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# Rediscovering local roots and interactions in management

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## Short papers

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Short Papers

edited by

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# The effect of dynamic capabilities on A.I. adoption and management in the Wine Ecosystem[♦]

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**Abstract**

*Over the last decades, grape farming and wine production have been influenced by technological advances, especially in A.I. (Artificial Intelligence), IoT (Internet of Things), M2M (Machine to Machine) infrastructures, Robotics, and Cobotics (collaborative robots.) For wine business companies, gaining and sustaining a competitive advantage through those technologies is becoming crucial for creating vast opportunities for stakeholders in the wine ecosystem. What drives managers' willingness to adopt those technological infrastructures in the wine industry is an underexplored territory, which we aim to investigate. This research aims to explore the role of dynamic capabilities on companies' intention to adopt AI-based technologies in the wine sector. To do that, we plan on conducting field observations, focus groups and interviews among US-based wine companies, which succeeded so far in implementing A.I. technologies and can function as best practices for Europe-based producers. The preliminary results of non-intrusive observations of U.S. wine companies that have adopted new technologies indicate that staying competitive is no longer a matter of whether to adopt new technologies but rather the level of technological adaptation intensity. That is why our study intends to determine the moderating or mediating role of the influential factors in the decision-making process on adopting A.I.*

**Framing of the research.** *In the era of the Fourth Industrial Revolution (4IR), advances in artificial intelligence (A.I.), including the Internet of Things (IoT), sensor and robotic technology, remote-sensing, Machine to Machine Communication (M2M), machine learning, smart algorithms that learn from patterns such as keyboard strokes, in complex data or big data - are rapidly transforming the world of viticulture and its management within the global wine ecosystem (Winkler et al., 2017).*

*These developments and the adoption of technological infrastructures present vast opportunities and challenges for stakeholders in the global wine ecosystem. Specifically, an A.I. structure is an intelligent machine-based system capable of influencing the ecosystem by collection, analysis, and synthesis of data to generate useful recommendations and make predictions or provide other results for a determined set of purposes. It uses data collected by intelligent machines or human-based inputs/data to make assumptions and generate simulation models to formulate various options with perceived outcomes (Portinale et al., 2017).*

*Future business existence and longevity will depend on the adoption intensity of new technologies; thus, A.I. can be adopted at any stage of the supply chain and value chain. In the U.S., wine is produced or imported and then distributed through the "Three Tier Distribution System". Consequently, A.I. systems can be designed and applied to operate autonomously or be fully integrated, from sourcing grapes for wine production or importing the finished product to distribution to retailers and consumers. However, based on the country's laws, A.I. can improve the competitive position of an enterprise through cost minimization and pricing optimization, therefore making wine more competitive to benefit the consumer as in the case of the U.S. Three Tier Distribution System (Wine Folley, 2023)*

*According to Tardaguila, et al. (2021), A.I. applications in grape farming use various technologies and tools, including remote and proximal sensing technologies, Global Positioning System (GPS), Geographic Information System (GIS) to collect Geo-Spatial Data (GSD), and Decision Support Systems (DSS). According to the National Institute of Food Agriculture (NIFA), "Collecting data from one sensor, or many sensors, is only the first step in the overall decision-making process, which might be inspection, monitoring, tracking, etc.;" (NIFA, 2023).*

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♦ *This extended abstract is a work in progress. The study will continue with the following post-conference activities:* focus group interview and data collection; questionnaire development and survey; data collection from self – administered online questionnaire.

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*An example of a successful A.I. adoption and integration coined as "Intuitive Farming" is that of Las Palmaz Winery Management in Napa, California, which uses advanced Geographic Informational Systems (GIS) to provide the winemaking team with information about vines' nutritional requirements based on the conditions above- and below the ground. Using a GIS-generated digital map of vineyards and blocks Las Palmaz Vineyards Management can assess and provide multiple data of the grapes grown at differing microclimates, geographically located between 300 feet and 1,400 feet elevation, about ± 91. m. and 426. m. above sea level. Hence, remote sensing using A.I. applications provides grape producers with essential data to monitor grape nutrition and growth and to provide derived predictive data to viticulturists regarding the vineyard's health, water level and usage, and potential production yield, and act upon anything requiring attention to mitigate the effect of quality and quantity of the end product (Romero et al. 2018).*

*As new A.I. technologies evolve, so do the applications that winery management can adopt. An example of advanced A.I. applications is premium grape sorting before being processed into must at a modern winery fully integrated with A.I., from grape production to packaging and distribution (Palmaz Vineyard, 2022). It uses an optical berries' sorting table using color density recognition with M2M technologies. For the process, grapes arrive at the winery from the vineyard; grape clusters are placed in a destemming machine. Grape berries are separated and sorted out through an optical lens screening and sorting process that separates ripe berries from others, according to the color density programmed into the A.I. procedure, based on a pre-established outcome to create an end product that the consumer demands (Palmaz Vineyard, 2022).*

*Additional A.I. applications exist across the wine production and distribution systems. For example, using a drone, the viticulturist can treat a single vine affected by diseases from the office without spraying the entire vineyard with a crop duster. Fast forwarding, the end consumer uses smartphone apps to shop for wine and place an order. Consequently, the global wine ecosystem players might be compelled to deal with the constant evolutionary technological changes in the wine business. Looking ahead, it is inevitable that the ecosystem has reached the point of no return and is moving forward to challenge each player with the following considerations: "it is not a matter anymore whether to adopt evolving technologies; it is more a question of the intensity of technology adoption by the stakeholders striving to produce the most competitive product". Evidence is shown in the legislation changes in many wine-producing countries in the free market economy. Across the global wine markets, there is a thrust to implement a system of wine traceability using A.I. applications (Agnusdei et al., 2022; Beck, 2022; GS1, 2023). In the U.S., for example, alcoholic products are strictly regulated, and labeling is the first approval that must be obtained from the Alcohol and Tobacco Tax and Trade Bureau (TTB) before producing commercial wines. Among several other agencies like the United States Department of Agriculture (USDA, 2023) and the Food and Drug Administration (FDA, 2023), the TTB is a Federal Government Agency that regulates the alcohol industry (TTB, 2023). As new developments are introduced and adopted, so does the alcohol law. The global industry competes mainly on the following wine products: Organic, Biodynamic, Natural, Sustainable, Vegan, Fairtrade, and No Sulfites Added.*

*A.I. applications in the wine supply and value chains are here to stay and are evolving like every other technological advance across industries. The Government's regulatory agencies are concerned about truth in advertising through product labeling; therefore, producers must be regulated. Hence, the label is the first step in obtaining the approval to produce and sell wine with a specific designation. Nevertheless, despite being one of the most overly regulated industries, counterfeiting remains a problem for high-profile wineries. In 2018, the U.K. lost £218 million in economic activities from counterfeit wine and spirits. In the U.S., in response to counterfeit import activities, Avery Dennison And Everledger launched the Authenticated Provenance Tracking System using Blockchain technology (Avery Dennison, 2019).*

*The applications and implications of A.I adoption in the wine industry are multiple. Practitioners and researchers concur that A.I. within the wine business ecosystem will determine how the wine companies will operate and how the application and adoption of artificial intelligence will influence consumer shopping behavior. Through adopting A.I., wine producers competing in the global hypercompetitive market are exploring alternative strategies to predict what consumers will demand to create better products and increase profits (OPENGOV, 2021). The International Organization of Vine and Wine (OIV) has introduced a new center to monitor and identify main developments in digitalization and technologies and the adoption in the viticulture and enology sectors (OIV, 2021). According to The Indian Express (2017), "over the next few decades, the wine ecosystem would undergo a sea change, from how consumers buy wine to the involvement of machines in the production". Literature shows that A.I. adoption is happening across the wine supply chain and value chain, particularly in viticulture.*

*However, no comprehensive research has been undertaken to study the dynamic capabilities across the wine supply chain - within the wine business ecosystem, as a fertile ground to explore companies' willingness to adopt A.I technologies. Over the past decade, A.I. accessibility and adoption have advanced the scientific understanding of viticultural and winemaking processes. The unpredictable climatic variability in most wine regions globally is a critical issue that led some grape scientists to study and adopt A.I. in viticulture. They determined that due to these uncertain events' complications and the effects on grape growing and winemaking, a wiser methodology is necessary to gather related information and analysis to improve efficiency in the decision-making process (Prabha, 2021; Fluentes et al. 2021).*

*This research is based on the theory of dynamic capabilities to create a competitive advantage in a complex ecosystem. According to Teece et al. (1997), a dynamic capability is "the firm's ability to integrate, build, and reconfigure internal and external competencies to address rapidly changing environments" (Teece et al., 1997; Teece,*

*2014.) For this study, we adopt Teece's (2007) model, which distinguishes three macro-categories of dynamic capabilities within an ecosystem.*

*Since the early development stage of this conceptual work, various authors have engaged in further developments and possible application of the framework (Teece et al., 1997; Helfat et al., 2007; Teece, 2007; Teece, 2010; Teece, 2014; Kevill et al., 2017; Teece, 2018). Di Stefano et al. (2010) deconstructed the conceptual framework literature by examining the research domain's origins, development, and future directions. The deconstruction showed that the conceptual framework, first published within the management domain, had sparked the interest of other scholars. Subsequent research was conducted in various disciplines, such as information systems, marketing, and operations. However, most publications remained in management journals: Strategic Management Journal, Journal of Management Studies, Academy of Management Review, Industrial and Corporate, and Organization Science (Di Stefano et al. 2010).*

*Dynamic capabilities are not internal and external operation capabilities; they are operations that deal with the firm's current "going concern". In comparison, dynamic capabilities are about the capacity to create, extend, or modify how best to exploit the firm's resources and capabilities, hence its core competencies, in a decisive and well-planned manner.*

*Within this conceptual framework, a firm uses a well-planned strategy to make tactical changes to its competitive status quo and uses those changes as the basis to gain and sustain long-term competitive advantage (Barreto, 2010; Di Stefano et al., 2010). These capabilities have been widely investigated and applied in many research studies to determine their effect on global performance (Jantunen et al., 2005; Evers, 2011; Prange & Verdier, 2011). Based on the literature, this research examines the presence and the use of dynamic capabilities to foster the adoption and application of Artificial Intelligence technologies in a "volatile, uncertain, complex, and ambiguous (VUCA)" environment of the global wine ecosystem (Schoemaker et al., 2018; Hercheui & Ranjith 2020), to assess the current performance and the potential future creation of competitive advantage of wine businesses. Within the context of striving to achieve a competitive advantage by adopting evolving technologies within the domain of Artificial intelligence, the dynamic capabilities framework consists of the following three pillars: sensing, seizing and transforming (Schoemaker et al., 2018), which are explained below.*

A. Sensing

*The capability to assess the changes in the local and global wine business landscape by analyzing the opportunities and threats that may present themselves then and possibly in the near future. This first pillar is supported by exploring what advantages A.I. technologies might offer to managers.*

B. Seizing

*The analysis of the external environment is crucial but not sufficient for the management to seize the opportunities by adopting adequate technologies within the framework of Artificial Intelligence. The management must also seize the opportunity promptly and attempt to determine the unexpected changes needed to innovate and implement new systems. Consequently, this represents the second pillar when current business models are improved or new ones are developed and implemented.*

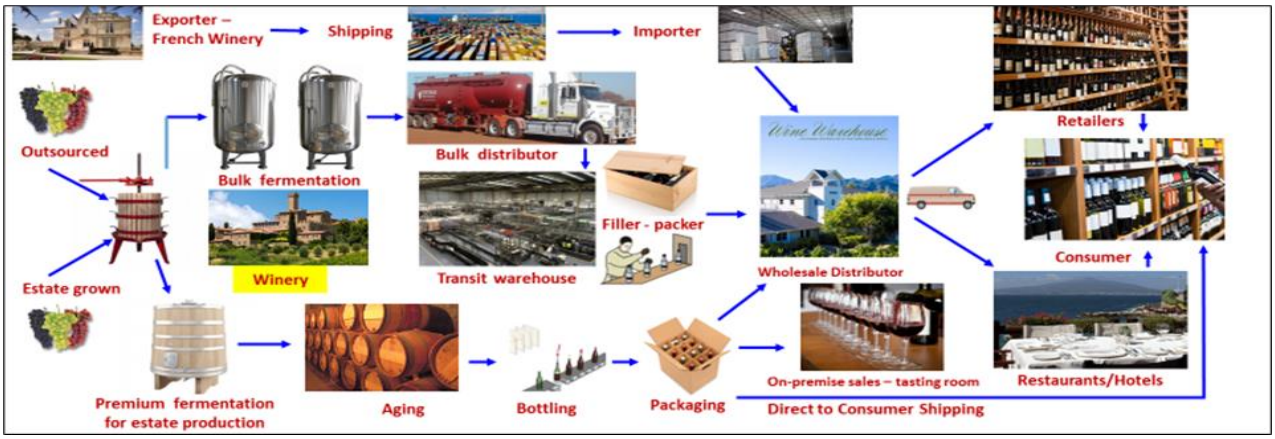
C. Transforming

*According to the dynamic capabilities framework, exploiting the capabilities in an uncertain environment is often insufficient for the management to adapt to changes gradually. Management may need to stay vigilant and wait for the changes to reshape themselves and possibly their ecosystems to gain full advantage of new business models. Continuous structural renewal represents the third pillar of dynamic capabilities. However, management must be conscious that a major investment has been made, and if the transformation in this third pillar is not successful, the status quo is at the point of no return, and the strategy will have failed. Thus, investing in an A.I. infrastructure is expensive, and if achieving a competitive advantage is not feasible, the return on investment cannot be exploited.*

Application of dynamic capabilities

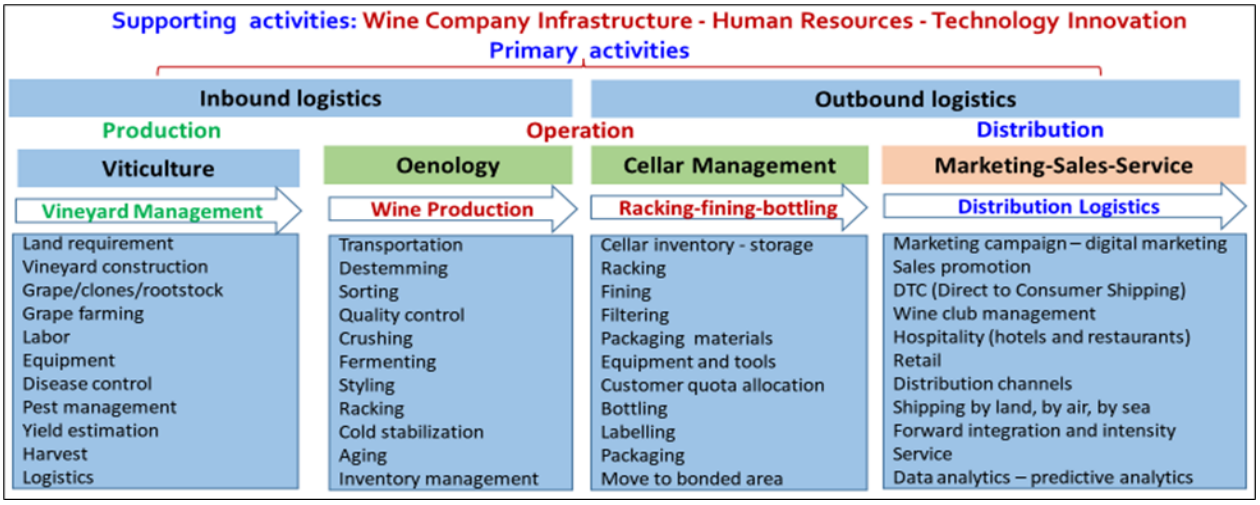
*Artificial Intelligence (A.I.) is known to influence any ecosystem globally. A.I. plays an essential role in the wine business, from planting a vineyard to how wine is made and aged to how consumers select and buy wine, whether for personal consumption or investment. In the wine industry, A.I. applications are used along the supply chain, from resource acquisition to production, operation, packaging, marketing, distribution, and post-sales activities with the end consumer. Figures 1. and 2. Depict the U.S. wine supply and value chains based on the three-tier distribution system. The activities described in the three pillars of the dynamic capability framework, through the application of A.I. technologies, will moderate and/ or mediate the activities within the ecosystem, as described in Figure 3.*

*Fig. 1: Graphic Representation of the Wine Supply Chain based on the "U.S. Three Tier Distribution System"*



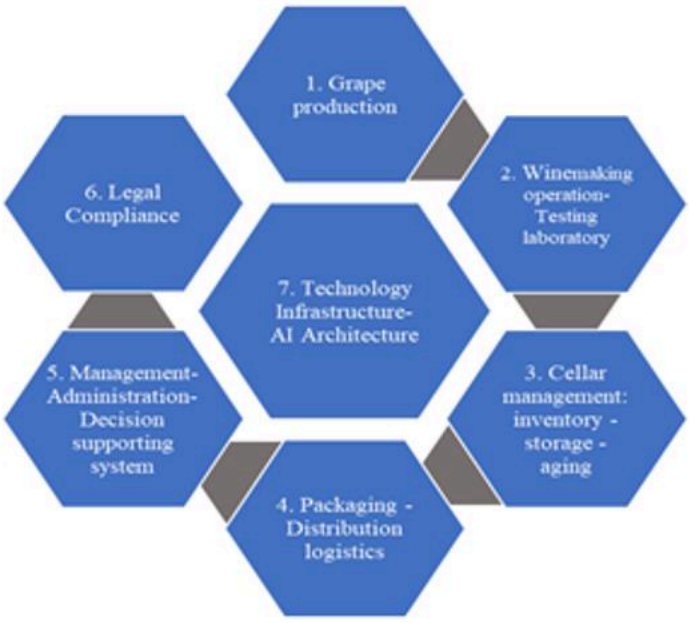

*Source: The management of production, operation, and distribution in the wine supply chain (A. A. Camillo, 2022)*

*Fig. 2: Graphic Representation of the Wine Value Chain based on the "U.S. Three Tier Distribution System".*




*Source: The management of production, operation, and distribution in the wine supply chain (A. A. Camillo, 2022)*

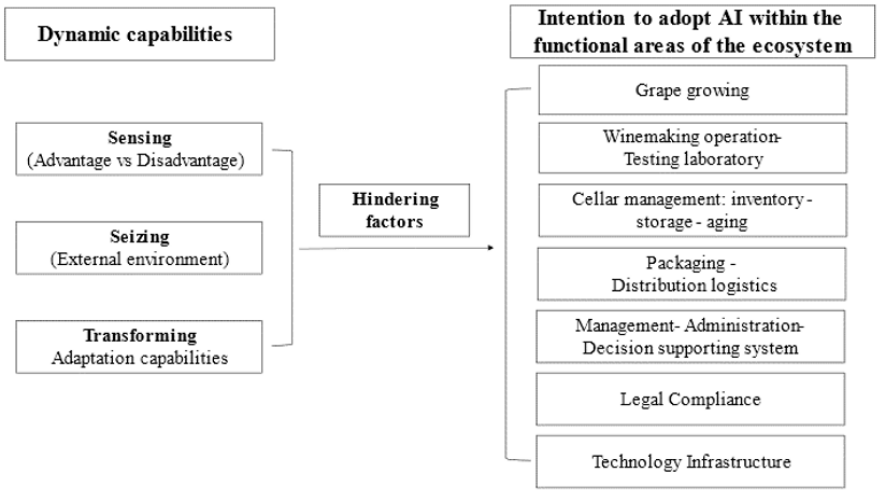
*Fig. 3: below shows a proposed wine business ecosystem based on the wine supply chain and wine value chain models presented above in Figures 1 and 2.*




*Source: Authors' elaboration based on the U.S. wine business supply chain and value chain*

**Purpose of the paper.** *This study investigates the role of dynamic capabilities on companies' intention to adopt AI-based technologies in the wine sector, with the aim of determining A.I. adoption intensity and management in the global wine ecosystem and the creation of competitive advantage. Specifically, we intend to determine the moderating or mediating role of the influential factors in the decision-making process on adopting A.I. technologies to gain and sustain competitive advantage. To the best of our knowledge, no previous study has addressed the effect of dynamic capabilities on A.I. adoption, particularly in the wine sector, and the effect of hindering factors such as financial investment and organizational and operational capability, and capacity constraints. Accordingly, we propose the following research model to be tested.*

*Fig. 4: shows a graphical representation of the theoretical model to be tested*




**Methodology.** *This research adopts an exploratory approach, given the lack of literature on artificial intelligence and the role of dynamic capabilities applied to the wine business ecosystem. We plan on applying qualitative and quantitative methodologies based on dynamic capabilities theory through adopting and managing artificial intelligence technologies to investigate how wine business managers create a sustainable competitive advantage for the ecosystem. This study will use focus groups and face-to-face interviews with wine industry players to collect data to develop a questionnaire to survey a purposive sample of participants. The questionnaire will be self-administered online. Depending on the variables' development from data collected through the focus group and structured interviews with industry experts, the final instrument may contain multidimensional variables which will allow measuring the effect and the probability of adopting A.I. technologies through possible regression analysis and partial least square and structural equation modeling.*

**Results.** *The preliminary results of non-intrusive observations of wine companies that have adopted new technologies indicate that staying competitive is no longer a matter of whether to adopt new technologies, but rather the level of technological adaptation intensity. This is a work in progress and the final results will be available following the focus group interviews, face-to-face interviews with industry leaders, and an online survey with a purposive sample of participants who operate a wine business in the United States, which functions as a benchmark player for the purpose of this study.*

**Research limitations.** *Despite this study being a work in progress and, therefore, not having produced any results thus far, we can certainly detect a first limitation of the research due to the fact that the focus groups and face-to-face interviews will be primarily directed only to successful cases of A.I technology adoption. Future avenues of research can, therefore, focus on investigating the limitations of A.I technologies adoption under the lens of poor dynamic capabilities presence.*

**Managerial implications.** *This research can produce effective replicable results for Europe-based wine producers, by suggesting to managers in the wine industry a dynamic capability framework that can boost their ability to adopt A.I technology and manage it for the benefit of the entire wine ecosystem.*

**Originality of the paper.** *To the best of our knowledge, no previous study has addressed the effect of dynamic capabilities on A.I. adoption, particularly in the wine sector. To investigate the phenomenon, we propose a model that represents the wine business ecosystem and a research model to test the effect of A.I. on current wine business operations or make predictions for future investments. The ultimate goal of the study is to measure and determine the effect of the "hindering" or moderating - mediating factors within the A.I. - dynamic capabilities frameworks, such as financial investment, organizational and operational capability, and capacity constraints, among other factors unknown at this point. Accordingly, we wish to present this developmental paper to seek feedback from peers to help us strengthen our research.*

**Keywords**: *Artificial Intelligence, Wine Industry Technology, Competitive Advantage, Wine Ecosystem, Dynamic Capabilities.*

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