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# African Journal of Business Management

February 2020  
ISSN: 1993-8233  
DOI: 10.5897/AJBM  
[www.academicjournals.org](http://www.academicjournals.org)

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*Full Length Research Paper*

# How universities fill the talent gap: The data scientist in the Italian case

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Received 13 September, 2019; Accepted 22 January, 2020

**This research paper explores Italian study programs in data science in order to verify if knowledge and skills developed during the universities' path are fit with data scientist job demand. The issue is introduced considering the companies' growing need to derive insights from data, and consequently, to search for a staff with analytical expertise, the so-called data scientists quite rare. Literature review is focused on the data scientist's specific characteristics. According to the ideal profile, the data scientist should possess skills enabling the scientific collection, analysis and use of quantitative data in addition to managerial and communication skills, ensuring profitable interactions with decision-makers. The methodology introduces an innovative semi-automatic linguistic analysis of textual data, which enriches traditional statistical methods in text annotation and increasingly constitutes a key step to retrieve more and more precise information from large corpora. As results, the data scientist education in Italy is not widespread and the skills match highlights significant gaps between universities and companies in developing programming and software development skills. In conclusion, an intensive university-business cooperation in order to prepare future professionals, in line with technological trends and company requirements, could contribute to fill this gap, producing positive effects for the social and economic development.**

**Key words:** Data scientist, business management, higher education, university, innovative skills, text mining, NooJ.

## INTRODUCTION

The big data revolution (McAfee et al., 2012; Kitchin, 2014) has changed the way in which institutions, governments and companies rethink decision-making processes (Cukier and Mayer-Schoenberger, 2013). This has impacted on the job market and, as a result, several new professional figures are emerging to face the challenge posed by the considerable volume of data

generated on the Web. Data scientists, analysts and engineers are in greater demand than ever before and, for many companies, they are still hard to find (Storey and Song, 2017). Thus, although in 2012 the Harvard Business Review baptised the data scientist as the sexiest job of the 21<sup>st</sup> century (Davenport and Patil, 2012), understanding and dealing with data remains a

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major challenge for organizations (Schewe and Thalheim, 2008). The data scientist's profession is a complex one based on a multifarious set of capabilities and knowledge: according to the ideal profile, the data scientist should possess technical skills enabling the scientific collection, analysis and use of quantitative data in addition to managerial and communication skills ensuring profitable interactions with decision-makers and managers (Agasisti and Bowers, 2017). These skills can only be acquired by completing an interdisciplinary study path, but universities have been slow to meet this educational challenge: there is a fair number of data science degree programs, specializations and master's programs around the world (Dumbill et al., 2013), while undergraduate degree programs are scant and imprecise (Aasheim et al., 2015). What is needed is a strong response and a joint commitment from both educational institutions and companies in order to balance supply and demand in the field of data science (IBM, 2017).

As drivers of innovation, universities can influence the social and economic environment in which they operate (Goldstein, 2010; Kruss et al., 2012; Guerrero et al., 2016; Etkowitz and Zhou, 2017). In an ever-changing world, therefore, universities must engage in upgrading strategies and policies in order to prepare students with knowledge, skills and aptitudes in line with technological trends and advances: the alignment of academic goals with the business world is thus essential in order to enhance the creation of future professionals (Perera et al., 2017).

Davenport and Patil (2012); Fisher et al. (2012); Granville (2014) and Besse and Laurent (2016) on the issue of data scientist tried to describe this professional figure, highlighting the characteristics and the main work tasks they carry out within companies: unfortunately, there is still no clear and shared definition, given the complex set of skills that a data scientist must have to be present in different market sectors.

The objective of this study is to explore the gap, in terms of developed skills, between universities' educational offer and the companies' competences requirements, explored by means of job demand on the business-networking website LinkedIn in Italy. The match detected refers to the wider debate about cooperation between universities and business in building programs, in order to allow graduates to acquire the right skills and mindset required by the job market.

In Italy, the Big Data Analytics market is growing steadily: in 2018, it was estimated to amount to 1.4 billion euros, +26% compared to 2017. According to Osservatori.Net (2018), investment in analytics, mostly in large companies, is focused on software development (45%), services (34%) and infrastructure (21%), and the demand for data science skills is increasing: 46% of large companies have already hired data scientists. Despite the growth of a ripe data science management model (from 17 to 31%), more than half (55%) of these apply a

traditional organizational model. The adoption of descriptive analytics has resulted in an increase in the number of fast data initiatives, such as real-time advertising, fraud detection, predictive maintenance and new product development. The most serious obstacles to progress along this path are the lack of both skills and an internal workforce (53%), followed by scant management involvement (27%), as well as the difficulty in recruiting professionals with suitable skills (18%).

The data scientist's job requires a unique combination of skills, usually comprising both a solid foundation in data science and an innate talent for synthesizing complex ideas, thus addressing decision-making processes in organizations. The data scientists are so rare that some managers likely associate them with unicorns. Some researchers tried to give a definition of the data scientist by analysing the main work tasks in companies. On the contrary, other researchers qualify data scientists for their knowledge in statistics, computer science and information technology, in order to determine the appropriate skills to perform these certain tasks. We intend to contribute to this topic, sustaining a greater collaboration between universities and companies to fill the talent gap combining all the skills requested.

In order to understand what Italian universities are doing to fill the talent gap, we have collected data on current study programs in data science. The textual data retrieved on universities' official websites constitute the linguistic corpus, which we have processed using the Natural Language Processing (NLP) software environment NooJ. This tool gives researchers the opportunity to match large corpora with specific linguistic resources. The linguistic resources used in this paper are a set of automatically annotated local entries that express the data scientist's characteristic features, taken from the literature survey and from companies' job advertisements on LinkedIn. In this way, we explore the skills developed through data science education and match them with those most requested by companies in order to draw up guidelines by balancing supply and demand. After this introduction, we provide a survey of the literature on data science and then focus on data science education within specific study programs. This is followed by an explanation of the methodology used to process the textual data on study programs. The NLP experiment is then described and the main results are shown. The final section presents a discussion of the results and some concluding remarks.

## THE DATA SCIENTIST: A LITERATURE REVIEW

In recent years, organizations' need to derive insights from data is growing, and consequently, companies are searching for a staff with analytical expertise. However, the so-called data scientists are quite rare.

Demand for data scientists started to rise in the late

20<sup>th</sup> century, especially among companies operating in the San Francisco area (Davenport, 2014). According to the Data Scientist Report 2018, data scientists are still in great demand and people with analytical expertise are being presented with new job opportunities several times a week. This survey involves 240 respondents from companies, 70% of whom still work with structured rather than unstructured data (Figure Eight, 2018). As a result, the advent of big data poses a number of challenges for management (Schewe and Thalheim, 2008; Chen et al., 2013), including difficulties in recruiting data scientists (Davenport and Patil, 2012). Hence, while many large companies, like LinkedIn, IBM, Macy's and General Electric are augmenting their teams with data scientists capable of managing big data technologies (Davenport and Dyché, 2013), other companies still seem to be struggling to source these rare professionals (Storey and Song, 2017).

Provost and Fawcett (2013) observe that, in order to serve the business demand for data scientists, it is important first of all to define the discipline of *data science*, pointing out its fundamental features and their relationship with other knowledge fields. The authors suggest that there are two reasons why this concept is often confused: firstly because it has been developed simultaneously with other concepts such as big data or data-driven decision-making; and secondly because the absence of academic programs leads people to associate the data science field only to what practitioners do, without identifying appropriate theoretical aspects.

From our point of view, Davenport and Patil (2012) provide one of the first definition of the data scientist: 'a high-ranking professional with the training and curiosity to make discoveries in the world of big data' (p. 72). However, there is a clear research gap in the formal definition of the 21<sup>st</sup> century's most prominent job (De Mauro et al., 2018; Hu et al., 2018), partly in view of the great number of different job roles that have been erased with the advent of big data (Miller, 2014), such as the data analyst, the data engineer, the big data expert or the big data architect. Giaume (2017) highlights how the data scientist is not a novelty and suggests that the innovative element of current data scientists probably lies in the fact that they now deal not only with numbers, but also with different type of contents, like images, audio and video. On the other hand, Besse and Laurent (2016) state that the new role of the data scientist should associate two types of approaches or logics: the *statistician logic*, which infers or checks for errors or risks in specific procedures, and the *computer scientist logic*, which designs the best strategy to minimize errors and optimize complex models in order to reach research objectives. The challenge for data scientists is methodological: innovative technological change affects choices of analysis strategy.

Some studies have attempted to classify data scientists according to their features. Granville (2014) identifies Vertical and Horizontal data scientists. *Vertical data*

*scientists* have highly developed technical knowledge and skills. They are experts in statistics, computer science and operational research or hold an MBA, but they do not manage all these aspects together. *Horizontal data scientists*, on the other hand, combine vision with innovative data-driven techniques applied to unstructured data: they need to possess cross-disciplinary knowledge, including computer science, statistics, machine learning and domain expertise. These features can be related to the model by Davenport (2014), who recognizes five data scientist personalities: *the hacker*, who has the ability to write and program codes; *the scientist*, who can take decisions and possesses improvisation, impatience and orientation to the action; *the adviser*, who possesses strong communication skills; *the quantitative analyst*, who is able to use innovative quantitative techniques in statistics; and *the business expert*, who has a thorough knowledge of the business domain in which he/she operates.

Other authors have also defined the data scientist by underlining different aspects. For instance, Van der Aalst (2014) considers data scientists as the engineers of the future. He affirms that data science involves social sciences, industrial engineering and visualization: the data scientist is an engineer with quantitative, technical, creative, communicative skills, 'able to realize end-to-end solutions' (p.10). Dahr (2012) points out how machine learning skills are fast becoming a necessary skill set comprising statistics, computer science and problem-solving. In addition, text mining and knowledge of mark-up languages are also becoming fundamental.

A few studies focus on the typical data scientist workflow in companies. For instance, Fisher et al. (2012) interviewed 16 data analysts at Microsoft and identified their typical activities as consisting of acquiring data, choosing architecture, shaping the data to the architecture, writing and editing code, reflecting and iterating on the results. In a prior study, Kim et al. (2016) also interviewed 16 Microsoft data scientists and, two years later, presented a large-scale survey with 793 data scientists, again at Microsoft, in order to understand their educational background, the main work topics, the tools used and activities accomplished (Kim et al., 2018). Harris et al. (2013) investigate how 250 data scientists view their own skills, careers and experiences. The authors recognize four types of data scientist: Data Businesspeople, Data Creatives, Data Developers and Data Researchers, each of them with a profound expertise in a single skill set. They include the skill list obtained in the 'T-shape' model, made by Business, Machine Learning/Big Data, Mathematics/Operations Research, Programming and Statistics. Finally, Kandel et al. (2012) also interviewed 35 analysts in commercial companies ranging from healthcare to retail, finance and social networking. The authors recognize that analysts must have an aptitude for *discovery*, *wrangling*, *profiling*, *modelling* and *reporting*. Lastly, the role of visualization



skills is emphasized as an outcome of the whole data scientist workflow.

### Universities' commitment in filling the talent gap

The heated debate over the skills data scientists need to have brings the role of education into play. According to Song and Zhu (2016), education is the key to success in data science: appropriate strategies are needed to prepare future professionals and universities should fast-track in creating degree programs for students (Fisher et al., 2012; Miller, 2014). According to Deloitte (2016), universities and colleges do not produce data scientists fast enough to meet business demands: despite the surge in data science programs the response of higher education seems to be inadequate because of the multifarious skills set that a data scientist should possess.

Some authors provide a description of current data science programs in order to assist universities in designing and developing undergraduate courses (Anderson et al., 2014; Aasheim et al., 2015; Baumer, 2015; Hardin et al., 2015; Asamoah et al., 2017). De Veaux et al. (2017) introduce an integrated curriculum that combines three disciplines offered separately in traditional courses like mathematics, computer science and statistics. Moreover, six main subject areas are identified in order to create a successful data science program: Data description and curation, Mathematical foundations, Computational thinking, Statistical thinking, Data modelling, Communication reproducibility and ethics.

In some cases, researchers pay attention to current or future programs that regard graduate students as analytics managers. Wilder and Ozgur (2015) propose an innovative Business Analytics program incorporating features of management and computer science in which they enhance the role of quantitative and technical skills together with soft skills like problem solving, teamwork and communication. Gupta et al. (2015) aim to develop a new training model, in which appropriate elective courses are added to existing curricula in order to foster the development of Business Intelligence skills, knowledge and experience for undergraduates, masters and MBAs. Finally, De Mauro et al. (2018) provide a big data skills framework that is useful for human resource recruiters and education providers in meeting the demand for four job families: business analysts, data scientists, developers, system managers. In particular, data scientists need knowledge of business impact, project management, database management and analytics.

In short, the literature reviewed shows a growing interest in data scientists and the majority of authors agree on the lack of academic programs. A stronger commitment to university-business collaboration is needed in order to design innovative educational paths and offer a better training. In the light of the literature

examined, our proposed classification groups data scientist skills in nine clusters:

- (i) Analytical skills. The ability to collect, analyse and interpret data, in order to help solve business problems and assist in decision-making.
- (ii) Educational requirements. The degree of education, certifications, qualifications and the scientific domain of specialization.
- (iii) Effective communication. The ability to communicate work results in one's own language but also in at least one foreign language (both in writing and orally).
- (iv) Machine learning. The ability to research and develop algorithms and the capacity for automatic application of complex mathematical calculations to data.
- (v) Knowledge management. Knowledge of the employer company and the ability to understand how the data can be useful in different business units.
- (vi) Mathematics and Statistics. The ability to apply statistical models, concepts and processes to given situations using innovative tools.
- (vii) Programming and Software development. The ability to write and program codes together with an understanding of big data architectures and infrastructures.
- (viii) Soft skills. Interpersonal qualities and individual aptitudes, abilities such as teamwork and problem-solving, communication and self-management, critical thinking and ethics.
- (ix) Visualization skills. The ability to turn data into innovative graphics or charts so as to uncover patterns, correlations and trends that will help people to understand which insights should be gained from the results.

We provide keywords or expressions used to describe the desirable features of a data scientist in Table 1, which will be used to build the linguistic resources necessary to carry out our text mining experiment.

### MATERIALS AND METHODS

To compare the skills that universities intend to develop with those that companies seek to achieve their strategic goals, we combine quantitative and qualitative techniques in analysing textual data: the qualitative analysis is used to explore the meaning of words, while the quantitative analysis gives us the dimension of phenomenon in numerical terms. In business studies, this combination of quantitative and qualitative methods involves a sort of sensitivity to context, thus getting richer descriptions rather than only quantifiable metrics. When both approaches are used together, we can retrieve wider information.

Therefore, the analysis that we apply to textual data is not based only on key words, but it examines the context in which they are expressed and determines the meaning. We realised a semi-automatic textual analysis of the two main sources of information: on the one hand, all the texts referred to study programs and educational objectives; on the other hand, all the texts referred job advertisements that companies publish when they research the

**Table 1.** Words or expressions contained in each data scientist skill cluster.

Skill cluster	Some words or expressions
Analytical skills	Information retrieval; data storage; cloud computing; business intelligence; sentiment analysis; text mining; predictive analysis
Educational requirements	Bachelor's Degree; Master's degree; Doctor of Philosophy; PhD; MBA; Degree in Computer Science, Statistics, Mathematics, Physics
Effective communication	Communication ability; interpersonal communication; public presentations; ability to summarize; fluent in English; native speaker
Machine learning	Artificial Intelligence; neural networks; deep learning; learning algorithms; robotics; machine translation; pattern recognition
Knowledge management	Decision support systems; digital transformation; project management; market researches; customer satisfaction; business strategy
Mathematics and Statistics	Mathematical background; linear algebra; calculus; probability; statistical modelling; multi-dimensional data analysis
Programming and Software development	Solutions architecture; Python; Java; NoSQL; Web Development; Agile methodologies; real-time processing
Soft skills	Team working; problem-solving; leadership; goal orientation; emotional intelligence; motivation; entrepreneurial mindset; creativity; sense of responsibility
Visualization skills	Visualization of networks; interactive dashboards; reports; data visualization; reporting and analysis; dash-boarding

data scientist on LinkedIn. We took into consideration the population of all Italian universities and all the announcements for the data scientist on the business-networking website LinkedIn, all published in the time when we started our data collection, in March 2019.

### The Lexicon-Grammar: A conceptual framework for textual analysis

The investigation carrying out in this paper performs a combination of statistical and computational linguistics techniques of analysis. We introduce a semi-automatic linguistic analysis of textual data that enriches traditional statistical methods in text annotation and increasingly constitutes a key step to retrieve more and more precise information from large corpora. To understand better the method and the techniques used, we start from the Lexicon-Grammar (LG) conceptual framework, according to which, in a text, the elementary unit of meaning is the simple sentence. It is not possible taking in consideration words without considering the linguistic context in which they are expressed. Maurice Gross defines LG as the method and the formal description of the natural language in the second half of the 1960s. The LG involves the systematic syntactic description of the lexicon and goes beyond the exclusive search for general syntactic rules, regardless of the lexical material (Gross, 1968, 1979). In order to ensure good reproducibility of the observations, the affirmative simple sentence is considered as the minimal linguistic unit: a word acquires a certain meaning only in a certain syntactic context (Vietri, 2004). In other words, in order to derive high-quality information from texts, we cannot only consider single words and how many times they occur in the text, but we must observe the context in which words are inserted. In the LG methodology, therefore, the collection and analysis of a large quantity of linguistic resources and their continuous comparison with the reality of linguistic usages are crucial. This linguistic approach applied to NLP makes it possible to enrich statistical methods used in text annotation and increasingly constitutes a key step in the analysis of large corpora.

The LG uses electronic dictionaries (Appendix) to have definitions about special terms), lexicon-grammatical tables and

local grammars to formalize the natural language. For this experiment, we have built a specific local grammar to define the data scientist semantic field. Local grammars are algorithms that, through syntactic, morphological and lexical instructions, formalize linguistic phenomena and enable the automatic processing of texts. By *local* we mean that these grammars can be used for the description of specific linguistic phenomena.

For instance, the data scientist grammar that we have created is a collection of 276 entries referring to data scientist features: 105 are single words, while 171 are multiword expressions. *Single words* are words without breaks or blanks, whereas *multiword expressions* are sequences of two or more simple words separated by a blank and characterized by a semantic atomicity (Gross, 1986). These expressions unambiguously identify a specific concept and, for this reason, multiword expressions are more relevant although less frequent than single words in terminology or technical lexicons. The linguistic resources are in Italian and English, due to the massive presence of English words in the data science semantic field. The local grammar contains ten graphs with the skill clusters presented in Table 1 above: there is one main graph and nine embedded ones. The words and expressions declared therein are examples of words inserted into each graph.

### Collection, pre-processing and processing corpus

The first research phase consisted of a text collection. We collected texts from all the official websites of Italian universities offering study programs in data science for the academic year 2018-2019. In March 2019, we collected by means a scraping procedure published texts about program presentation, objectives, study plans, lessons, requirements, contents and learning methodology. In statistical terms, our data represent the whole population with reference to textual online materials about study programs in data science offered by all Italian universities. We gathered texts according to their educational degree: Bachelor's degree (BA), Master's Degree (MA) and Master postgraduate programs. In order to obtain a general overview of data science education in Italy, we also collected other types of information in a dataset that we would consider in the descriptive statistical analysis. The dataset, built

**Table 2.** Distribution of local entries in the corpus parts

Part	Size	AF	EF	SS
Bachelor's degree (BA)	8,235	64	37.05097	1.219891
Master's degree (MA)	70,854	319	318.7868	0.00965
Masters post graduate	33,153	122	149.1622	-1.22954

likewise in April 2019, contains the following fields taken from the official websites of Italian universities: program type, program name, degree class, program duration, university, location, department, internship, language, costs and requirements.

The second phase involved the cleaning and normalization of the retrieved texts so as to give them a format suitable for the corpus-processing phase. Linguists perform the text cleaning and normalization manually: for instance, white spaces and punctuation are removed in this process. Even numbers, dates, acronyms and abbreviations are *non-standard words* (Sproat et al., 2001) and had to be standardised in order to obtain the correct results in the linguistic analysis. Moreover, some words needed to be transformed from upper case to lower case, e.g. 'Big Data' to 'big data', and punctuation marks and some type of accents had to be deleted.

In the third phase, we included and processed all the texts in a single corpus using NooJ: a NLP software environment and corpus processor constructed by Silberstein (2003, 2015). The NooJ software environment makes it possible to process large corpora and develop orthographical and morphological grammars, dictionaries of simple or multiword expressions, as well as local and structural syntactic grammars. In other words, NooJ gives researchers the possibility to create specific linguistic resources and to store them in large corpora in the form of concordances, which represent the context in which the words are inserted.

## RESULTS

### Descriptive analysis

Data science is not widely taught in the Italian education system. Currently, out of 97 Italian universities (MIUR, 2019), 17 offer study programs in data science and big data analytics. In total, there are 21 study programs: 13 in Northern Italy, 6 in Central Italy and 2 in the South. As far as their educational level is concerned, 5% are BAs, 67% are MAs, 19% are first level Masters (after BA) and 9% are second level Masters (after MA). The degree classes to which the study programs belong are Statistics (9.5%), Physics (9.5%), Mathematics (9.5%), Computer Science (19%), Electronic Engineering (4.8%), Computer Science Engineering (4.8%), Techniques and Methods for the Information Society (14.3%). However, we can observe a prevalence of 2-year study programs (81%).

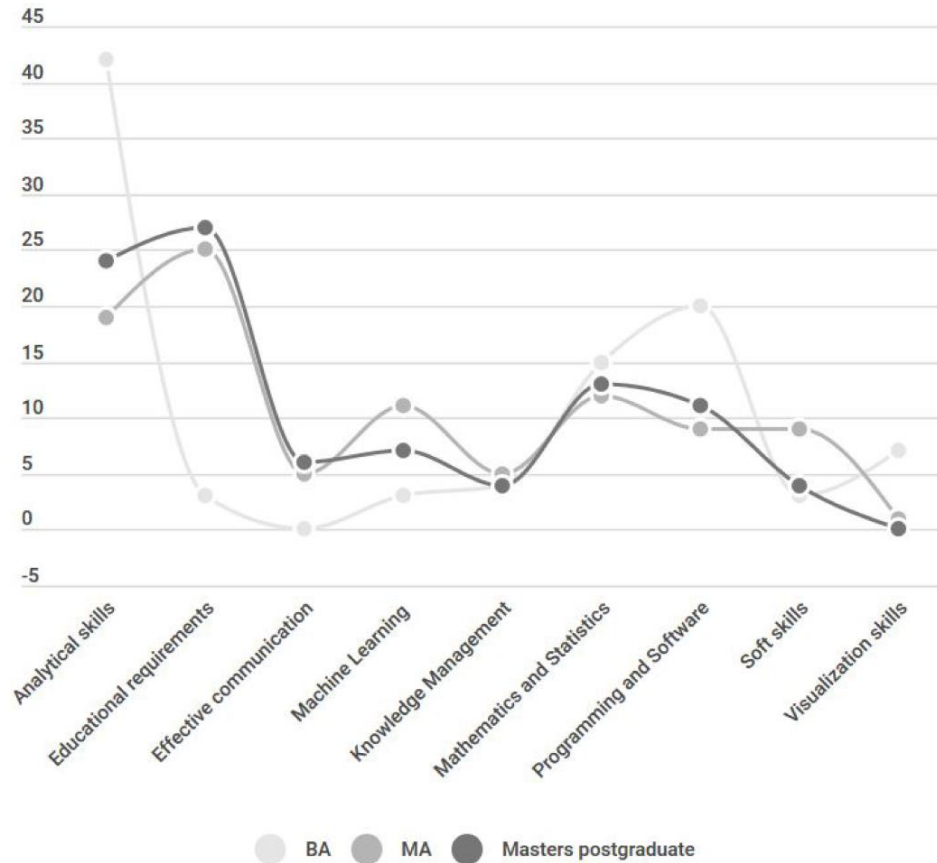
All the study programs identified are conducted in English. Indeed, the most common entry requirement (86%) is at least a B2 level of English, although only 14% of these need a formal certificate, while 57% of the study programs require a qualification in specific disciplines like Computer Science, Computer Engineering, Physics, Mathematics or Statistics. The cost of registering varies

from 0 to 16,000 euros per annum, depending on the students' income, type of course and university. In particular, the BA in data science costs from 0 to 2,500 euros and the MA in Data Science costs from 1,350 to 14,000 euros; the cost of the first level Master's course varies between 3,200 and 6,000 euros, whereas the second level Master ranges from 9,000 to 16,000 euros. Finally, an internship is envisaged in the majority of study programs (81%), in 14% it is not provided for and in 5% no internship is specified.

### Concordances and statistical analysis

According to the linguistic analysis within NooJ, the corpus consists of 112,242 characters and 18,478 tokens, of which 15,720 are word forms. In the phase of lexical acquisition by the corpus, we extracted a further 63 lexical entries to add to the data scientist local grammar: 60 multiword expressions and 3 single words. At present, there is a total of 399 lexical entries in the grammar, of which 108 are single words and 231 are multiword expressions. For example: *Matematica*, Noun (N), 'Mathematics'; *trattamento di dati*, Noun+determiner+Noun (NdN), 'data processing'; *statistica inferenziale*, Noun+Adjective (NA), 'inferential statistics'; *scientific communication*, Adjective+Noun (AN); *finance for big data*, Noun+Preposition+Adj+Noun (NPN).

At this point, we performed concordance analysis, which matches the local resources with word forms in the corpus. We found 505 matches in the corpus, distributed in word forms as follows: 21% N, 58% AN, 6% NA, 8% NdN, 2% NPN and 5% Acronyms (Acr.). The number of multiword expressions is higher than single words, which makes it possible to disambiguate a larger number of lexical entries and enables a deeper analysis of the meaning hidden in the corpus. The value of the Normalized Standard Deviation (NSD), indicating the distribution of words in relation to the number of matches in the corpus, is 0.0437. This points to a fairly regular distribution of lexical entries among all the texts. Table 2 reports the difference between corpus parts in terms of words frequency. The size of the texts (number of characters) is indicated in the first column, AF indicates the Absolute Frequency of matches in each text, EF is the Expected Frequency in each text and SS is the Standard Score  $(AF - EF) / SD$ , where SD is the Standard Deviation. In the MA, the AF and the EF values are

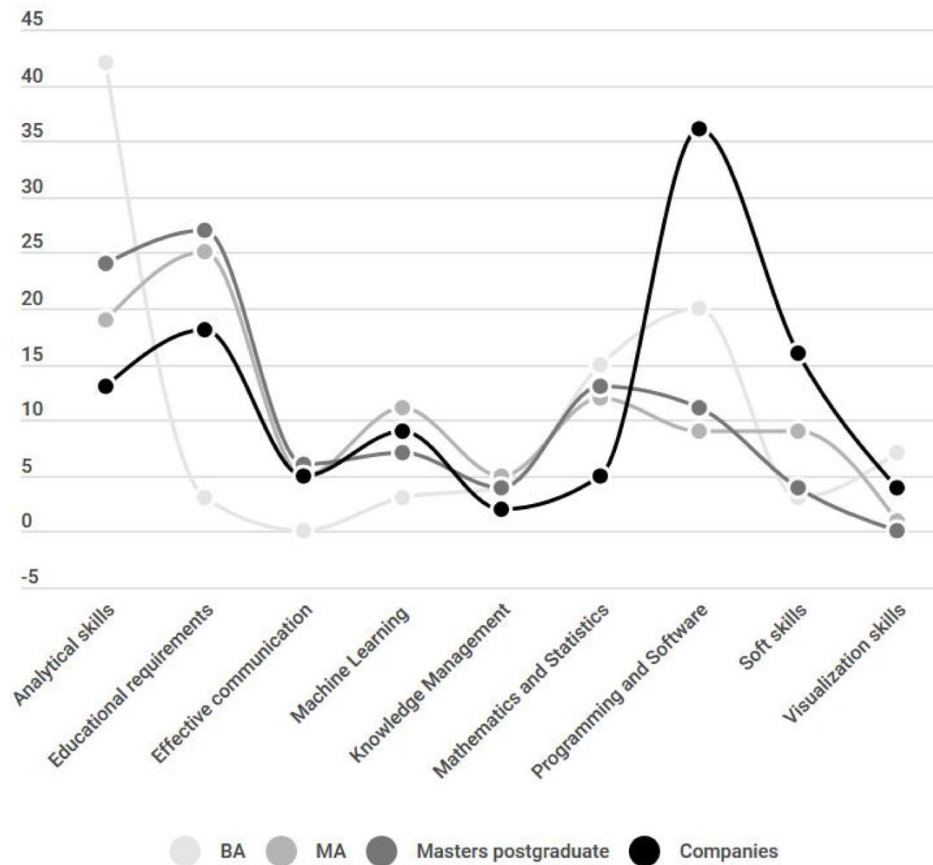


**Figure 1.** Skills cluster distribution in different study programs.

similar, so the value of SS is close to 0. This does not occur in the BA and Masters.

In order to ensure a clearer picture of word frequency in the corpus, we have put words with similar or identical meanings together. In the pre-processing phase, every possible variation of natural language has to be considered: after concordance analysis, lexical entries are regrouped according to different criteria. For instance, we combine the translation from Italian to English and vice versa, such as 'Game theory' and 'Teoria dei giochi' or even 'trattamento di dati' and 'data processing'; plural and singular entries, such as 'report' and 'reports'. Another criterion is referred to the lexical entries with the same meaning in terms of owned skills: 'data warehousing' with 'data warehouse', where the first identifies the storing activity and the second represents the storage, but in both cases, they refer to the same ability to cope with a data repository. Another issue in the NooJ processing phase concerned the difference between capital and small letters, which in some cases is essential to disambiguate entries; in other cases, it doubles word frequency (e.g. 'data processing' and 'DATA PROCESSING' or 'Data mining' and 'data mining'). We regrouped these lexical entries as far as possible. We were then able to identify the ten most

frequent entries in the corpus of data science study programs in Italy: 'machine learning' (33) and 'statistics' (33), followed by 'Computer Science' (23), 'algorithmic methods' (18), 'data management' (18), 'data analytics' (18), 'data mining' (15), 'Engineering' (13), 'English' (13), 'Physics' (13). Concordance analysis highlights word distribution according to the nine clusters mentioned above. In the pre-processing phase, we divided lexical entries into nine hidden hubs composing the data scientist local grammar. The most relevant cluster was Analytical skills (24%), followed by Educational requirements (23%), Mathematics and Statistics (13%), Programming and Software development (11%), Machine Learning (10%), Soft skills (7%), Effective Communication (5%), Knowledge management (5%) and Visualization Skills (2%). Subdividing the findings into the BA, MA and Masters programs identifies the differences in cluster distribution. In other words, we learn what kind of skills the university aims to develop in students, according to the educational level (Figure 1). The Analytical skills cluster (42%) prevails in the BA, followed by Programming and Software (20%), Mathematics and Statistics (16%). The educational requirements cluster (MA= 25%; Masters= 27.9%) occurs more frequently in both MA and Masters, followed by Analytical skills (MA = 20%;



**Figure 2.** Comparison between companies' skill clusters and universities' skill clusters.

Masters= 12%) and, finally, Mathematics and Statistics (MA= 25%; Masters= 13%). The least important clusters are Effective communication for the BA and Visualization skills for the MA and the Masters. Another difference worth noting concerns the Programming and Software cluster, which is more important in the BA than in the MA and the Masters programs.

In order to verify the talent gap, a comparison has been made between what universities offer and what companies demand regarding data scientists' skills. In previous research (name deleted to maintain the integrity of the review process), we processed a corpus of 394 job advertisements on networking website LinkedIn so as to classify the skills required to be hired as a data scientist by companies in Italy. We applied the results of the linguistic analysis of companies' job advertisements to the universities study programs (Figure 2). The curve generated by the clusters distribution in companies appears to have a similar trend for the MA and Masters programs, except for the Programming and Software cluster which presents a lower value in the study programs compared with the companies' value. However, the MA and Masters programs appear to offer a better fit for the working world. The BA follows a different evolution, giving greater importance to Programming and

Software.

## DISCUSSION

Despite the increasing need that companies in Italy have for data scientists, higher education has been slow to react: in the 2018/2019 academic year, we find just 17 study programs. Moreover, they are not evenly located throughout the country, because their concentration has been relieved mainly in Northern Italy, the most highly industrialized part of the country. The study programs offered by universities are not only few, but most of them, are specialized post-degree paths lasting one or two years, with just one path lasting three years. This kind of study path is too short to acquire the adequate and complex skills set necessary to become a data scientist. As we explored in literature, this profession involves not only technical skills enabling the scientific collection, analysis and use of quantitative data, but also a multifaceted set of competences, being able to predict problems and to communicate the best solutions for the company according to Agasisti and Bowers (2017) and Van der Aalst (2014). It means also being able to handle the whole process of storage, analysis, integration,

visualization and communication of data. The data science profession supersedes the traditional profession of the data scientist (Davenport, 2014). While once it was sufficient to acquire technical knowledge in order to become an expert in statistics, computer science or operational research, nowadays the data scientist needs to develop a cross-disciplinary knowledge, which includes traditional domains and adds a more innovative and data-driven vision. As far as higher education is concerned, this calls for a commitment in designing new study paths for data scientists, while not neglecting soft skills, creativity and data visualization. In a changing environment, soft skills assume greater importance in increasing students' responsibility and their ability to adapt to a dynamic job market. It entails understanding the commitment and specific characteristics of the workplace: being ethical, balanced, able to work autonomously or as part of a team, leadership, results orientation, management and continuous improvement skills (Succi and Canovi, 2019). Differently from suggestions by literature analysed and companies requirements, Italian study programs are not focused on enhancing soft skills because they are only recognised as having a low value. Our linguistic analysis associates them exclusively with words like 'problem solving', 'active participation' and 'team working', reducing the richness and the variety of the concept which includes the ability to plan and communicate work results, self-management, critical thinking and creativity.

The talent gap, which emerges in a very visible way from the study, underlines the increasingly necessary cooperation not only in the phase of leaving the university, but also within the training path. For too long universities have been disconnected from the companies, producing a marked misalignment between job supply and demand, leaving both unsatisfied the employment needs of companies and the professional aspirations of graduates.

Within companies, the conflict between chaos and discipline, order and disorganization, strictness and imagination is mostly unresolved: overall, companies prefer regulation to imagination or creativity. However, creativity helps to add innovation to the organization, because it breaks the rules and makes it possible to assimilate new elements. As a result, the data scientist profile needs to open up to creativity, so as to be able to handle numbers with an innovative vision. Data visualization is likewise undervalued in the study programs considered. Although data mining allows us to extract knowledge, there are many hidden or unknown aspects, which can be analysed or identified only with human judgement: data visualization 'may reveal patterns that would otherwise remain unnoticed' (Van der Aalst, 2014: 12) by exploiting human capabilities for perception.

Our findings reveal further information on the distribution of skill clusters in study programs: the only BA study program is mostly focused on the development of

Analytical skills such as big data analytics, data integration and data warehousing: concepts aiming to introduce data analysis. The MA and Masters are more likely in Educational requirements: these study programs are oriented towards deep knowledge fields that have already been studied in a previous degree path, such as Statistics, Mathematics, Physics and Computer Science, while effective communication, knowledge management, soft skills and visualization are largely undervalued.

Finally, the comparison between companies and universities reveals some difference between what education offers and what business requires. Companies need a strong specialization in Programming and Software, which is less relevant in universities' study programs. From the companies' viewpoint, data scientists must be able to use programming languages that allow them to access, explore and model data; data scientists must be skilled in software development, such as Java and C++, and familiar with many aspects of computational science and software engineering.

An internship is envisaged in most of the study programs analysed, in recognition of the importance of interaction between university and industry, but it is generally too short to enable this practical experience to generate interesting results in terms of new knowledge. We look forward to the internship being improved in terms of duration and quality (Della Volpe, 2017).

The challenge for higher education is to design new interdisciplinary paths, integrating knowledge from STEM disciplines (Science, Technology, Engineering, Maths), with those from humanities in an innovative vision. While the university programs considered are entirely focused on STEM disciplines, companies are already looking for creativity and communication skills. This means that the future is moving towards new frontiers and universities should not neglect this.

At the same time, it is important to remember that as data dissemination comes from a wide variety of data sources, it requires a rapid shift in the workforce in order to meet demand in the job market. In order to fill the gap between the academic and the business worlds, a new up-skilled and re-skilled workforce needs to be developed. As technologies change rapidly, students and workers should be prepared to engage in continuous training and learning in order to be employed in future jobs, the ones that have not yet emerged. The next generation of students should be trained in data literacy so as to manage data relevance while they are still at school (Deloitte, 2019). Universities and industries could collaborate by creating common data labs or communities so to work together in solving real business problems.

## Conclusion

The challenge for universities is to integrate new study

programs in more interdisciplinary paths; the challenge for enterprises give space to the creativity, in order to view common collaboration. We limited our analysis to Italian case: for a comprehensive and worldwide overview, one should analyse other context in different countries universities. At the same time, we took into consideration only the public information provided by official universities' websites, because they constitute the best way to know the educational offer. However, we actually ignore what universities communicate on other social platforms, such as Twitter, Facebook, Instagram, LinkedIn. Besides, we are aware that this data provided by the universities' official website are related to the academic year 2018-2019: they can change year by year and it should be realized a longitudinal analysis to catch the change. Future researches could focus on comparative studies on this topic to highlight similarities and differences among countries.

## CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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## APPENDIX

**Concordance:** collection of all the co-texts of the same word (pivot) in the corpus.

**Corpus:** collection of texts, consisting of one or more elements (fragments), consistent with each other for study purposes; when the collection of texts that makes up the corpus is large (several tens, hundreds or thousands of fragments), it is possible to associate structured information (coded data constituting quantitative or qualitative variables) to each element of the collection.

**Disambiguation:** elimination of the ambiguity of a lexical unit; action to attribute to a word the right grammatical category or the authentic meaning in a given context.

**Electronic dictionary:** it is a dictionary stored in the form of computer data (lexical database) rather than in human readable format. An electronic dictionary can be loaded into a database and interrogated by means of special software. The term electronic dictionary is also used to refer to an electronic vocabulary or lexicon, such as those used by spelling checkers. If a dictionary is structured through a hierarchy of supertype-subtype concepts, it is called taxonomy. If it also contains other relationships between concepts, it is called ontology. Search engines use vocabularies, taxonomies or ontologies to optimize search results. Specialized electronic dictionaries are, for example, morphological or syntactic dictionaries.

**Entry:** unit of a list or of a dictionary or of other lexical index.

**Lemma:** pair of information [canonical form, grammatical category] present in a language dictionary.

**Lexical Analysis:** level of study of the language in a corpus; the domain of Lexical Analysis is the vocabulary of the corpus; the product of a Lexical Analysis activity is the annotation of the lexical units.

**Natural Language Processing (NLP):** natural language treatment; set of automatic procedures for linguistic and / or semantic recognition of the words or of the sentences in a text.

**Occurrence:** (token, reply), each appearance of a word in the text; the frequency of a word in a text is given by the number of its occurrences (more properly we speak of normalized frequency).

**Semantics:** discipline of linguistics that studies the meaning of words or of sentences. The semantic units of analysis are lexemes, that is, the words studied from the point of view of meaning. The set of lexemes of a language constitutes its lexicon.

**Text Mining (TM):** exploration and "excavation" activity in a deposit of textual materials (corpus) for information retrieval and extraction; complex procedures for extracting knowledge, aimed at creating value, from vast documentary bases of companies or institutions

**Text Normalization:** Transforming non-standard words in a readable format for the computer. For example, white spaces and punctuation are removed in this process. The use of extensive social media has resulted in a new form of written text, this poses new challenges to natural language processing.

**Text unit:** lexical analysis unit for the automatic analysis of a text; occurrence; type; V = verb, N = noun, A = adjective, AVV = adverb etc.

**Textual Analysis:** level of study of the occurrences (single appearances of the lexical units) of a corpus; the domain of Textual Analysis is the set of fragments of the corpus; the product of a Textual Analysis activity is the annotation of the context units (categorization of fragments or documents).

**Textual data:** information about phenomena expressed by words. The textual sources are, therefore, interviews, open questions of a questionnaire, reports of a focus group, political speeches, material taken from the Internet, documents and much more.

**Textual:** attribute inherent in the text that is concerning the development of discourse in the corpus

**Token:** single occurrence or replica of a type; the set of tokens of a corpus expresses its extension or amplitude in occurrences.

**Tokenization:** process of segmenting the text into occurrences or tokens, based on a sequence of characters - defined as belonging to an alphabet - delimited by separators.

**Vocabulary:** list of the different lexical units of a corpus with the corresponding occurrences.

**Word:** conventional and generic term to identify the text analysis unit.

*Full Length Research Paper*

# Research on risk early-warning system of transitional operation of Africa-related enterprises

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Received 23 October, 2019; Accepted 15 January, 2020

The growing business prosperity in African countries has brought new opportunities for enterprises to carry out transnational operation in Africa; however, it may also be accompanied by some transnational operation risks. Enterprises incorrectly identify and analyze these risks, which brings enterprises great uncertainty and huge losses. So enterprises should establish a transnational operation risk management system as soon as possible to ensure the healthy transnational operation in Africa. Based on the survey of 83 experts at African research and the relevant literatures, this paper puts forward a transitional risk early-warning evaluation index system composed of 8 primary indexes including strategic management risk, operation management risk, human resource risk, marketing risk, supply chain management risk, financial management risk, national political risk and macro environmental risk. This paper also determines the weights of the indexes by AHP method and sets the transitional operation risk early-warning evaluation standards based on advice from experts. Furthermore, this paper takes 259 Zhejiang Africa-related enterprises as samples and assesses the transitional operation risk of them by the system established, finds that human resource risks, financial management risks, national political risks and national macro environmental risks are relatively large. Finally, some suggestions are given.

**Key words:** Risk early-warning index system, transitional operation, Africa-related enterprises.

## INTRODUCTION

Since the 21st Century, with the rapid development of information technology and the high degree of globalization of industry, transitional operation has not only been widely adopted by large enterprises in developed economics such as EU, US and Japan; more and more SMEs (small and medium-sized enterprises) in emerging economies, with China as the representative, have been rapidly improving their transnational operation, and have obtained a remarkable transnational operation

performance (Li et al., 2017). As one of the largest emerging markets in the world, Africa has abundant resources and great market potential; in addition, a series of remarkable changes have taken place in political and economic situation in recent years, which is characterized by increasingly stable overall political situation and sustained economic growth. At present, Africa markets are ripe with business opportunities for enterprises to exploit. Thus, it is important for Chinese enterprises to

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timely grasp these business opportunities in Africa as well as effectively manage the potential risks (Modou and Liu, 2017). The proposal of the belt and road has also brought a new historic opportunity for Chinese enterprises to expand their investment in Africa and deepen the cooperation with Africa. At the same time, African countries have seized the historical developing opportunity to speed up the industrialization and economic integration in Africa. With China-Africa economic and trade cooperation constantly upgrading, Africa becomes a new blue ocean and the favored destination for Chinese enterprises to expand international presence. However, in the face of great opportunities, there are also some challenges in the transnational operation in Africa for Chinese enterprises (Doku et al., 2017). Under this background, how to scientifically analyze and evaluate transnational operation risks has become an important issue in transnational operation of Africa-related enterprises. The Africa-related enterprises are the enterprises that carry out transitional operation in Africa countries.

Throughout the existing literatures, a lot of research on risk early-warning of transnational operation has been done by scholars (Tong and Reuer, 2007; Jensen and Young, 2008). However, due to different economic development status in different parts of the world, the research abroad cannot entirely satisfy the urgent need of transnational operation risk management practice of domestic enterprises (Wu et al., 2015). Besides, most of the existing research focuses on technological innovation, localization operation, industrial clusters effect and macro-countermeasures to further transnational operation with little focus on specific regions (Buckley et al., 2007; Poulis et al., 2012). As a result, there is a large deviation between the existing risk early-warning system and the need of these enterprises for risks management practice. Zhejiang Province is the pioneer of the development of China-Africa economic and trade cooperation, accounting for more than 20% of China's trade with Africa. By the end of 2018, Zhejiang enterprises have brought its total investment fund for Africa to 3.1bn dollars, and their investment expand from traditional fields such as textile and wholesale to new fields like medicine, security, e-commerce and culture. Zhejiang enterprises actively invest, which promotes the economic development of Africa, increases local employment opportunities, brings theologies suitable for Africa and enhances independent construction capability. At the same time, Zhejiang enterprises' transnational operation in Africa is an important support for the development of external trade of Zhejiang.

In order to respond to the actual needs of domestic Africa-related enterprises for transnational operation risk management and make up for the lack of pertinence of existing research, this paper aims to construct a risk early-warning index system of transnational operation and build a risk management model of transnational

operation based on analytic hierarchy process (AHP) for Africa-related enterprises in Zhejiang. This paper also sets a transnational operation risk evaluation standard. Further, this paper evaluates the transnational operation risk of 259 Africa-related enterprises in Zhejiang in order to provide decision support for Zhejiang enterprises to carry out transnational operation in African countries.

## THEORETICAL REVIEW

Transnational operation is more complex and difficult to control because it involves the operation between different countries and regions, and the risks of transnational operation are diversified. Therefore, risk management is particularly important in transnational operation of enterprises (Oetzel and Miklian, 2017). Risk management is defined as a kind of management method that economic units control and deal with risks by using known theoretical knowledge and effective economic and technical measures after identifying risks, analyzing risks and measuring risks, and finally reduce the loss of risks to an acceptable range by the most acceptable cost or loss (Miller, 1996). It includes three stages: risk identification, risk assessment and risk response.

To improve the reliability and accuracy of risk early-warning, based on subjective assignment method, principal component analysis method and factor analysis method, a series of risk early-warning models have been proposed, including the single variables predicting model (Beaver, 1966), the Z-Score model (Altman et al., 2017), the hybrid intelligent early-warning model (Wang, 2010), the back propagation artificial neural networks (Pradhan and Lee, 2009; Cao et al., 2009). Furthermore, some scholars have constructed different risk early-warning model for transnational operation. Xie et al. (2010) proposed a dynamic transitional operation risk warning model by using the methods of logistic regression and multiple linear regression. Ge and Shi (2014) analyzed and quantified various overseas investment, and quantified the overseas investment risks as risk indexes to provide risk early-warning countermeasures for enterprises' overseas investment. Liu (2008) built a three-level prevention mechanism of transnational risk management and a transitional operation risk early-warning index system for SMEs. The dynamic transitional operation environment determines that enterprises must make timely strategic adjustments (Ahn et al., 2003). Further, Persaud (2005) put forward the corresponding risk management strategies according to the new characteristics of the risk management of multinational corporations. Wu et al. (2010) also put forward a risk prevention mechanism under the internal and external linkage between the government and the enterprise.

With the vigorous development of Chinese enterprises' transitional operation activities in Africa, the risk early-warning issues have attracted the attention of a large

number of scholars. The corporate investment in Africa offers high returns, but at the same time, enterprises face the complicated risks of law, policy, finance, culture and so on (Swanepoel et al., 2010). Besides, the investment environment of African countries is significantly different, so there are still quite a lot of difficulties in transitional operation of Africa-related enterprises in Africa, the most important of which is insufficient awareness of the risks when entering into a new country (Fosu et al., 2001). To overcome these difficulties, Africa-related enterprises should have a comprehensive analysis and investigation of the social, cultural, legal and institutional environment of Africa to fully understand the existing and potential risks of transnational operation in Africa (Zhang et al., 2013). Further, Zhang et al. (2013) classified the operating environment of various African countries in light of economic growth, international trade, human resources and other indexes, and put forward the corresponding risk management strategies. Cheung and Haan (2012) analyzed the location decision, entry path and strategy of Chinese enterprises' transitional operation in Africa, and selected several Africa countries with better investment environment. The SMEs align with other enterprises in the same industry to enter the African market, which can make up for the shortage of the SMEs and reduce the possible risks (Buhlungu, 2011). Due to the great importance of Africa, the SMEs are encouraged to enter into Africa in a cluster way and innovate the development mode of overseas parks, and effectively manage the existing and potential transitional operation risks, promoting healthy and sustainable development of enterprises (Zhang and Li, 2010).

## MATERIALS AND METHODS

The risk early-warning system of transitional operation is composed of the transitional operation risk early-warning evaluation index system and evaluation standards (Wu et al., 2010). This paper follows the principles of scientific, systematic, independent and measurable in order to improve the effectiveness of the transitional operation early-warning evaluation index system (Wang et al., 2018). 100 experts in the fields of politics, manufacturing, education, law, management consulting, and human resources management were questioned, 83 effective questionnaires collected; the effective questionnaire recovery rate is 83%.

Firstly, this paper establishes a transitional operation early-warning evaluation index system based on literature research and questionnaire survey (Modou and Liu, 2017; Mhaka and Jeke, 2018). The secondary indexes were obtained through filtering and merging of 145 transitional operation early-warning evaluation indexes selected from the relevant literatures; the primary indexes were extracted from the secondary indexes by exploratory factor analysis following the rule of Kaiser with the survey data of 83 experts.

Further, based on the transitional operation risk early-warning evaluation index system and the questionnaire data from 83 experts, the weights of the transitional operation early-warning evaluation indexes were determined by analytic hierarchy process (AHP) and Delphi. The hierarchical structure model was built using the software of Matlab 2016. The importance comparison data among each index collected from 83 experts was input into Matlab.

This paper establishes the judgment matrix among indexes and tests the rationality and effectiveness of the matrix. Then the weight of each index was automatically calculated by Matlab. According to the relevant literatures (Altman et al., 2017; Fosu et al., 2001), the standard transitional operation early-warning evaluation standard was set combined with the experts' suggestion.

## RESULTS

By exploratory factor analysis, 8 common factors with characteristic values greater than 1 were extracted from 30 secondary indexes. These 8 factors explain 62.253% of the variance of all indexes of the original scale, which are higher than the standard value of 60%. After the maximum orthogonal rotation of the factors, the load of each index on each dimension factor is obtained. The results show that the factor load of the 30 indexes is above 0.5. Executive quality, resource ability, strategic foresight, dynamic adaptability and credit level have a large load on factor 1, and the characteristic value is 7.235, which explains 24.117% of the total variance. These 5 indexes are classified into dimension 1 named strategic management risk. In the same way, the rest indexes are classified into 7 dimensions respectively named operation management risk, human resource management risk, marketing risk, supply chain management risk, financial management risk, national political risk and macro environmental risk. The transitional operation risk early-warning evaluation index system includes 30 secondary indexes and 8 primary indexes, as shown in Table 1.

The weights of 8 primary and 30 secondary transitional operation risk early-warning evaluation indexes are also shown in Table 1. The weights of financial management risk (0.2037), national political risk (0.1514) and macro environmental risk (0.1584) are greater than others so that they need more attention. The weights of strategic management risk (0.0835), operation management risk (0.1002), human resource risk (0.1042), marketing risk (0.0954) and supply chain management risk (0.1032) are also not low so that they should not be ignored. The transitional operation risk early-warning condition was divided into five levels: Level I indicates a security condition and level V indicates a crisis condition, as shown in Table 2.

## Evaluation of risk early-warning of sample enterprises

Africa-related enterprises in Zhejiang were sampled for this paper, because Africa has been an important region for Zhejiang's enterprises to carry out transitional business (Modou and Liu, 2017; Hua et al., 2016). It took nearly two and half months and nearly 300 questionnaires were distributed; 276 questionnaires were collected and 259 questionnaires were valid accounting for 86.3% of the total amount of questionnaires. Samples include 259

**Table 1.** The transitional operation risk early-warning evaluation indexes and their weights.

$B_i$	$W_i$	$C_{ij}$	$W_{ij}$
Strategic management risk [B <sub>1</sub> ]	$W_1=0.0835$	Executive quality (C <sub>11</sub> )	0.0256
		Resource ability (C <sub>12</sub> )	0.0141
		Strategic foresight (C <sub>13</sub> )	0.0052
		Dynamic adaptability (C <sub>14</sub> )	0.0141
		Credit level (C <sub>15</sub> )	0.0080
Operation management risk [B <sub>2</sub> ]	$W_2=0.1002$	Cost control (C <sub>21</sub> )	0.0091
		Quality control (C <sub>22</sub> )	0.0147
		Timely delivery (C <sub>23</sub> )	0.0162
		Safety production (C <sub>24</sub> )	0.0062
		Research and development ability (C <sub>25</sub> )	0.0180
Human resource risk [B <sub>3</sub> ]	$W_3=0.1042$	Cross-cultural management (C <sub>31</sub> )	0.0055
		Employee turnover rate (C <sub>32</sub> )	0.0869
		Compensation management (C <sub>33</sub> )	0.0174
Marketing risk [B <sub>4</sub> ]	$W_4=0.0954$	Market uncertainty (C <sub>41</sub> )	0.0224
		Scientific marketing plan (C <sub>42</sub> )	0.0096
		Marketing channel diversity (C <sub>43</sub> )	0.0159
		Consumer credit (C <sub>44</sub> )	0.0149
		Consumer satisfaction (C <sub>45</sub> )	0.0359
Supply chain management risk [B <sub>5</sub> ]	$W_5=0.1032$	Relationship with suppliers (C <sub>51</sub> )	0.1033
		Product or service value (C <sub>52</sub> )	0.0327
Financial management risk [B <sub>6</sub> ]	$W_6=0.2037$	Debt paying ability (C <sub>61</sub> )	0.0836
		Financial paying ability (C <sub>62</sub> )	0.0212
		Financial operation ability (C <sub>63</sub> )	0.0991
		Financing capacity (C <sub>64</sub> )	0.0107
National political risk [B <sub>7</sub> ]	$W_7=0.1514$	African policy changes (C <sub>71</sub> )	0.0327
		African policy support (C <sub>72</sub> )	0.0577
		Stability of African political situation (C <sub>73</sub> )	0.0609
Macro environmental risk [B <sub>8</sub> ]	$W_8=0.1584$	Foreign exchange restrictions in Africa (C <sub>81</sub> )	0.0486
		Bilateral trade agreements (C <sub>82</sub> )	0.0419
		Difference in consumption preferences (C <sub>83</sub> )	0.0679

Africa-related enterprises across manufacturing, agriculture, mining, construction, information technology, wholesale and retail and service consulting. These enterprises include limited liability companies (41%), joint ventures (19%) and so on. As for the annual sales in Africa, enterprises with sales of less than 500 thousand RMB account for 36%, with sales of 500-2000 thousand RMB accounting for 38%; sales of more than 2 million RMB account for 16%.

According to the transitional operation risk early-warning evaluation model established above, the values

of the primary indexes are represented by  $B_i$ , and the values of the secondary indexes are represented by  $C_{ij}$ . Meanwhile,  $W_i$  indicates the weights of the primary indexes, and  $W_{ij}$  indicates the weights of the secondary indexes. Through the following formula, the value of the primary risk early-warning indexes was obtained and then was matched to the corresponding risk early-warning interval to obtain the risk early-warning level and warning status of the sample enterprises. Using the comprehensive evaluation method, the 8 integrated risk values and the 30 single risk values of 259 samples were

**Table 2.** Transitional operation risk early-warning evaluation standard.

Warning level	V	IV	III	II	I
Warning range	[1.0,1.8)	[1.8,2.6)	[2.6,3.4)	[3.4,4.2)	[4.2,5.0]
Warning state	Crisis	Quasi crisis	Neutral	Quasi security	Security

**Table 3.** The results of risk early-warning evaluation of 259 Zhejiang Africa-related enterprises.

Integrated risk value (Bi)	Single risk value (Cij)	Integrated risk value (Bi)	Single risk value (Cij)
B <sub>1</sub> =3.4531	C <sub>11</sub> =3.6888	B <sub>4</sub> =3.4648	C <sub>41</sub> =2.5978
	C <sub>12</sub> =3.5917		C <sub>42</sub> =3.3095
	C <sub>13</sub> =3.3579		C <sub>43</sub> =3.6479
	C <sub>14</sub> =3.3393		C <sub>44</sub> =3.8918
	C <sub>15</sub> =4.0292		C <sub>45</sub> =3.9699
B <sub>2</sub> =3.7633	C <sub>21</sub> =2.5975	B <sub>6</sub> =3.2848	C <sub>61</sub> =2.5799
	C <sub>22</sub> =3.7414		C <sub>62</sub> =3.8455
	C <sub>23</sub> =4.0833		C <sub>63</sub> =3.7601
	C <sub>24</sub> =4.2479		C <sub>64</sub> =2.5134
	C <sub>25</sub> =3.5044		C <sub>71</sub> =2.5100
B <sub>3</sub> =3.3691	C <sub>31</sub> =3.3769	B <sub>7</sub> =2.4956	C <sub>72</sub> =2.4290
	C <sub>32</sub> =3.3699		C <sub>73</sub> =2.5509
B <sub>5</sub> =4.1154	C <sub>33</sub> =3.3656	B <sub>8</sub> =2.4886	C <sub>81</sub> =2.3333
	C <sub>51</sub> =4.1154		C <sub>82</sub> =2.5131
	C <sub>52</sub> =3.8209		C <sub>83</sub> =2.5845

calculated.

$$B_i = \sum_{j=1}^x C_{ij}W_{ij}$$

Based on relevant research, the risk early-warning evaluation standard for transitional operation of Africa-related enterprises uses a 5-point scale. The lower the score, the greater the risk is, accordingly, the higher the warning level. The results of the risk early-warning evaluation of 259 Zhejiang Africa-related enterprises are shown in Table 3.

Compared with the risk early-warning standard in Table 2 and the calculated results in Table 3, it indicates that the values of strategic management risk (3.4531), operation management risk (3.7633), marketing risk (3.4648) and supply chain management risk (4.1154) are smaller, which means that they are in a quasi-security state; the enterprises should pay attention to the trend of these specific relevant risks' changes, and timely adjust the strategies of transitional operation in Africa to reduce the loss caused by these risks. It also indicates that the values of human resource risk (3.3691) and financial

management risk (3.2848) are in a neutral level and state. In such a condition, there is no obvious problem that affects the development of transnational operation and no absolute advantage in the process of carrying out transitional operation in Africa; so these relevant risks need attention and reasonable prevention. It indicates, moreover, that the values of national political risk (2.4956) and macro environment risk (2.4886) are relatively higher, which illustrates that the 2 types of risks are in a quasi-crisis state; the normal transnational operation of enterprises has been affected. In this situation, Africa-related enterprises would suffer losses if the corresponding measures are not taken in time.

**Suggestions**

Based on the weight values of risk early-warning indexes summarized above and the risk values of 259 Zhejiang Africa-related enterprises, the following three countermeasures are proposed for transitional operation of Africa-related enterprises:

Firstly, target a transitional operation risk early-warning index system. With the increasingly rapid economic globalization and good economic development of Africa,

the Africa-related enterprises should take this risk early-warning system as the reference to carry out various forms of transitional operation in Africa, such as international strategic alliances. The enterprises should not only reinforce the exchange and interaction with African partners in order to overcome the entry barriers to African markets (Poulis et al., 2012), but also effectively manage the existing and potential transitional operation risks, so as to reduce the losses caused by the risks to an acceptable range and ensure the transitional operation in Africa normally.

Secondly, implement classified and graded measures for different types and levels of risks (Liu, 2008). Africa-related should pay more attention to these riskier indexes with lower scores and not ignore these potential risks with middle scores. Zhejiang Africa-related enterprises should focus on national political risk, macro environmental risk, financial management risk and human resource risk and pay reasonable attention to potential risks in policy environment, finance and cross-cultural by empirical research. In conclusion, Africa-related enterprises should rationalize the distribution of resources, identify and deal with risks of different importance in time as well, so as to avoid risks reasonably and keep the healthy development of the transitional operation. The specific measures are as follows:

(i) In terms of national political risk management, domestic government should build an information platform for overseas investment assessment and early-warning, actively integrate various aspects of data, and establish an authoritative and comprehensive risk assessment database (Wu et al., 2015). In the face of political risks, Africa-related enterprises should also know how to use African laws to protect their own interests and establish an independent political risk management system, especially the identification mechanism of political risks and the stop loss shock mechanism when political risks occur.

(ii) In terms of financial management risk management, in the face of foreign exchange risk and market risk brought by economic fluctuation, Africa-related enterprises should fully understand the financial policies and monetary market situation in host countries, use stable currencies as settlement currencies and buy derivative financial instruments such as futures to reduce the impact of fluctuations in the international monetary market (Tian and Yu, 2011).

(iii) In the aspect of human resource risk management, Africa-related enterprises should recruit local staff as much as possible, select and appoint local specialists, and respect the value of African employees to overcome the conflict of heterogeneous cultures. They should build a local human resource risk early-warning mechanism; maximize the potential of international human resources.

Thirdly, optimize the operation process and organizational mechanism of transitional operation risk early-warning.

The risk early-warning system is the key to developing sustainable competitive advantages. Accordingly, Africa-related enterprises should construct and optimize the operation process and organizational mechanism of transitional operation risk early-warning which consists of organization mechanism, information collection and transmission mechanism, analysis and early-warning mechanism and handling mechanism, so as to effectively support objectives of transnational operation.

## Conclusions

This paper constructs a transitional operation risk early-warning evaluation system based on the relevant literatures and survey data of 83 experts. It includes 8 primary risk early-warning indexes, strategic management risk, operation management risk, human resource risk, marketing risk, supply chain management risk, financial management risk, national political risk and macro environment risk as well as 30 secondary risk early-warning indexes. The establishment of a reasonable and effective risk early-warning evaluation system can effectively avoid various transnational operation risks and make it more convenient for Africa-related enterprises to manage transnational operation risks, and further improve the transnational operation ability of Africa-related enterprises.

This paper determines the weights of risk early-warning indexes by analytic hierarchy process (AHP) and Delphi method. The results show that macro environmental risk, national political risk, financial management risk and human resource risk had larger weights than others. Otherwise, the risk early-warning warning evaluation standard has been set which was divided into five levels and five corresponding states: crisis state, quasi crisis state, neutral state, quasi security state and security state.

Taking 259 Zhejiang African-related enterprises as samples, this paper conducts a risk early-warning evaluation on the transnational operation risks of Zhejiang Africa-related enterprises. The integrated risk values of 8 primary indexes and the individual risk values of 30 secondary indexes were obtained, as well as the early-warning level and state of the sample enterprises. The evaluation results indicate that the national political risk, macro environment risk, financial management risk and human resource risk are larger while the strategic management risk, operation management risk, marketing risk and supply chain management risk are smaller.

This paper enriches the existing research on transitional operation risk. The existing research on transitional operation mainly focuses on its origin, motivation and mode but seldom focuses on its risk. Although scholars have divided the risk of transnational operation into political risk, foreign exchange risk, management risk, operational risk and technical risk, the research on risk

early-warning of transitional operation of Africa-related enterprises is relatively insufficient. On the basis of the research on the transnational operation risk early-warning, this paper constructs transnational operation risk early-warning evaluation system for Africa-related enterprises by using both qualitative and quantitative research methods, and assesses the transitional operation risk of 259 Zhejiang Africa-related enterprises, and further propose several targeted suggestions for Africa-related enterprises to carry out transitional operation in African countries.

Due to the limitation of time and ability, there are still some shortcomings in this paper. There are only 83 groups of valid data, but the index system includes 8 primary indexes and 30 secondary indexes, so the training of the model cannot reach the optimal level. Due to the variety of risks in transnational operation, the risk segmentation is inadequate. This paper only uses the AHP method to determine the weights of the indexes that do not use a variety of evaluation methods and adopt the best for the weights not to be accurate enough. In further study, the improvement of questionnaire and more data collected can make the system more accurate; the indexes need more research and improvement. An optimal evaluation method based on the adoption of different evaluation methods to determine the weights of the indexes is needed.

## Acknowledgements

The authors thank the Humanity and Social Science Foundation of Ministry of Education of China (Grant NO. 20YJA1237) for their support.

## CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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*Full Length Research Paper*

# How crowdfunding makes museum value relevant: An Italian university museum experience

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Received 9 November, 2019; Accepted 28 February, 2020

**This study has attempted to enlarge the debate on museums relevant function, in connection to their mission to contribute to the development of the civic society. The research idea has stemmed from the issue of museum accessibility, through measured observation of a co-creation project carried out by a University Museum of Lombardy (Italy) through a crowdfunding campaign. The research has aimed at exploring the many facets of crowdfunding as a tool for advocacy in engaging users, non-users and generic stakeholders, both for the legitimacy of the museum as a “forum” and for enabling a co-creation project. Findings have provided new insights about museum management practices and opened new research into the co-creation of “relevant museum value” under an interdisciplinary perspective and at the international level.**

**Key words:** Co-creation, relevant museum value, crowdfunding, advocacy, accessibility, participation.

## INTRODUCTION

Managing museums in today's world may be highly challenging for several reasons. Among the others, the recent financial crisis, which began in the USA in 2007 and spread throughout Europe in 2008, has led to a dramatic decline in national budgets, with proportionately drastic reductions in public spending (Zan et al., 2007). In order to cope with the austerity, governments have attempted to apply new approaches of governance and management based on citizens' participation and engagement in the creation of public value (Moore, 1995; Benington, 2011).

These approaches refer to the theoretical model that places the public interests at the centre of the value co-creation (Cepiku and Giordano, 2014). Hence, the value created in those approaches is socially constructed and

consistent with the needs and priorities of the main stakeholders. Those theoretical approaches have been practically applied not only by public administrations, but also by cultural organizations, which have to achieve their mission by managing a shrinking budget (Cameron, 1971; Davies et al., 2013; Kotler and Kotler, 2000). In particular, museums, as no-profit and permanent institutions, are called to acquire, preserve, research, communicate and exhibit the tangible and intangible heritage of humanity and its environment “in the service of society and its development, for the purposes of education, study and enjoyment” (ICOM Statute, Article 3, Section 1). This general definition encompasses any type of museums, including the University ones. Their collections represent assets - such as the memory of the

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scientific or artistic heritage of the University and of its environment which need to be promoted and enhanced in order to disseminate knowledge into the society. The attention towards university museums has been increasing, in Italy at least, when the so-called “third mission” of the higher education system was introduced by the National Agency of the Ministry of Education and Research in 2012. According to this regulation, Universities undergo a quality assessment from the Ministry, not only in relation to teaching and research parameters, respectively “first” and “second” mission – but also considering the performance achieved in terms of technology transfer, continuous education and public engagement – that is the “third mission”. In this regard, university museums are directly involved in the third mission performance, as their collections have to be available and accessible for any audience. Even though the University ranking is influenced by the museum performance within the third mission, there is not a central Ministerial budget for sustaining the collections management, whereas the latter can rely only on the scant resources provided by the University. Therefore, university museums, like other public museums, must cope with the austerity by searching for additional financial resources in order to create value for their visitors and, in the meanwhile, contribute to increase the relative higher education ranking (Chan, 2016).

All these considered and acknowledging the international debate about museums role in the civic society (Cameron, 1971; Davies et al., 2013; Kotler and Kotler, 2000), this research attempts to propose a contribution to the literature on cultural heritage management, specifically focusing on the role of university in the society issue (Cameron, 1971; Davies et al., 2013; Kotler and Kotler, 2000). Particularly, this research addresses a core question that has been feeding the interdisciplinary debate still opened (Holden, 2006; Stevenson, 2013), that is: How do university museums achieve the mission through a shrinking budget?

Recent studies have explored whether and how crowdfunding could help museum managers to face the discussed challenges (Mozzoni et al., 2018; Howe, 2006). As museums managers are called upon to satisfy their visitors and to engage as many stakeholders as possible (Kotler and Kotler, 2000), crowdfunding can also work as a means of communication, that is as a way to enlarge the number of people engaging with the museum. Moreover, crowdsourcing also reflects the participants' willingness to complete crowd sourced tasks and, in the meanwhile, advocate a project (Ridge, 2013; Bonacchi et al., 2019).

According to the museum managerial approach, nowadays the use of the platform is fundamental for fostering public engagement and for facilitating the exchange and integration of resources. Notwithstanding

that, the way through which this happens requires more empirical evidence (Colurcio et al., 2016). Therefore, how crowdfunding platforms contribute to the value co-creation represents another critical issue that this research attempts to investigate.

Particularly, this study aims at understanding and thoroughly examining the relationships between the implementation of a university museum crowdfunding project and the effects of the latter in terms of public engagement, visitor behaviour, museum-visitor interaction, and the expected outcome for the stakeholders involved in the project.

Furthermore, the investigation seeks to contribute to the enlargement of the co-creation theory (Bryson et al., 2017) within the museum context, building on the Museum Value Framework (Davies et al., 2013). Assuming the critical perspective on value co-creation, this research firstly addresses the understanding of how museums can contribute to the development of the civic society, as a core function, through the development of an accessibility project. Then, it explores the role of crowdfunding in the co-creation of museum value.

This study is developed as follows. Next section critically reviews the literature on public value co-creation in university museums and on the potential role of crowdfunding in this context, thus highlighting the research gaps and refining the research questions formulation. In order to answer the latter, the critical - case study of a university museum located in Lombardy (Northern Italy) is chosen because it is particularly suitable for this investigation (Yin, 2017). There, a museum crowdfunding campaign has achieved a successful result in terms of perceived goals (financial resources gathered), since it was the only project launched by the university crowdfunding platform to be linked with the “third mission”, relating to museum collection. Moreover, several types of stakeholders were engaged by this crowdfunding project and, hence, had the chance to get to know the museum and visit it. Within this context of analysis, stakeholders are not considered passive actors, but potential players in the museum's value creation process (Colasanti et al., 2018). Thus, third section describes the data sources and the research methods (platform analysis, ethnographic observations, and unstructured interviews) used. Then, the relative evidences are presented and discussed. Finally, theoretical and managerial implications, research limitations and further developments of the study are remarked.

## **THEORETICAL FRAMEWORK**

### **Co-creation of public value in university museums**

The wide spread of austerity has led governments to

question how to approach the community in the creation of public value (Cepiku et al., 2016). In management studies, the participation in the production of goods and services by individuals who are not ‘in’ the same organization” is intended as co-creation (Ostrom, 1996; Pollitt and Hupe, 2001; Bovaird et al., 2017; Loeffler and Bovaird, 2019). The evolution of this concept is due to the involvement of individual citizens and groups of them in different phases of the value creation process (Cepiku and Giordano, 2014). Its implementation assumes the development of a “new communitarian thinking”, based on the awareness of individuals as part of a pluralistic web of communities (Etzioni, 1993). In-depth investigations have acknowledged three types of co-creation in terms of citizens’ involvement: (a) the citizen as co-implementer of activities that are fundamental for the service provision, formerly carried out only by governments; (b) the citizen as co-designer, involved in the content or process of service delivery; (c) the citizen as initiator who contributes to formulate specific service (Voorberg et al., 2015).

Agreeing with this claim, co-creation is a cornerstone for innovation based on citizen collaboration (Crosby et al., 2017). More specifically, the service management literature has used the concept of value co-creation to depict a new and promising vision of innovation (Russo-Spena and Mele, 2012). It refers to the engagement of consumers and other actors in the context of value creation (Vargo, 2009), outlined by the “Seven Co-s model” in the following settings: co-ideation, co-evaluation, co-design, co-testing, co-launch, co-consumption and co-financing (Quero et al., 2017: 412). In addition, public management research emphasizes the social aspect of this innovation by focusing on the citizen’s perspective, which shifts from consumer to value co-creator (Pollitt and Hupe, 2001). In fact, social innovation mobilises each citizen to be an active part of value co-creation (Wegrich, 2019). Hence, collaborative innovation comes out as the implementation of product, process, technology or service that is new for public organizations (Osborne and Brown, 2005).

Social innovation and co-creation are “magic concepts” (Pollitt and Hupe, 2001) not only in the public environment, but also in the context of museums (Quero et al., 2017). It is not surprising that recent museum management approaches build on the co-creation theory (Davies et al., 2013) or embed the latter in relation to the museum value development (Pencarelli et al., 2017). Nevertheless, visitors and museums co-creation is still less investigated (Conti et al., 2017).

The new museum management literature argues that one of the critical elements for the value co-creation from cultural experience consists in the capacity of museums to build networks with the audience and other stakeholders (Minkiewicz et al., 2014). In this regard, Coffee (2008: 261) argued that: “no museum is an

island”, meaning that social forces underlie museums existence, including (or excluding) various museum audiences through the cultural programme provided. Accordingly, a museum is a *locus* of social relationships among visitors and between them and the museum. Hence, accessibility is a key value driver for museums, whose “organizational culture” can influence individual and collective behaviour (Quinn, 1988; Hopper-Greenhill, 2007). Consequently, museum managers are commissioned by the society to search for public value. According to the paradigm of Public Value (Moore, 1995), engaging citizens in the creation process is the *conditio sine qua non* for providing public value. Indeed, understanding what citizens want and need without engaging them, provides merely results in public service (Scott, 2009). Nevertheless, the latter does not necessarily coincide with public value, which in the museum context refers to what Holden (2006: 14) defines, as intrinsic value, “the set of values that relate to the subjective experience of culture intellectually, emotionally and spiritually”.

The capability of a museum to provide intrinsic value for communities, a sense of belonging, is not to be taken for granted. On this matter, the Museum Value Framework identifies, in relation to the focus (internal/external) and to the knowledge and interpretative strategies (single narrative/formal source and multiple interpretation/informal sources), four types of museums: “temple”, “club”, “visitor attraction” and “forum”. Considering the latter two, which are consistent with the object of this study, they both focus on external audience/stakeholders and their perception of the museums’ functions. On the one hand, the “visitor attraction” type stresses communication towards visitors in order to satisfy their needs, identifying a customer-focused museum. On the other hand, the “forum” type, attempts to benefit society and individual well-being, stressing the museums’ function as contributing to the development of civil society. Therefore, a visit of the museum is no longer an occasional day out, but rather a drop-in service (Gurian, 2007), and its fruition becomes a cognitive process that takes place in the mind, stimulated by participatory experience and dialogue (Nielsen, 2015).

As Piber et al. (2019: 3) point out in the context of participatory cultural initiative, the audience, or part of it, is not only the visitors but also the actors in the co-creation process in various ways. It is the audience that confers legitimacy to a museum’s functions and its existence. This occurs in any public organization that is accountable for the value created to the benefit of the community by managing common resources (Sinclair, 1995). Legitimacy, indeed, is the “right to be and do something in society” (Edwards, 2000: 20). The latter implies tactics enabling organizations to achieve goals in line with certain purposes and needs recognised by the society (Martin and Capelli, 2017). Besides rational

analysis and citizens' participation, advocacy represents one of those tactics, as it aims at influencing public opinion and behaviour (Taylor and Warburton, 2003; De Cesari and Dimova, 2019). Research on this matter highlights the central relationship between (public) funding and advocacy (Arvidson et al., 2017), even though it has been generally investigated within cultural heritage sector, rather than in museum context (Fanelli et al., 2015).

However, Garrow and Hasenfeld (2012) explore the linkage between organizational identity and advocacy, underpinning the mission of the organization. On this basis, advocacy practices are fundamental for museums as levers for raising funds and developing their core functions, such as the preservation of cultural heritage, the divulgation of their aesthetic and historical values to the community and future generations (Barnett et al., 2006; Santos et al., 2020). From this viewpoint, ICT provides a valid support for the museum advocacy, boosting the public engagement and, consequently, the legitimacy of the museum (Nielsen, 2015). The online platforms could open a space for "decentralized dialogues" (Yu and Humphreys, 2013; Bruni and Caboni, 2017), extending the co-creation of value by engaging visitors, communities, citizens, entrepreneurs and other generic stakeholders. Furthermore, the relevance of new technologies has been highlighted by managerial studies focused on University museums at the European level (Pugnaloni, 2003; Martino, 2016). This evidence has also emerged in the Italian scenario, where the university collections and museums keep memory of one of the oldest higher education systems all over the world (Mozzoni et al., 2018). More specifically, those museums have to self-finance their functions even though they are embedded in the so-called "third mission" of the Italian University. In addition to the two traditional ones, like teaching and research, universities have to be accountable to the Ministry of Education and Research not only for the performance achieved in those core functions, but also in relation to the impact of the dissemination of knowledge on the society (Trencher, 2013). Required by the National Agency for the Evaluation of the University and Research System (ANVUR, 2012), the third mission of the Italian university system encompasses three main settings, that are technology transfer, continuous education and public engagement.

The latter includes the management of University collections and museums, whose performance is assessed by ANVUR indicators referring to the European guidelines (Council of Europe, Rec. 13/2005), which are related to: accessibility, financial sustainability, and communication to the stakeholders. As mentioned above, university museums have to face that challenge with a shrinking budget, as the Ministry does not provide any funds directly to University in relation to their museum

performance. Recent research on this matter encourages more investigations on that critical issue, aiming at identifying innovative practices that would enable these museums to achieve their mission - aligned with the public engagement of the University - by combining the performance in terms of accessibility, financial sustainability and communication (Mozzoni et al., 2018).

From the previous theoretical speculations, the following research question has arisen:

*1) Which factors do university museums drive to achieve their mission, according to the Council of Europe recommendations?*

### **Crowdfunding as a mean for museum value co-creation**

Research on value co-creation has demonstrated how Internet-based technology represents a privileged channel for activating interactive relationships, providing a digital space where different actors can meet and share additional information, skills, creativity knowledge as well as financial resources (Colurcio et al., 2016). In particular, the digital infrastructures which allow to open the funding support to a "crowd" referred to what is known as crowdfunding (Lasher and Cook, 1996). The latter is defined as "an open call, essentially through the Internet, for the provision of financial resources either in the form of donations (without rewards) or in exchange for some form of reward and/or voting right in order to support initiatives for specific purposes" (Lambert and Schwiembacher; 2010). Furthermore, according to Halaburda and Yehezkel, (2016), crowdfunding is a two sided mediated market, within which three main actors operate: the projects proponents, who seek financial resources for different scopes; donors, who provide financial resources to the proponents; and crowdfunding platforms, which are the intermediaries. The operating principle of crowdfunding is summarized as follows: through a public call, the project's proponents submit their idea to the "crowd", which is made up of a large group of individuals, known as donors. This call usually takes place on the Internet, through a specific online platform (Kleemann et al., 2008; Schwiembacher and Larralde, 2012; Belleflamme et al., 2013a, Casadesus-Masanell and Llanes, 2015). Once registered on the platform, project proponents provide a description of the crowdfunding campaign, especially in terms of output and outcome, the goal (funding target) and intermediate results. All this information has the task of advocating potential donors to support the project during the campaign. Furthermore, there is a minimum amount of money that a supporter can send, but not a maximum. A crowdfunding project lasts for a short time, usually some weeks or months. Moreover, platforms can have different

operating rules: some of them allow projects proponents to keep the money raised only if the campaign reaches the goal or a certain percentage of it (“all-or-nothing” model) (Hemer, 2011); others allow them to keep all of the money raised during the call, ignoring the required budget fixed at the beginning of the project (“keep-it-all” model) (Wash and Solomon, 2014).

Among the different types of crowdfunding platforms, such as donation-based, reward-based, loan-based and equity-based (Mollick, 2013; Schwienbacher and Larralde, 2012; Meyskens and Bird, 2015; Futko, 2014), the former considers donors as philanthropists who do not have any expectations in exchange for their support (Mollick, 2014). Within donation-based platforms, all those wealthy people who are willing to donate their money to a good cause, expecting no type of return, compose the “crowd” (Belleflamme et al., 2013b). According to Meyskens and Bird (2015), the donation-based model creates high social value, but low economic value. Indeed, donors are not interested in generating income, since they are focused on the social benefit created by their donations. On this basis, that model is suitable for cultural organization funding. Therefore, crowdfunding could be the tool through which cultural organizations can engage a larger “crowd”, by encouraging transparency and accountability (Legget, 2009; Wheat et al., 2013; Colasanti et al., 2018). Relating to this perspective, knowledge and information sharing with donors can be a critical success factor for a crowdfunding campaign in terms of output (Leone and Schiavone, 2019; Viotto da Cruz, 2018).

According to recent studies (Eiteneyer et al., 2019; Viotto da Cruz, 2018), crowdfunding is not only a way to gather financial support from donors, but it is also an opportunity to interact with several types of actors. Although it has been acknowledged that crowdfunding frames the context in which value creation takes place (Quero et al., 2017), more in-depth investigations on how it occurs, in terms of network among actors involved, activity and resources for creating value and different types of value created in that collaborative process, are still called.

In this perspective, the following research question came out:

*2) How does crowdfunding enable university museums to co-create public value?*

## METHODOLOGY

Taking into consideration the epistemological point of view, this study is based on an interpretative approach, which keeps the standards of qualitative studies. In order to acquire deeper knowledge and awareness of the context of analysis, an explorative case study is carried out (Yin, 2017). The case is represented by a museum that is part of the Museum System of an Italian University in Lombardy (Italy). The choice of this case study is justified by the

success of the fundraising campaign arranged by this museum through the university crowdfunding platform. The University Museum (hereby UM) case study, indeed, represents an example of successful participatory cultural initiative, because it achieved and surpassed the funding goal (€ 5.000,00) in only four months (March-June 2017), during which the platform launched numerous research project against cancer and on 3D biomedical devices for healthcare diagnosis. Moreover, the University crowdfunding platform had previously shown other two cultural heritage projects, which unfortunately did not achieve the goal required.

During this period, several events of public engagement were organized, both linked to the on-line crowdfunding campaign and to more general fundraising purposes, in order to promote, and raise money for the cause. The aim of the crowdfunding project was to make the permanent collections of the Museum available to all visitors, with specific attention to people with disabilities, who were actively involved in the project. Hence, the case study is particularly relevant because of the role of the several and varied stakeholders engaged in the value creation process (21 donors composed of individuals, associations, local entrepreneurs, corporations).

In order to identify the actors involved in the crowdfunding campaign, secondary data from the University crowdfunding platform have been analysed. Moreover, the ethnographic approach (Dey, 2002; Spradley, 1979) has been considered suitable for exploring the crowdfunding functionality under the advocacy and the co-creation perspectives. It was carried out by attending the back stage of the UM submission in the University crowdfunding platform, the kick-off event of the UM crowdfunding project, that were all cultural initiatives run for increasing the sensibility of people toward the social inclusion as a cultural policy issue (Sandell, 2003). Attending these Museum’s initiatives, lasted about three hours each, enabled the researcher to verify directly their impact on the crowdfunding campaign in terms of number and types of donors, as measures of advocacy and museum project legitimation. The performance information has been recorded by the UM and reported on the University crowdfunding platform in the project section for public accountability. Additionally, the triangulation of the data, results and interpretations (Ryan et al., 2002) has been achieved by unstructured interviews to the UM project team (the UM curator, the Rehabilitation Centre of Visual Impairment of the Regional Hospital, the 3DLab Research Centre and the Department of Civil Engineering and Architecture of the same University) who was asked to talk about the crowdfunding experience under their professional perspective.

The interviews have been carried out in two moments: at the launch of the crowdfunding campaign, in order to investigate the professional contribution of the UM project team to the value co-creation project, as well as and at the end of that, in order to understand the further steps of its development. In details, three open questions have been asked to the four actors engaged in the UM project. At the launch of the crowdfunding campaign, all interviewees answered to:

- 1) *What motivations are underpinned by this project?*
- 2) *What will be your contribution to the value co-creation?*
- 3) *What are the expected results of the crowdfunding campaign?*

At the end of the crowdfunding campaign, the following questions have been posed:

- 1) *What activities will be carried out for the project development?*
- 2) *Will it be necessary to involve other actors for the development of these activities? Which ones?*
- 3) *What is the expected value from the development of this project in relation to the museum’s mission?*

The texts of all interviews, lasted about 30’ each, have been

recorded and transcribed by adopting the MAXQDA2020 program for social science-oriented data analysis.

The *in-vivo* coding has been based on the conceptual categories identified in accordance with the consulted literature. The interviews, together with the information gathered by the crowdfunding platform and by attending all the events aforementioned, have been used for the case study analysis and further discussion.

### The case study

From the analysis of the case study, carried out through the application of the three research methods mentioned above, evidence aligned with the cognitive objectives of the present study has sprung - up.

## RESULTS

### Results from the platform analysis

UM is one of the eight museums belonging to the University Museum System, and its collection exhibits the history of the electrical devices applied in industry, communication and in domestic living environment. At its first decade of activity (March 2017), the museum decided to organize and submit a research project on social accessibility to the University crowdfunding platform. Looking at the project explained on that platform, the UM's aim was to make the permanent exhibition accessible to all potential visitors, including the visually impaired and blind people.

Before launching the crowdfunding project, UM had already created a tactile map, with the aid of Lombardy Regional Law 39/74, 2016. A team of researchers and University professors (3DLab Centre and the Department of Civil Engineering and Architecture) designed the map and built it by using 3D printing technology. Furthermore, the Regional President of the Italian Union of the Blind and Partially Sighted validated the functionality of the map. Further vital contributions and support were given by the team of the Rehabilitation Centre of Visual Impairment of the Regional Hospital. Their experience in solving the everyday problems of people with acquired visual impairment allowed the staging to be targeted and to verify the effects. In order to take on active roles in the preparatory stages of the project, users and patients first experienced the museum exhibition spaces through touch, and also sensation, and in general perceiving the museum experience beyond 3D printing.

The object of the crowdfunding project was to complete the exhibition path for blind or partially sighted people by means of new technological devices. More specifically, the latter are represented by three components, each linked to an App that enables visitors to listen to the story of the object that they can touch along the route. These devices are labelled "Museum map of Tactile Experience" (MTE).

During the fundraising campaign, the platform updated

the amount of financial resources received, the type of donors and the remaining time within which it was necessary to achieve the goal of € 5,000 by the end of June 2017.

With this amount of resources, the Museum would have obtained a co-financing from the crowd to complete the museum path, for the visually impaired and blind people, with the support of the University budget and the contribution of the Lombardy Region. This was specified by the research team through the project and the video-telling available on the platform.

At the end of the campaign, the museum raised 134% of the resources requested from the crowd, thanks to the contribution of 21 stakeholders (event's participants, industrial associations, local entrepreneurs, public institutions).

### Results from the ethnographic observations

Most of the donors who made it possible to achieve and exceed the minimum of financial resources required to the crowd, in order to co-finance the museum project, have visited or attended at least one of the events arranged by the museum during the 4 months of the crowdfunding campaign.

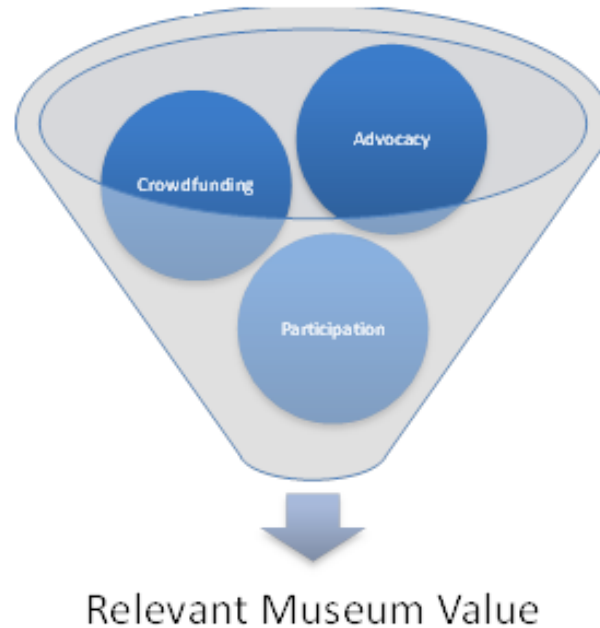
The number of donors represented by visitors was 1,204, whose contribution was enough to reach the goal.

The participatory cultural initiatives were made up of 3 cultural workshops in March 2017, 2 performing art events for museum visits respectively in April and May 2017, 2 Creative Lab for Kids and Families in and 2 ateliers during two months of the campaign.

All initiatives started with the presentation of the crowdfunding project, with the purpose to make the audience aware of the objective of the fundraising and specially to stress the value that they would have contributed to co-create for the welfare of the community.

During that presentation, the UM staff stressed the social inclusion as a museum value. The curator declared, all the times, how the UM aims at feeding and satisfying the curious visitors who want to know about the history of the electrical technology and their inventions and inventors. The curiosity, indeed, is perceived by both children and adults in complete possession of all five senses or not. This challenge has been stressed in order to increase the sensibility of the event participants towards the project, which would enable blind or visually sighted adults and children to "touch" the science, experiencing something new and exciting at UM.

From the observation of the behavior of the attendants who, after the visit, proceeded to the donation, it emerged how direct interaction with the museum was important under the advocacy perspective. The museum attracted the visitors and dialogued with them as in a "forum", according to the Museum Value Framework (Davies et al., 2013); after the donation occurred, the value co-



**Figure 1.** The three components of the relevant museum value.  
Source: own elaboration.

creation project was run. In other words, participation, advocacy and crowdfunding have enabled the Museum to co-financing public value creation, considered “relevant” by the crowd for the well-being of the society (Figure 1).

### Results from the interviews

During the interviews at the crowdfunding launch, the curator declared that the motivation to develop the project of a new collection path was aligned to the museum mission to enable all visitors, including blind or visually sighted adults and children, with a common sense of curiosity/knowledge, to “touch” the science, experiencing something new and exciting at UM. The Rehabilitation Centre of the Regional Hospital decided to be part of the project team in order to develop a new rehabilitation practice for their patients in that University Museum, characterised by huge spaces (more than 2,500 metres squares) and collections that can be touched. The Department of Civil Engineering and Architecture accepted to be engaged in this project because it could be a way to extend the research topic on accessibility within the engineering studies. The 3D Lab Research Centre participated to the proposal with the aim to create a product innovation.

As for the contribution to the value co-creation, the UM curator answered to the related question stressing the

effort of the Museum, in terms of additional working time and human resources, to arrange new participatory cultural initiatives in order to extend the audience and make it aware of the intrinsic value of the project based on the principle of accessibility. In fact, the latter is recognized by the UN Convention on the Rights of Persons with Disabilities, which states the importance of the participation of people with disabilities in cultural life, recreation, leisure and sports (Art. 30). The Rehabilitation Centre of the Regional Hospital has committed itself to involve patients in this experimentation and to test the prototype devices. The Department of Civil Engineering and Architecture provided value as co-designer of the Museum accessibility devise, while the 3D Lab Research Centre contributed to co-implement the latter by experimenting new materials, considered more suitable for the touch of the section map by the visual impaired and blind visitors.

The expected results of the crowdfunding campaign, pointed out by the UM curator, referred to the participation of the devoted visitors to the events arranged for this purpose, as well as to facilitate the project advocacy through the project presentation *in situ* and through the transparent and updating communication about the intermediate results on the platform. The Museum attempted to increase not only the sensibility for the accessibility, as acknowledged by Human Right, but also the contribution of the crowd to sustain the project within the museum context. The Rehabilitation Centre of the



Regional Hospital expected the enthusiastic participation of patients from this project, given the novelty of the rehabilitation practice. In addition, the opportunity of training for medical students who wanted to specialize in rehabilitative ophthalmology was another expected result. On the University Department and Research Lab side, the possibility of increasing engineering knowledge on accessibility devices and promoting a new product for the blind and visually impaired have been expected in case of the successful crowdfunding campaign.

From the interviews done at the end of the project, interesting evidence sprang up. The UM curator declared that the first steps of the project development would have been the record of the audio-guide for the Museum map of the Tactile Experience (MET) and the Implementation of the pedestrian-tactile path, as recommended by the patients of the Rehabilitation Centre of the Regional Hospital, which tested the preliminary results of the devices crafted. These innovative applications have required specific competences outsourced by UM to high tech company, audio-maker entrepreneurs and by a manufacturing enterprise. The development of that sensory exhibition would have been able to provide a new museum experience in force of the accessibility principle, legitimizing the public investment. The Rehabilitation Centre of the Regional Hospital contributed to record the audio-guide for the MET and to test its efficacy for the therapy. That audio production required the collaboration of the patients as well as of the Medicine students who were engaged in that training. The development of this UM project allowed that Hospital Centre to implement a new practice of visual rehabilitation and, in the meanwhile, to provide a new specialised ophthalmology course.

The activity of the Department of Civil Engineering and Architecture, carried out by a researcher team, consisted in co-designing the App, together with the other members of the project team and in collaboration with the Italian Union of Blind and Visual Impaired people. The co-creation of MET enabled that Research Unit to introduce a new research pathway, to public new scientific products, and to add new contents in the engineering course focused on accessibility. Similarly, the 3D Lab Research Centre, as co-implementer, collaborated the development of the MET by producing the tactile map section posed as MTE cover, and so that co-created an innovative product through an innovative process carried out by an interdisciplinary research network.

The summary of the content analysis findings aforementioned is shown in Table 1.

## DISCUSSION

The case study highlights how co-creation is strictly bound up with the mission of museums as contributors to

the development of civil society. The evidence from this research has demonstrated how a university museum must face a big challenge in order to extend the accessibility of the collections, considering the scant resources available for its management (Mozzoni et al., 2018). The *condictio sine qua non* for achieving this goal is co-creation based on the capacity of UM to build network with the audience and other stakeholders, moved by motivation linked to the museum project objective (Minkiewicz et al., 2014). This capacity is implied in the managerial approach of the Museum as “forum” (Davies et al., 2013), where the interaction with the audience and generic stakeholder is yet embedded in the organizational culture as social practice. The dialogue with the public has been developing *in situ* and by digital space in order to trigger public engagement and advocacy. This latter represented a lever for legitimising the museum functionality under the community perspective and stimulated the co-financing of the value creation (Stevenson, 2013).

Therefore, relating the first research question, the case study has demonstrated how advocacy, participation and crowdfunding are three critical factors that have driven the UM to achieve the mission in terms of accessibility, financial sustainability, and communication, according the Council of Europe recommendations. The synergic contribution of these pillars (Figure 2) was critical for the UM project result. Indeed, without the participation of the visitors to the UM events, and the advocacy *per sé* induced by the dialogue between the latter and the Museum staff, the crowdfunding campaign would have not been able to stimulate the co-financing of the project (Coghlan, 2018). This is due to the fact that crowdfunding culture is not yet widespread but still uncommon in the Italian context, especially at the University level, considering that the first University crowdfunding platform in Italy was dates back to 2014.

Nonetheless, the accessibility project required funds from different financial sources, such as regional funding calls and sponsorships. The UM decided to turn to crowdfunding, being aware of its advocacy function.

In this regard, the case study could answer to the second research question. The crowdfunding platform was able to create a digital space where UM and stakeholders have exchanged financial (the amount of donation) and managerial information (type of donors). Therefore, it provided a room for decentralized dialogue (Yu and Humphreys, 2013), knowledge (Leone and Schiavone, 2019) and information (Viotto da Cruz, 2018) sharing between the museum and the community (Etzioni, 1993). As such, the university crowdfunding platform allowed UM to guarantee a digital communication with the stakeholders, based on transparent and updating information. This kind of communication is a prerequisite to facilitate the exchange and integration of resources through new technologies (Colurcio et al., 2016). The

**Table 1.** Textual evidences from the interviews' analysis

<b>Interview Contents (at the launch of the crowdfunding campaign)</b>	<b>UM curator</b>	<b>Rehabilitation Centre of Visual Impairment</b>	<b>Department of Civil Engineering and Architecture</b>	<b>3D Lab Research Centre</b>
Motivation	Museum Accessibility	New rehabilitation practice	New Research area	Product Innovation
Contribution to value co-creation	Cultural Events Project Presentation Extended visiting hours	Engaging patients Testing the prototype of device	To design a new engineering device for museum accessibility	To experiment new materials for the 3D section map To specialize competences
Expected results	Visitors Participation Advocacy Donations Financial sustainability Transparency Communication	Patients participation Medicine students training	To extend engineering knowledge on museum accessible deviZce	To tailorise an innovative product for blind and impair museum visitors
Interview Contents (at the end of the crowdfunding campaign)	UM curator	Rehabilitation Centre of Visual Impairment	Department of Civil Engineering and Architecture	3D Lab Research Centre
Activity	MET App Pedestrian-tactile path	Contribution to the audio-guide Test the device	To design the section maps over the App	To craft the section maps over the App
Who engages	High tech company Audio-maker enterprise Manufacturing enterprise	Medicine student and PhD students Patients	Italian Union for Blind and Visual Impair people Researcher Team	Italian Union for Blind and Visual Impair people Specialised Team
Value Expectation	A new Museum Experience Public Consensus (legitimation)	Provide a new form of rehabilitation New specialized doctors	New research pathway New scientific publication Extended teaching course on Civil Engineering and Accessibility	Product and Process Innovation

Source: own elaboration.

crowdfunding platform built the relationship between the UM and the community and fostered

the ones within the project team. Relating to the latter, the contribution to value creation from all

members of the project team was highlighted by the digital project, as well as through the video



**Figure 2.** The UM crowdfunding Project and the research development results  
Source: own elaboration.

posed on the platform. In fact, the content analysis has clearly shown how the Rehabilitation Centre of the Regional Hospital, the Department of Civil Engineering and Architecture and the 3D Lab Research Centre firstly co-created value in terms of co-launch of the UM project, co-ideation of the devices, co-design them, and co-test the prototype version of the MET App. The co-consumption of the preliminary output of the UM project engaged the end-users (the blind and visual impair patients of the Rehabilitation Centre) as co-initiators of public value creation (Moore, 1995). In this sense, Tzortzi (2014) argues that visitor navigation is critical for understanding any museum collections' meanings and for transforming experience beyond physical infrastructures. Indeed, UM attempted to enable blinded and sighted people to touch and feel this experience by applying innovative technological devices co-created by the interdisciplinary work-team to the collections. The tactile map, combined with the app of the three MTE devices was created by engaging the patients of the Rehabilitation Centre of the Hospital as end-users. Visually impaired adults and children were invited several times by the Museum to explore the collections through this technology, in order to test the validity of the materials adopted, the effectiveness of the technology applied to the latter, and their perception of the experience. Indeed, they expressed a desire to add a pedestrian-tactile path to enable them to approach the collections on their own, contributing to formulate a relevant museum (and public) value (Colasanti et al., 2018; Eiteneyer et al., 2019; Gurian, 2007). Once the campaign was completed, the museum started the App development process (MET). During this stage, the co-creation phase has been carried out by an extended network made by the project research team in collaboration with both local enterprises and patients to co-evaluate the functionality of the output of this social innovation project (Figure 2) (Eiteneyer et al., 2019; Leone and Schiavone, 2019).

## Conclusion

The new museum management approach underlines how

the relevant value able to meet the visitor need consists in providing a memorable experience and/or a personal transformation at the emotional, intellectual or spiritual level (Pencarelli et al., 2017). This is valid also for university museums, which are deemed to play a key role for the performance of university connected to the technology transfer, continuous education and public engagement. In the Italian context, such dimension of performance has been institutionalized within the so called third mission of the higher education system. The challenge to perform better with scant resources has stimulated University museums to adopt new managerial tools in order to achieve their mission that is evaluated by ANVUR in relation to the three principles as accessibility, financial sustainability and communication.

Considering the low attention paid to this issue so far (Mozzoni et al., 2018), the UM case study has contributed to the debate with some insights within the value co-creation theory. More specifically, the research has identified three pillars of "relevant museum value" - that are participation, advocacy and crowdfunding - as an experience for specific audience, represented by the blind and visually impair visitors. These pillars are key value drivers that enabled UM to perform under the assessment criteria aforementioned. In fact, accessibility implies audience participation (Brawne, 1982), as the more the visitors achieved, the better the museum will perform, especially if it attempts to include different targets according to the principle of social inclusion (Sandell, 2003). The performance will be even higher if the museum engages visitors in the creation of value from its ideation, design and implementation. The UM case study demonstrated that this could happen through a transparent and updating communication, applying both digital and traditional tools. Even though the new technologies are fundamental for facilitating interactive relationships, museums should integrate the real and the virtual space of dialogue in order to engage different actors in value creation processes (Pencarelli et al, 2017; Bruni and Caboni, 2017). However, the efficacy of communication could be appreciated in terms of the advocacy of the cultural project by the community (De Cesari and Dimova, 2019). The capacity of the museum to influence the behaviour of the public, stimulating its

engagement on the value creation process, is boosted by the direct relationship as well as through online platform. Advocacy led stakeholders to co-financing the UM project through the crowdfunding campaign, thanks to the financial and managerial information sharing. Moreover, the crowdfunding platform provided public accountability about the financial performance achieved by the UM project during the campaign. This donation-based model allowed to create a trusty network between project team and the community and, in the meanwhile, to legitimate the museum value co-creation (Stevenson, 2013). In other words, crowdfunding has represented, in this case study, an innovative tool for boosting the financial sustainability of the project. It was a *conditio sine qua non* for starting the value co-creation process. In fact, participation and advocacy have been prerequisites for strengthening the effectiveness of crowdfunding: without them, it would have been difficult to achieve the goal in a context where fundraising is still marginal.

Moreover, the three pillars can be used by the management to enhance strategically user's behaviour, engagement and co-creation only if the "organizational culture" of the museum is based on openness towards interdisciplinary integration and network (Hopper-Greenhill, 2007). It does occur in participatory museum characterized by the *modus operandi* as forum (Davies et al., 2013).

This research underpins some limitations, such as the focus on a single-case study and the exclusive consideration of the museum and project team viewpoints. Nevertheless, some theoretical and managerial implications deserve to be presented. Under the former perspective, the study has demonstrated how accountability should be guaranteed for fostering the effectiveness of the crowdfunding platform in value co-creation (co-financing) and for networking. In addition, the three pillars model induced University museum to reflect on performance measurements system suitable for self-assessment within the strategic areas identified by ANVUR. This issue should be a new research path worth investigating in Italy as well as at the international context.

The managerial implications of the study regard some different aspects. First of all, the relationship between University and community should not be taken for granted, as since the recognition of the "third mission", Italian University system has typically been perceived detached from the surrounding environment and the related museums have been considered like "storage" or, at best, research labs. This explains the remarkable effort of University museums to achieve their mission, by engaging community in value co-creation for the well-being of society. The UM crowdfunding campaign has contributed to increase the visibility of the museum as well as the community awareness of its social-economic impact.

Moreover, the platform was structured in a way to create network among the team project and the

stakeholders (entrepreneurs, associations, visitors, public institutions), demonstrating how University museum could activate the cultural and creative eco-system.

At the same time, the outcome of the UM crowdfunding has improved the university ranking under the third mission perspective, in terms of public engagement. Moreover, the interdisciplinary competences required by museum accessibility project leads to develop new professional profiles and to update the academic program, boosting the linkage between university and the job-market.

All these implications need more investigations for their generalization, extending the perspective of the analysis to all the stakeholders' viewpoints, within the university museums context at the national and international levels.

## ACKNOWLEDGEMENTS

The author is very pleased with the Curator of the University Museum, the Head of the3DLab Centre and the Department of Civil Engineering and Architecture of the University, the staff of the University Crowdfunding Service and the Head of Rehabilitation Centre of the Regional Hospital for their insightful support on the development of the case study. Last but not least, the author thanks the reviewers of this article for the useful suggestions given in order to improve and make it ready for publication.

## CONFLICT OF INTERESTS

The author has not declared any conflict of interests.

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