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INNOVATION STRATEGIES AND COMPLEMENTARITY BETWEEN INNOVATION ACTIVITIES: THE CASE OF COMMERCIAL ARCHAEOLOGICAL FIRMS

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ABSTRACT

As a key part of their professionalization process, creative industries (CIs) including private or contract archaeological firms (AFs) increasingly rely on bundles of technological (product/service and process) and non-technological (organizational) innovation activities. Adopting a complementarity perspective the study clarifies how technological and non-technological innovation initiatives are combined in an intertwined way. Drawing on a sample of 217 AFs, this study examines uncovers synergies between innovation strategy and innovation practices and the further effects on innovation performance in AFs. Specifically, results show that successful AFs combine multidimensional service, process and organizational innovations to generate higher innovation performance.

Keywords

Innovation strategy; innovation practices; complementarity; technological innovation, non-technological innovation, innovation performance; creative industries; archaeological firms

1 Introduction

Services have become a driver of productivity and growth in developed economies, being the only sector of the European economy that resulted in net job creation in the last two decades (Crevani et al. 2011). However, the term "service" is used in a rather broad sense, since it includes a wide range of economic activities ranging from personal services to distributive services and social and collective services to name just a few (Miles 2005). The fact that there is such a variety of activities and levels of knowledge intensity suggests that services are far from being one single, well-delineated activity.

Among the various knowledge intensive services one of particular interest for its complex functioning are creative industries (hereinafter CIs), which according to UNCTAD (2008), includes the following activities: creative arts (e.g., visual arts, audiovisual multimedia and computer games), media and entertainment activities (e.g., video and TV, books and press), or cultural sites and services (e.g., architecture, museums, cultural heritage and archaeology). As with other knowledge intensive services, CIs are tantamount to the 21st century knowledge economy that pursues cultural significance as much as economic value. Cultural and creative industries comprise a heterogeneous activity populated by small and entrepreneurial to multi-billion, multinational firms, like software companies and media conglomerates, that have become an important driver of national economies (Flew and Cunningham 2010; Hartley 2005; Newbigin et al. 2010).

Similar to other cultural activities, like cultural heritage management (Castañer 2013), private or contract archaeological firms (hereinafter AFs) emerged from the privatization of otherwise public service activities. The main duty of these firms is to satisfy the needs of their clients in competitive markets (Zorzin and St-Pierre 2017). Differently from other Western countries like France where cultural resources are fully regulated, in Spain, USA and UK, public administration has outsourced archaeological heritage management to private business

firms. As such, private archaeology is a rather recent, 'under-the-radar' cultural activity in the academic cultural and innovation studies.

The literature has characterized CIs, including AFs, as less prone to professionalize than other service activities (Gundolf et al. 2018). However, as these firms become an integral part of the global economy, their strategic management is becoming increasingly complex and dynamic (Konrad 2013). A discussion in the specialized literature is whether CIs emphasize economic growth and firm growth or the "cultural, artistic or simply entertainment values" tied to their activities (Caves 2000, p1). In this context, a crucial aspect in their success is their capacity to innovate to overcome the tension between cultural and commercial objectives (Chaston and Sadler-Smith 2012; Horowitz 2014). Innovation is both a demand and a capability for firms to remain competitive. By now, the literature on CIs innovation represents an increasingly important field of research, which sheds new light and poses new questions on the relationship between different forms of innovation and firm results. Innovation permits firms to maneuver between their financial, managerial objectives and their cultural, artistic priorities and to pursue both goals, "the improvement of profitability and the ability to further pursue unprofitable but cultural and creative activities" (Gundolf et al. 2018, p. 156).

This is particularly true in AFs characterized as science-based, human-capital intensive and advanced knowledge services, where human capital rather than physical inputs constitute the critical capability for generating a competitive advantage (Castellacci 2008; Miozzo and Soete 2001). Since their activity is based on managing intellectual activities and the interface with their service output, AFs depend almost entirely on the knowledge, skills and experience of their staff for their success (Greenwood et al. 2006). In this context, AFs are expected to adopt a comprehensive innovation strategy (Karlsson and Tavassoli 2016) including a broad, complex portfolio of innovation initiatives. Here we follow Cassiman and Veugelers (2006) and Schmiedeberg (2008) applying the concept of complementarity in innovation as the way in

which firms undertake several forms of innovation (Martin-Rios and Pasamar 2018). To date, research has not investigated the effects of various forms of innovation on innovation performance in AFs. With few exceptions (Doran 2012), most innovation studies in CIs do not consider whether by implementing two or more innovations simultaneously the combined benefits may be greater than the sum of the parts. Moreover, researchers and practitioners still need to understand innovation through a more comprehensive perspective, which includes non-technological areas and capabilities (Hervas-Oliver and Sempere-Ripoll 2015; Martin-Rios 2014; Martin-Rios and Erhardt 2017).

The objective of this paper is to empirically test the interaction effects of innovation strategies through technological and non-technological innovations on AFs' innovation performance. From this perspective, we hypothesize that the benefits of adopting technological innovations are greater when they are paired with non-technological innovations, as the recent literature suggests (Camisón and Villar-López 2014; Hervas-Oliver and Sempere-Ripoll 2015; Martin-Rios and Parga 2016b; Martin-Rios and Pasamar 2018). Yet, when it comes to the characteristics and nature of innovation activities, substantive questions still loom large: What impact do innovation strategy and the complementarity between innovation practices have on the innovation performance of AFs? What kind of innovation activities has a greater impact on the innovation performance of AFs?

Drawing on an original survey-based firm-level dataset, we explore innovation patterns in Spanish AFs, evaluating the relationship between various sources of innovation (service, process and organizational innovations) in achieving service innovation performance, measured as a component created from the most important objectives for innovation of archaeological firms resulting from an exploratory factor analysis. The paper is structured as follows: the next section highlights the theoretical aspects of this work based on the complementarity in innovation literature and AFs. Next, the analytical strategy is explained as well as data sources

and the methodological design of this study. Results based on the exploration of innovation activities and its complementarity in Spanish archaeological firms is explained in detail. Some reflections are included in the discussion section. The paper concludes with a summary of the main findings and conclusions.

2 Literature review

Similarly to the general cultural and creative sector, AFs rely heavily on professional knowledge or expertise on a specific discipline or functional domain (Müller et al. 2009). In general, AFs are small companies with a modest turnover that on average employ less than five people, a considerable number of whom are employed on a part-time basis, a recurring factor in the cultural sector (Towse 2003). As a consequence, and it is also the case for the rest of firms in the creative economy (Chen et al. 2015), AFs operate in a turbulent environment with high uncertainty and relatively high failure rates (Martin-Rios and Parga-Dans 2016b). These creative activities require placing a bundle of capabilities and competences (human, technological, organizational) at the disposal of a client and to organize a solution, which does not principally involve supplying a good (Potts et al. 2008). Knowledge intensity, professionalized workforce and intrapreneurs' previous experiences influence innovation performance in AFs (Boix et al. 2013). Consequently, the expectation is that innovative patterns in AFs will differ from those of manufacturing firms, as they are characterized by less technological (i.e., service innovation) and more non-technological (i.e., organizational innovation) innovation (Evangelista and Vezzani 2010).

Some studies have been devoted to understanding how AFs generate innovation capability and to detail the consequences of innovation on firms' level of adaptability (Martin-Rios and Parga-Dans 2016a; Hotho and Champion 2011). Creativity and innovation is at the core of the archaeological activity. Innovation fosters new ways of delivering service and of achieving

outcomes while enabling the professionalization of the management team. Despite emergent literature emphasizing the role that innovation plays in AFs, little is known about the prevalence of innovation strategy in AFs and the extent to which these firms purposively engage in more or less formal innovative activities and the overall contribution of complementarity to innovation performance (Martin-Rios and Parga-Dans 2016b).

The present study aims to fill this research gap, stressing the strategic importance of the combination of various forms of innovation for innovation performance in AFs (see Figure 1). This paper focuses on all of the innovation types identified by the OECD guidelines except for marketing innovation, defined as new methods of commercialization, due to its orientation towards clients and markets. This consideration goes beyond the scope of AFs production, which is the focus of this study.

Insert Figure 1 about here

2.1 Technological innovation: Service and process innovation

According to OECD guidelines, technological innovation involves product or service and process innovation (OECD and Eurostat 2005). Service innovation enables AFs to differentiate its service from those of competitors, establishing a market share (Bessant et al. 2005). In this sense, service innovation can be considered essential for the firm to sustain competitiveness and for developing a competitive advantage in the market (Barney et al. 2001). Process innovation is pursued to reduce delivery lead-time or decrease operational costs, which changes the way an organization produces and delivers its services (Damanpour 2010). Thus, process innovation has an internal focus orientated towards efficiency, which helps firms to implement cost leadership strategies (Piening and Salge 2015). For example, Damanpour and Gopalakrishnan (2001) have found that in service firms, innovations in the service are likely to be followed by innovation in the service process.

Technological innovation plays a relevant technical function within the firm, providing important determinants for performance and success (Jiménez-Jiménez and Sanz-Valle 2011). Specifically, the adoption of technology-based innovation may play a direct role in generating innovation returns and firm performance (Evangelista and Vezzani 2010). Technological innovation is important for service development, equipment and production. A large number of studies have shown the positive effects derived from the implementation of technological innovation practices on the generation of innovation performance (Battisti and Stoneman 2010; Mairesse and Mohnen 2002; Martin-Rios and Pasamar 2018). Moreover, technological innovation is critical for service firms to adapt to changing consumer behavior (Darroch and McNaughton 2002), to strengthen the potential benefits of open innovation (Hecker and Ganter 2016). However, literature has not yet addressed the impact of technological innovation in AFs. We propose the following hypotheses:

> H1. *For AFs, technological innovation has positive returns on innovation performance.*
> H1a. *For AFs, service innovation practices have a positive effect on innovation performance.*
> H1b. *For AFs, process innovation practices have a positive effect on innovation performance.*

2.2 Non-technological or organizational innovation

Compared to technological innovation, the literature on non-technological innovation is still in its infancy, and scholars have only recently begun to explore how these forms of innovation relate to more traditional forms of innovation (Damanpour 2014). Non-technological innovation involves a variety of organizational, management and administrative innovations (OECD and Eurostat 2005). Damanpour and Gopalakrishnan (2001) started a debate about the positive effects of the adoption of organizational innovation in firm performance. New or improved workplace practices (e.g. recruitment, training, incentive scheme, planned job rotation), organization structure initiatives (e.g. planned job rotation, interdisciplinary workgroups, organizational climate) and external relationships are much more likely to be

successful for innovation performance (Armbruster et al. 2008; Damanpour et al. 2009). Moreover, non-technological (organizational) innovation can also be a source of competitive advantage for services, as Janssen et al. (2015) exemplified through the creation of novel solutions. As a result, the need to enhance service delivery and explore new services may make participation in organizational innovation initiatives more salient. For cultural and creative firms in CIs, non-technological innovation represents a source of competitive advantage (Abecassis-Moedas et al. 2012; Miles & Green 2011). For example, Franklin and colleagues (2013) contend that innovation through internally developed projects (as opposed to externally driven R&D initiatives) helps creative firms to reduce demand uncertainty and respond to market disruption. However, literature in AFs is scant. Accordingly, we propose the following hypothesis:

> H2. *In AFs, there is a positive relationship between non-technological innovation and service innovation performance.*

2.3 Complementarity between innovation practices in AFs

An innovative approach to the management of AFs is believed to be influenced by firm-level factors such as innovation strategy (Karlsson and Tavassoli 2016; Tavassoli and Karlsson, 2015). Firms develop more or less formal innovation strategies resulting from various combinations of innovation inputs, including resources, ideas, information, knowledge and/or technologies (Karlsson and Tavassoli 2016). As a consequence, the existing body of literature on complementarity and innovation (Cassiman and Veugelers, 2006) considers that several combinations of different innovative practices can be adopted by the company, including technological innovations (e.g. service innovation and process) and non-technological innovations (e.g. new or improved managerial strategies, organizational practices and external relationships). Both of them play an important role in innovation performance (Hecker and Ganter, 2016).

A framework on the existence of complementarity between innovations is based on the assumption of synergies between technological and organizational innovations, fostering better innovation performance (Anzola-Roman et al., 2018; Martin-Rios and Pasamar, 2018; Sempere-Ripoll and Hervas-Oliver, 2014). Innovations grounded in technical aspects of final service development, while important, are part of the innovative effort that firms can carry out. These together with non-technological innovations are seen as complementary, suggesting that innovative firms in one dimension tend to be innovative in all dimensions, although with different intensity and regardless of the nature of innovation (Ballot et al., 2015).

This may be more the case for AFs as they seek to improve their overall performance via innovative activities. Consequently, AFs may benefit from these types of innovation and therefore be more willing to implement multiple forms of innovation jointly. In this study, we contend that analyzing a broad portfolio of innovation initiatives can help to explain the extent to which complementarity among distinctive types of innovation has a positive impact on the innovation performance of AFs. Accordingly,

H3. *The adoption of combinations of technological and non-technological innovation has a positive effect on AFs' innovation performance.*

3 Methods

3.1 Research setting

This study relies on the analysis of Spanish AFs as a paradigmatic case study on CIs. Private or commercial archaeological firms emerged in 1990 as a rather new science-based, human-capital intensive and advanced knowledge service in the US, the UK and Spain (Martin-Rios and Parga-Dans, 2016a). Differently from other countries with a huge amount of heritage resources but managed by public administrations (e.g. France and Greece), archaeological business emerged offering heritage safeguarding and management services in countries with high urban planning development or construction activity rates (Martin-Rios and Parga-Dans,

2016a). Archaeological firms offer a portfolio of knowledge intensive activities which includes: 1) documentation services (e.g. identification and radiocarbon dating of archaeological sites to be protected), 2) archaeological impact assessment (technical advice to protect and manage urban heritage resources under construction and development projects), 3) enhancement activities (archaeological heritage profitability services for its accessibility and visit) and 4) dissemination services (outreach and educative activities connecting archaeological heritage to society). Moreover, archaeological firms connect with other Cis' activities including cultural services (not exclusively archaeological) such as restoration, topography, environmental services or architecture (Castañer and Campos, 2002).

3.2 Panel data and sample

Data collection included the creation of a census of Spanish archeological firms in 2009, the first database about this business activity. The identification of firms followed different tasks and sources: 1) a search in the heritage departments of the Spanish public administrations, 2) the pursuit in the professional associations of history, philosophy and lyrics, 3) a search in the SABI database (a local version of European Amadeus or US Compustat for Spain and Portugal), 4) tracking through Internet search engines, public advertisements, websites and blogs; and 5) a snowball sampling (or referral sampling). All these search activities yielded a total of 273 archaeological firms.

3.3 Survey design and administration

We developed a survey instrument with which to trace innovation activities. To avoid confirmation bias and to further increase the validity of results, the questionnaire design drew on two large-scale surveys: the *Spanish Survey on Technological Innovation in Business* and the *EU's 2010 Community Innovation Survey* (CIS). All the items of the instrument are listed in Appendix A. Specific questions were posed to cover innovation future and past initiatives, the impact of distinct innovation activities for firm and innovation performance, as well as the

consequences of combinations of technological—service/process practices—and non-technological innovation activities. Demographic data, including geographic scope, firm size, age, and market capitalization, were also collected. The questionnaire was administered to owners and top executives of AFs as these respondents were assumed to have the knowledge or be responsible for their firms' innovation strategy and innovation practices. Previous research shows that experts are less influenced by the confirmation bias than novices (Hergovich et al., 2010). Moreover, selecting a single and qualified respondent may increase the incentive for research collaboration (Dyer and Chu, 2000) without adding systematic bias (Cullen, Johnson and Sakano, 1995). Survey administration included five stages, as follows:

1) *Telephone contact.* First, we contacted the 273 AFs by telephone. We explained the research to the firms, inviting them to participate. After that we registered and verified the contact information (e.g. location data, telephone number, CEOs' availability). This stage lasted one month.

2) *Online survey.* The second stage involved programming the questionnaire using an online application. Each firm registered in the database received an e-mail with detailed instructions to fill out the survey and a company password together with a link to access the questionnaire. Respondents had access to respond to the questionnaire during a three-month period.

3) *Telephone survey.* We completed unfinished or non-response electronic questionnaires through the Computer Assisted Telephone Interviewing technique (CATI). During this stage, firms completed the questionnaire with the mediation of an interviewer, helping the respondents if they had any doubts or difficulties in understanding the questions and answers. This stage took one month.

4) Data codifying and processing. Information and data compiled were codified and tabulated with SPSS. The resulting database consisted of 217 valid questionnaires,

which represents a high response rate (80%). The firms that did not participate (20%) in the study did not have any geographical or demographic characteristics that differ from those of the participating companies, so there is no reason to expect any systematic bias in the results.

3.4 Data analysis

We applied ordinary least squares regression analysis to explain the complementarity between technological and non-technological innovation activities (service, process and organizational innovation) and the effects on innovation performance. Innovation performance resulted from a factor analysis and was the dependent variable of the model. In the same way, service, process and organizational innovation constituted the independent variables. We finally controlled for geographical scope, firm size, age and firm capitalization. Table 1 shows variables, constructs and measures used for the statistical analysis.

Insert Table 1 about here

Dependent variable

Innovation performance was identified through an exploratory factor analysis, using the principal component method. We decided to adopt a perceptual and non-financial measure of innovation performance due to the difficulty in obtaining objective financial measures of innovation results. This approach is most consistent with previous research, which has sought to evaluate innovation performance in small firms (e.g. Oke et al., 2007).

Using a battery of items about innovation outputs derived from the 2010 CIS questionnaire, we selected the main innovation objectives pursued by archaeological firms (obtained through a specific question in the survey to archaeological firms), we developed an exploratory factor technique that identified patterns of innovation performance within CIs, including: 1) the improvement in the quality of services as a consequence of service innovation activities (PERF:

quality), 2) higher productive capacity resulting from process-oriented initiatives (PERF: capacity) and 3) time reduction for customer or supplier needs as an organizational improvement effect (PERF: response rate).

Since variables are dichotomous, we applied an exploratory factor analysis to the matrix of polychoric correlations rather than a matrix of Pearson's *r*. Polychoric correlation coefficients are maximum likelihood estimates of the Pearson's correlations for those underlying normally distributed variables (Oke et al., 2007). In sum, polychoric correlations extrapolate what the categorical variables distributions would be if they were continuous, adding tails to the distribution. The subsequent method reveals a principal component relying on the Kaiser-Eigen value criterion. The factor is characterized on the basis of the variables with loadings above 0.5. (Table 2).

Insert Table 2 about here

Independent variables

We defined three dichotomous independent variables, one for each type of innovation defined. These variables take the value 1 if the firm has innovated and 0 otherwise.

- *Service innovation*. We measured service innovation as: "the introduction of a service that is new or significantly improved with respect to its characteristics or intended uses. This includes significant improvements in technical specifications, components and materials, incorporated software, user friendliness or other functional characteristics. This measure is consistent with the definition of service innovation in accordance with the Oslo Manual.
- *Process innovation*. We measured process innovation as: "the implementation of a new or significantly improved production or delivery method. This includes significant

changes in techniques, equipment and/or software". This measure is consistent with the definition of process innovation in accordance with the Oslo Manual.

- *Organizational innovation*. We measured organizational innovation as "New business practices and methods of workplace organization, new knowledge management systems and external relations". This measure is consistent with the definition of process innovation in accordance with the Oslo Manual.

Control variables

We included four variables to control for: 1) *Geographic scope*. We controlled for the territorial area in which firms operate as an ordinal scale of 1-4, ranging from local, regional, national and international scope. 2) *Firm size*. We measured organizational size calculating the average number of employees of the firm over a three-year period (2006-2008). 3) *Firm age*. We measured age calculating the average number of years that the firm operated. 4) *Firm capitalization*. A critical control variable is the capital-to-asset ratio of the company over a four-year period (2006-2009). The capital-to-asset ratio helps determine whether a company has enough capital. Firms were asked to divide their capital by their assets and express the resulting figure as a percentage to obtain their capital-to-asset ratio.

4 Results

Descriptive results (Table 3) show that archaeological firms were characterized by their young age – less than 10 years on average (74% age less than 12 years), small size (86% of firms had ten or less employees, with an average of 5.75 workers), low capitalization (39.2% had capital of less than €100,000 on average for the period 2006-2009) and these firms operated in regional markets (73% of these CI firms operated in the region in which they were geographically located). In addition, these firms developed an intensive innovation activity:

66% of the firms developed service innovation activities during the 2006-2009 period; 52.8% process innovation and 54.2% organizational innovation.

The main results of the innovative activity include an increase in production capacity or services provision for 31.3% of the firms; a quality improvement of services for 28.2% of the firms, and time reduction for customer or suppliers needs for 25% of the sample.

Insert Table 3 about here

Table 4 presents the correlations among all variables in the model. With respect to the correlations, all of the control variables (geographic scope, age, size and capitalization) were positively but non-significantly related to performance innovation. As expected, innovation activities (service, process and organizational) were positively related to innovation performance. Interestingly, organizational innovation alone was not significantly correlated to either service or process innovation.

Insert Table 4 about here

Table 5 shows the results for the hierarchical regression analyses with innovation performance as the dependent variable**.** Six models were specified in this analysis. The coefficients presented in Table 5 are standardized regression coefficients. In model 1 we entered only the four control variables. The results show that, all alone, the controls did not have a significant effect on innovation performance, defined as improvement in service capacity, cut in response time, and improved service quality (R^2 .01). Model 2 shows that the introduction of process innovation activities (ß = 0.296; $p < .001$) significantly affected innovation performance after controlling for geographic scope, firm age, size and capitalization. The regression had an adjusted R^2 of 0.07 and is significant ($F = 11.94$, $p < 0.01$; see table 5), confirming that process

innovation had a positive effect on CIs' innovation results (H1a). Furthermore, model 3 suggests that service innovation practices connected to the introduction of new services (ß = 0.289; $p < .01$) are related to innovation performance when taking into account firm age. The regression had an adjusted R^2 of 0.06 and is significant ($F = 2.99$, $p < 0.05$). Thus, service innovation had a small but positive effect on CIs' innovation results (H1b). Model 4 shows that the introduction of organizational innovations (ß = 0.171; $p < .05$) significantly affected innovation performance. However, the regression was not significant. Therefore, it did not confirm a direct and positive relationship between non-technological innovation practices and service innovation performance (H2). Model 5 provides full support for our second hypothesis, which states that technological sources of innovation (both service (ß = 0.272; $p < .01$ and process (ß = 0.264; $p < .01$)) had a positive impact on the service's innovation performance. The regression had an adjusted R^2 of 0.13 and was significant ($F = 10.313$, $p < 0.01$). Finally, model 6 suggests that complementarity between innovation practices exists and has a positive effect on innovation performance. The regression had an adjusted R^2 of 0.16 and was significant ($F = 6.483$, $p < 0.05$). Taken together, technological and non-technological innovations, including service (ß = 0.26; $p < .05$), process (ß = 0.300; $p < .001$) and organizational innovations (ß = 0.264; $p < .05$) had a higher—and positive—impact on innovation performance than when introduced individually. Therefore, this model supported our third hypothesis. The complementarity adoption of technological and non-technological innovations had a positive effect on CIs' innovation performance.

Insert Table 5 about here

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5 Discussion

The present study explores the hypothesis of complementarity between innovations in commercial or private archaeological firms, investigating firm variety and common patterns of

innovation strategy configurations across different typologies of technological and non-technological innovation practices, including service innovation, process innovation and organizational innovation. Existing research and theory suggest the mutual association or complementarity between the different types of innovation, emphasizing the synergies between service, process and organizational initiatives (Leiponen and Drejer, 2007). However, the influence of technological innovation practices on the likeliness of introducing successful non-technological innovations is still under consideration (Anzola-Roman et al., 2018; Hervas-Oliver and Sempere-Ripoll, 2016; Hervas-Oliver et al., 2014). Recent research offers more specific conclusions, (for example, Abdirahman and Sauvée, 2016; Camisón and Villar-López, 2014) assuming organizational innovation as a necessary precondition for technological innovation as well as a capability that have a direct influence on service firm performance. For instance, Geldes, Felzensztein and Palacios (2017) provided initial evidence of the association between the implementation of organizational innovations and the propensity to innovate both in processes and products. Less scholarship, however, has addressed the impact of adopting complex portfolios of multiple innovation practices on CIs or AFs (Caniëls and Rietzschel, 2015).

There is a growing interest in CIs firms among organization theorists because this variety of knowledge-intensive service firm is presumed to be a strategic business for an increasingly knowledge-based economy (Camelo-Ordaz et al., 2012). Thus, innovation activities among CIs are crucial as a stimulating force of economic growth and sustainability. Since most previous studies on innovation practices in CIs have focused on various forms of innovation in isolation, the objective of this work was to provide an empirical analysis of whether alternative forms of innovation act as complements in archaeological firms. Our results suggest that there is a substantial degree of complementarity between technological innovation (service and process practices) and non-technological (organizational) innovation activities.

As recent research shows CIs engage in innovation and, to do so, do not depend exclusively on technological innovations (Abecassis-Moedas et al., 2012; Martin-Rios and Ciobanu 2019; Miles and Green, 2011). Our study contributes to new insights regarding the influence of innovation strategy and the combination of technological and non-technological innovation practices on innovation performance in AFs. Such way of measuring innovation performance is drawn from the Oslo Manual (OECD, 2005), and has been increasingly used in innovation management field (Martin-Rios and Ciobanu, 2019; Tavassoli and Karlsson, 2015). Innovation performance is critical to creative firms' success and survival in highly dynamic and turbulent environments (Boix et al., 2011; Hotho and Champion, 2011).

As we contend in this study, innovation performance is closely linked with the implementation of a variety of technological and non-technological innovation initiatives, such as the development of new models for the organization of work, investment in new technologies applied to the business, and the development or the improvement of new services. Moreover, our study highlights the mediating role of organizational innovation as a complementary mechanism between technological innovation actions and innovation performance. This indicates that, for AFs, locating non-technological innovation as a mediating initiative in the portfolio of innovation activities is particularly important for advancing service development and innovation. In this sense, we find that organizational innovation activities result in a better understanding of organization and employee issues relevant to successful service as well as in developing service networks and systems (Ramayah et al., 2011; Martin-Rios and Erhardt, 2017).

Organizational innovation alone has a minor impact on innovation performance, but when non-technological innovation is combined with technological innovation activities it generates additional benefits in innovation performance. These findings are consistent with previous studies determining how organizational innovation influences the probability of obtaining

technological innovations (Anzola-Roman et al., 2018). Our research findings provide evidence of the multidimensional conceptualization of innovation strategy that can be applied to creative firms. The results supported the hypothesis that those AFs that adopt organizational innovations have better innovation performance when they combine them with technological innovations. Therefore, we extend the focus of organizational innovation as a source of innovation performance, providing arguments in favor of the development of innovation strategies that enable AFs in particular, and the cultural and creative firms in general to develop highly interconnected innovation strategies and practices.

6 Limitations and conclusion

We do not wish to overstate our results, as this study has a number of limitations. The selected firm setting may influence our findings. All firms were archaeological, which by definition is a specialized service amenable to organizational innovation. A limitation of our theoretical focus is that we ignore the influence of some non-technological innovations, such as marketing innovation. Even though, the Spanish archaeological firms in our study did not introduce marketing innovations, further studies could include a larger variety marketing practices among the set of non-technological innovations, which are often ascribed to initiatives focusing on boosting competitiveness, marketing strategies and service access channels (Battisti and Stoneman, 2010; Damanpour et al., 2009; Cassiman and Veugelers, 2006). Furthermore, a causal interpretation of our results is made more plausible by longitudinal studies. Data from multiple points of time would improve the study. Finally, results from small and medium enterprises in the archaeological industry cannot be directly applied to the heterogeneous clusters of firms in the cultural and CIs, therefore future research needs to expand the focus of research into other creative industries. These limitations represent an exciting area for future research.

In conclusion, with this paper we have tried to understand how adopting an innovation strategy comprised of several innovation practices impact the innovation performance of AFs. We argue that AFs represent a unique subset of the CIs thus hold important information for the strategic management of the overall industry. Despite the appeal of this idea, empirical research produced to date on the relationship between innovation complementarity and AFs' innovation performance is scant (Martin-Rios and Parga-Dans, 2016b). Primary data collected from private or commercial AFs set the basis to test our hypotheses. Results show that several sources of innovation matter for innovation performance. There is a positive relationship between technological, non-technological sources of innovation and innovation performance. This conclusion is especially relevant to the successful development of innovation strategies and the management of innovation practices in AFs, in particular with respect to the level of innovation effort that is required for knowledge-intensive services in CIs to actually contribute to firm innovation success.

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FIGURES

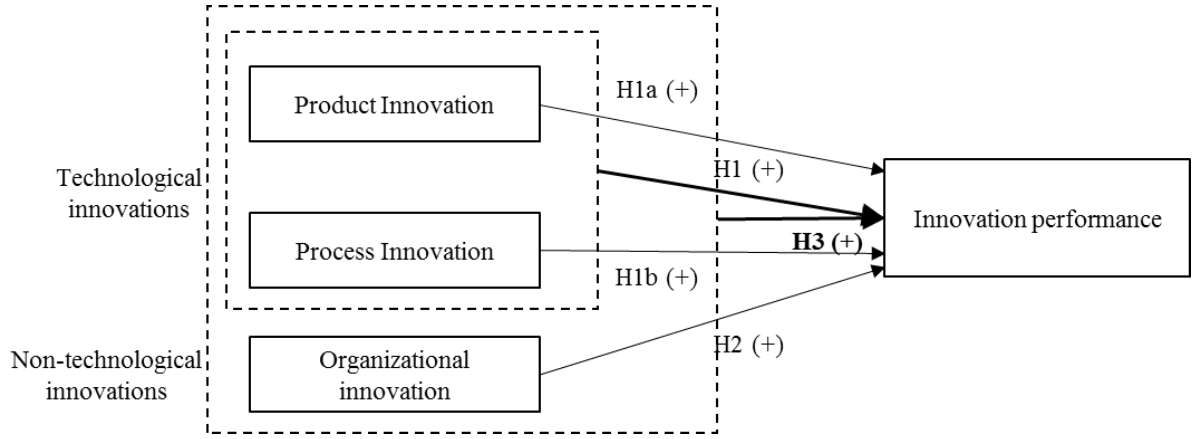

Figure 1. Theoretical model

TABLES

Table 1. Description of survey variables

Variable	Description	Measurement scale
Dependent variable (innovation performance)		
PERF: Quality	Improved quality of services (service-oriented effects)	Binary (yes, no)
PERF: Capacity	Increase capacity for producing services (process oriented effects)	Binary (yes, no)
PERF: Response time	Reduce time to respond to customer or supplier needs (organizational innovation)	Binary (yes, no)
Independent variables (service, process and organizational innovation)		
INN: Service:	Introduction of a service that is new or significantly improved	Binary (yes, no)
INN: Process	New or significantly improved production or delivery method	Binary (yes, no)
INN: Organizational	New business practices and methods of workplace organization, new knowledge management systems and external relations	Binary (yes, no)
Control variables		
Geographic scope	Territorial area in which firm operate	Ordinal, 1-4
Size	Average number of employees over a three year period (2006-2008)	Numerical
Age	Average number of years that the firm operated	Numerical
Market capitalization	The capital-to-asset ratio of the company over the four years period	Numerical

Table 2. Exploratory factor analysis

Matrix of components		
	Extracted factor scores (p-value <0,05)	
PERF: quality		0,782
PERF: capacity		0,808
PERF: response rate		0,603
Extraction method: Main component analysis		1 component extracted
Sample adequacy measurement Kaiser-Meyer-Olkim (KMO) and Barlett test		0,6
Bartlett sphericity test	Approximate Chi-square	55,975
	gl	3
	Sig.	0.000***

*p<0.05; **p<0.01; ***p<0.001

Table 3. Descriptive results

Variable	Descriptive results
Geographic scope	73% regional scope
Size	5.75 employees
Age	9.63 years
Firm capitalization	39.2% <€100,000
Product innovation	66%
Process innovation	52,8%
Organizational innovation	54,2%
Quality performance	28,2%
Capacity performance	31,3%
Response rate performance	25%

Table 4. Correlations among variables in the model

Variable	Mean	s.d.	1	2	3	4	5	6	7
1. Innovation performance	0,1	1,00							
2. Geographic scope	2,7	0,97	0,025						
3. Size	5,2	5,72	0,054	0,18*					
4. Age	2,3	5,69	0,098	-0,079	-0,246**				
5. Firm capitalization	7,2	6,11	0,074	0,178*	0,603**	-0,292**			
6. Service innovation	0,6	0,48	0,273**	0,262**	0,118	-0,101	0,22**		
7. Process innovation	0,5	0,50	0,288**	0,224**	0,266**	-0,064	0,282**	0,178*	
8. Organizational innovation	0,5	0,50	0,19*	0,054	0,229**	0,026	0,338**	-0,081	0,135

Notes: *p<0.05; **p<0.01; ***p<0.001

Table 5. Results of hierarchical regression analyses[a] for predicting innovation performance

Control and Independent Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Geographic scope	0,014	-0,036	-0,053	0,015	-0,094	-0,099
Size	0,028	-0,012	0,043	0,018	0,006	-0,003
Age	0,133	0,122	0,143*	0,109	0,133	0,105
Firm capitalization	0,093	0,039	0,035	0,034	-0,009	-0,087
Process innovation		0,296**			0,272**	0,26**
Service innovation			0,289**		0,264**	0,3***
Organizational innovation				0,1705*		0,212**
R^2	0,02	0,11	0,10	0,05	0,16	0,2
ΔR^2	-0,01	0,07	0,06	0,01	0,13	0,16
F	0,781	11,936**	2,995*	1,377	10,313**	6,483*
N	146	146	146	146	146	146

Notes: *p<0.05; **p<0.01; ***p<0.001

APPENDIX A. "THE INNOVATION STRATEGY AND PRACTICES" QUESTIONNAIRE

A product/service innovation is defined as the introduction of a service that is new or significantly improved with respect to its characteristics or intended uses. This includes significant improvements in technical specifications, components and materials, incorporated software, user friendliness or other functional characteristics

A process innovation is the implementation of a new or significantly improved production or delivery method. This includes significant changes in techniques, equipment and/or software.

An organizational innovation is defined as new business practices and methods of workplace organization, new knowledge management systems and external relations.

During the three years 2006 to 2008, did your enterprise introduce?

1. Service innovation ☐
2. Process innovation ☐
3. Organizational innovation ☐

In case you have answered the previous question we would like to know what the results of the introduction of these new or improved processes or work models have been (indicate three main characteristics)

1. Higher quality of services as a consequence of service innovation activities ☐
2. Higher productive capacity resulting from process-oriented initiatives ☐
3. Time reduction for customer or supplier needs as an organizational improvement effect ☐