognize and reduce that complexity to manageable levels without omitting fundamental factors [18,19]. In addition, the scarcity of historical and reliable data could drive to incorrect assumptions concerning risk factors, leading to risk models lacking transparency [18].

In addition, considering that categorization processes help to obtain a better understanding of nature and characteristics of a set of factors or elements [24], it was established that the eight implications fit into three concerns – strategy (shorter cycles and extent of the risk impacts), technology (vulnerability interconnections, new risk sources, real-time risk information, and data integration), and environment (dynamic and complex).
5. Challenges and opportunities for PPRA in DT context

Based on the eight DT implications on risk assessment identified, this section describes how these DT implications represent both challenges and opportunities for PPRA. Thus, five challenges and three opportunities were found. Challenges are reported in table 1 and opportunities are described in table 2. The first column of table 1 and table 2 shows the general implications previously identified; in the second column it appears the respective specific challenge or opportunity for PPRA within the DT context, followed by its description.

| Implications                       | Challenges                                                                                           |
|-----------------------------------|------------------------------------------------------------------------------------------------------|
| Shorter strategic cycles          | C1: Assessing the PPR derived from strategic cycles – Since a project portfolio is oriented and directly aligned with the organization’s strategy [17,25,26], PPRA should reflect the risk of the project portfolio against changes in the organizational strategy. Meaning, PPRA should evidence the project portfolio flexibility or project portfolio response capability as part of the PPR. If a project portfolio is rigid against changes in the strategy cycle, that project portfolio should reflect those conditions as part of the PPR. |
| New risk sources                  | C2: Designing an adaptable PPRA according to technological risk implications – Identify and understand the characteristics of new risk factors derived from DT on project portfolio being incorporated as a continuous process [23]. For that, it should be analyzed the possible new risk factors related to each phase of the project portfolio life cycle, and consequently, related to the project portfolio expected results. However, more than defining a set of risks derived from DT, PPRA should be flexible and highly adaptable for incorporating additional risk factors or modifying the risk factors configuration over time [23]. |
| Technological vulnerabilities     | C3: Incorporating technological vulnerabilities impacts on project portfolio – Projects interdependencies and risk interdependencies have been highlighted in the literature as one of the most critical aspects to consider in PPRA [27,28]. Therefore, it should be assessed how technological vulnerabilities can expand throughout the interconnection between technological risk factors, and how these risk factors impact on non-technological risk factors, on projects results and on the portfolio results exploitation. |
| interconnection                   |                                                                                                      |
| Highly dynamic environment        | C4: Requiring a dynamic PPRA – Risk modeling represents a vital element of organizational systems in DT context, from process design to process implementation or integration into regular organizational operations [16,18]. In this regard, a quantitative understanding of risk factors and their possible consequences can be obtained based on risk assessment [16,18]. The dynamic environment deriving from DT, in which organizations are immersed, requires dynamic risk analysis methods, through which representative, opportune, and reliable information should be obtained for an efficient PPRA [18]. |
| Complexity of the environment     | C5: Integrating data analysis processes to PPRA – PPRA requires going from being just an element of PPRM oriented to merely produce information as output, to being an information feedback loop, turning PPRA into a dynamic element of PPRM. For that, artificial intelligence and machine learning systems could be used to capture and analyze risk information in each PPRA cycle and to improve the PPR estimation in the next assessment cycles. In addition, In PPR context the scarcity of information is a typical issue, therefore, expert or professional judgment has been incorporated to provide information regarding parameters of risk factors in framed PPRA [2,29]. Thus, data analysis processes, as well as the incorporation of methods and information systems, that allow integration of qualitative and quantitative data, should be required. |
### Table 2. Opportunities of PPRA within the DT context.

| Implications                  | Opportunities                                                                 |
|-------------------------------|-------------------------------------------------------------------------------|
| Extent of risk impacts        | O1: Incorporating organizational perspective of project portfolio to PPRA – The integration of project risk and PPR into the enterprise risk management leads to a holistic decision-making process [30]. In this regard, emerging digital technologies and the continuous evolution of information systems could harness the interconnection of PPRA within risk assessment of projects, operational management systems, and corporative risk assessment. Consequently, the impacts of portfolio risk factors should be analyzed from an organizational perspective, additionally incorporating the view of project portfolio as an organizational unit interconnected with other organizational systems [21, 30]. |
| Real-time risk information    | O2: Allowing the digital environment to capture and provide PPR information – The results of PPRA should allow to obtain a comprehensive view of PPR according to relevant information that each group of stakeholders’ requires [19, 23]. In this regard, PPRA should allow analysis in real-time of implications or impacts on the project portfolio of changes in risk factors configuration, to support an informed decision-making process and to quickly alert the stakeholders regarding new information to take into account [20]. Thus, some elements of the digital environment, such as high connectivity, mobile devices and multi-cloud environment, can be seen as required enablers. Based on virtual collaboration principles, the project portfolio stakeholders can use PPRA as an opportunity to evaluate and recalibrate constantly the PPR. |
| Data integration             | O3: Designing processes for PPRA data processing and PPR visualization – Processes of Big Data collection and analysis can strengthen decision-making processes [16]. Therefore, Big Data processes can address a PPRA opportunity. In this concern, data quality and homogeneity regarding parameters of risk factors of the project portfolio, as well as standards and criteria for data collection and integration, should be required. It means that a structured and consistent PPRA process should be designed and defined. In addition, considering that results are interpreted by different specialists or stakeholders, PPRA should provide an appropriate PPR visualization structure. In fact, risk visualization and data visualization has been analyzed and their power highlighted in different studies [23, 31]. |

### 6. Conclusions

The research reported in this paper has two main contributions. Firstly, it identifies a set of implications of DT on risk assessment according to the analyzed literature, establishing five challenges for PPRA and three opportunities. These challenges and opportunities represent a current view of how PPRA can be able to integrate an organizational DT support and at the same time, how emerging technologies derived from DT can support an improved and dynamic PPRA. In this regard, PPR visualization and dynamic incorporation of change are part of the main identified challenges, and Big data or virtual collaboration are two examples of the opportunities identified.

Secondly, both challenges and opportunities here described can also be viewed as topics for future developments and research in the field of PPRA, and specifically in the field of DT integration in PPRA. Thus, the implications of DT on risk assessment, as well as the challenges and opportunities for PPRA within the DT context, give an informed overview for addressing future research. These challenges and opportunities can contribute to stimulating joint efforts in this interdisciplinary field.

DT is well underway. Thus, new emerging technologies and dynamic competitive environments are generating new demands to organizational systems. In this regard, PPRA is required to be robust and ensure an adequate representation of the fundamental factors, but, at the same time, it is required to be dynamic and flexible to respond to the quickly changing conditions.

This paper shows an overview of a set of challenges and opportunities identified from the literature. Additionally, further research could be oriented to an in-depth analysis of each challenge and opportunity, and to identify and characterize the interrelation between them. Thus, an improved and detailed characterization of the challenges and opportunities could support PPRA design and...
implementation according to the current DT context. Also, looking for a wider understanding of the implications of DT on PPRA from a practice perspective, analysis of case studies and empirical research could also be conducted.

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